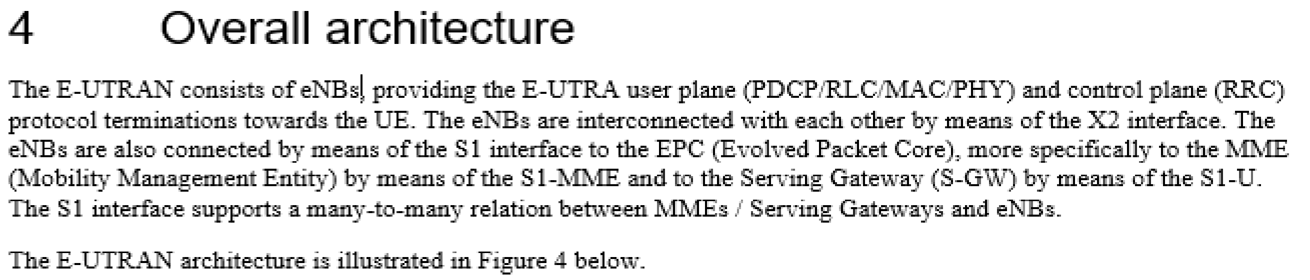
EXHIBIT E

Plaintiff's Infringement Contentions to Ford

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, Ford's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* Ford's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Ford offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

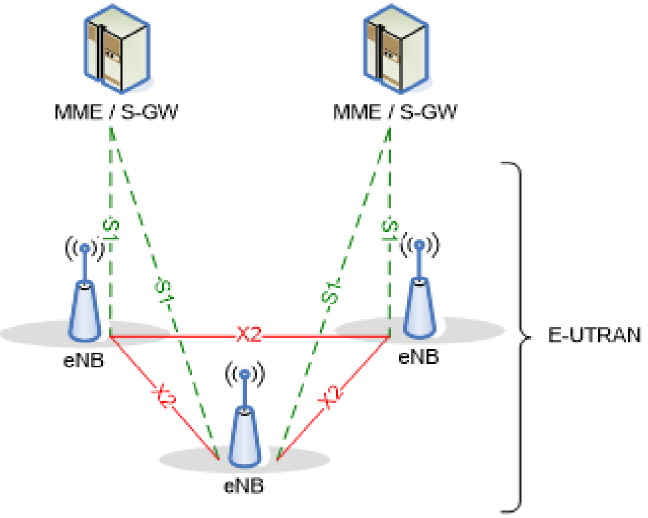
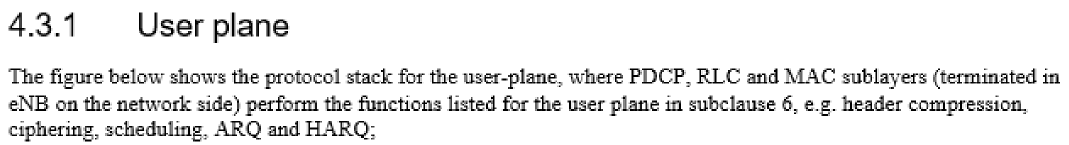


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

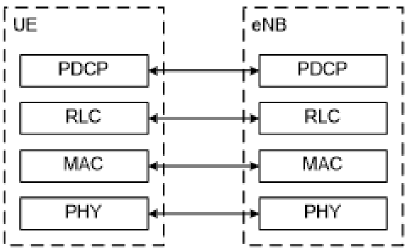


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

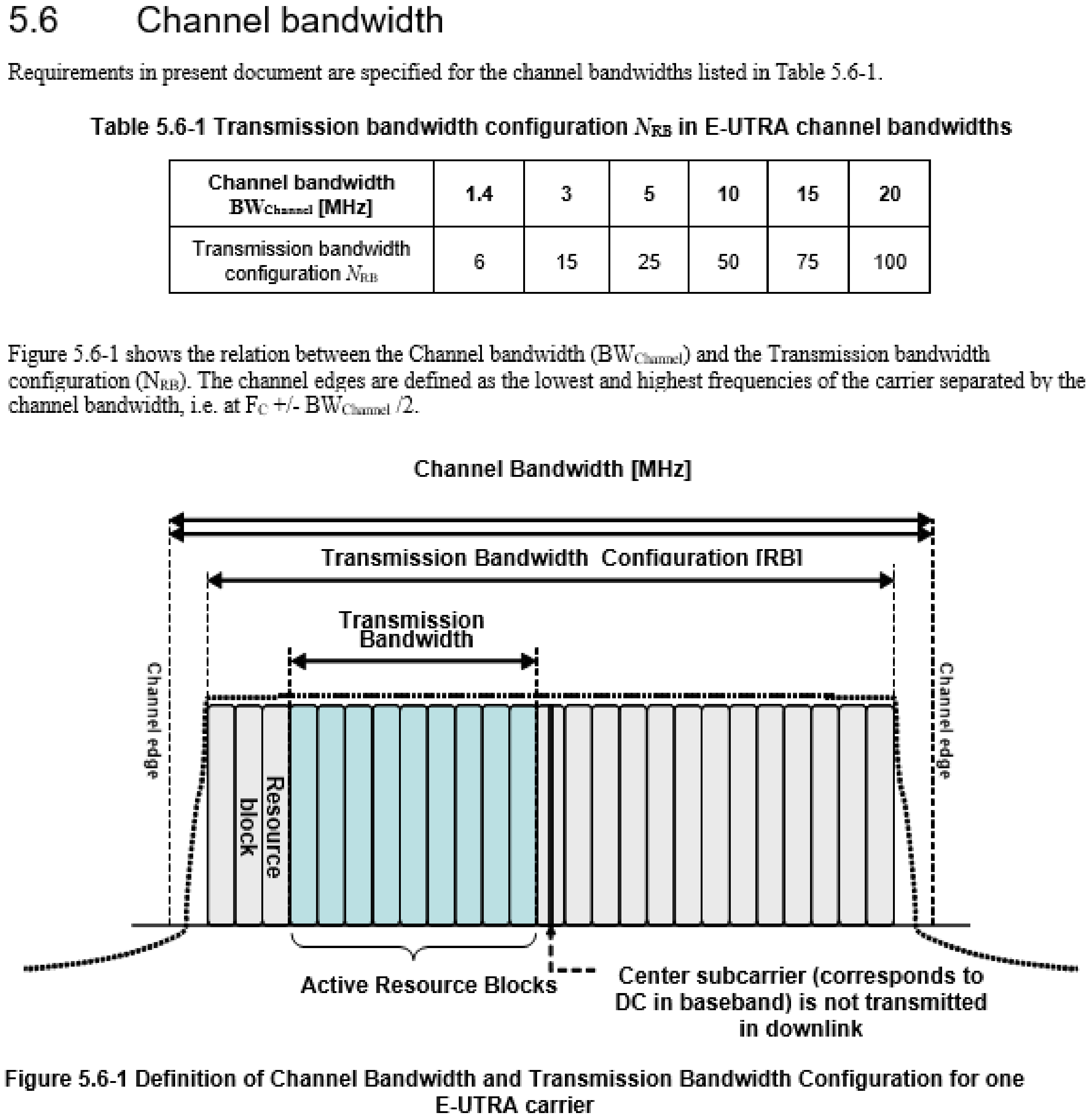
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Ford’s Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, Ford’s Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

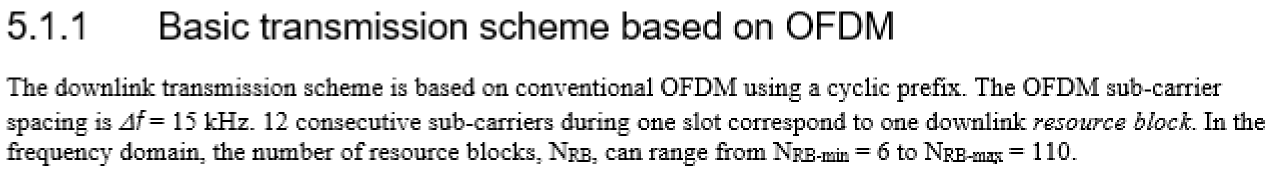
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

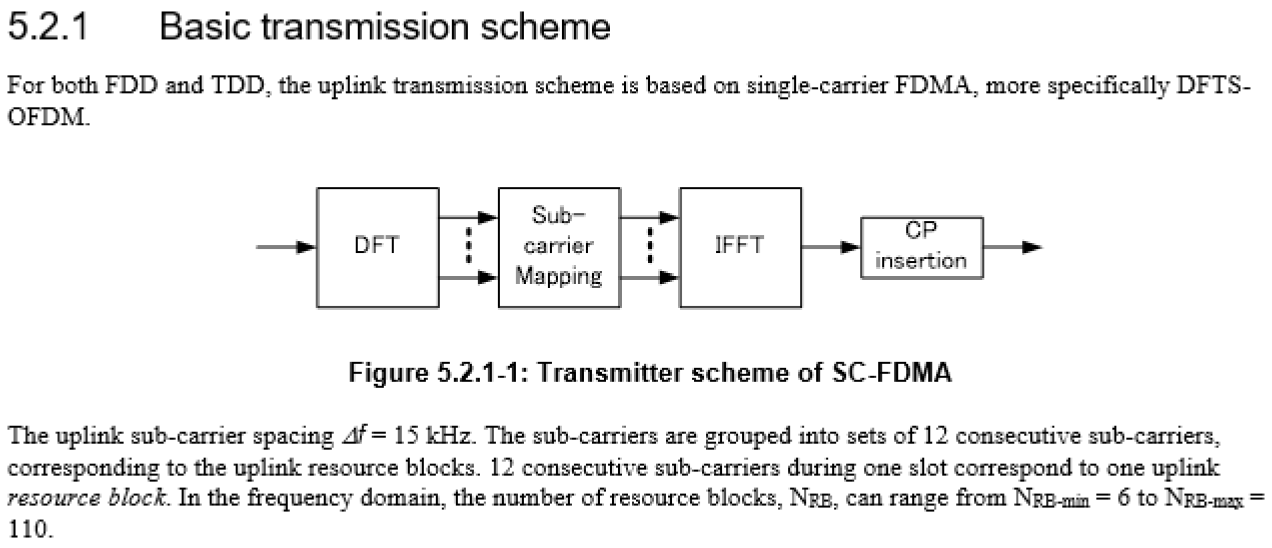
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

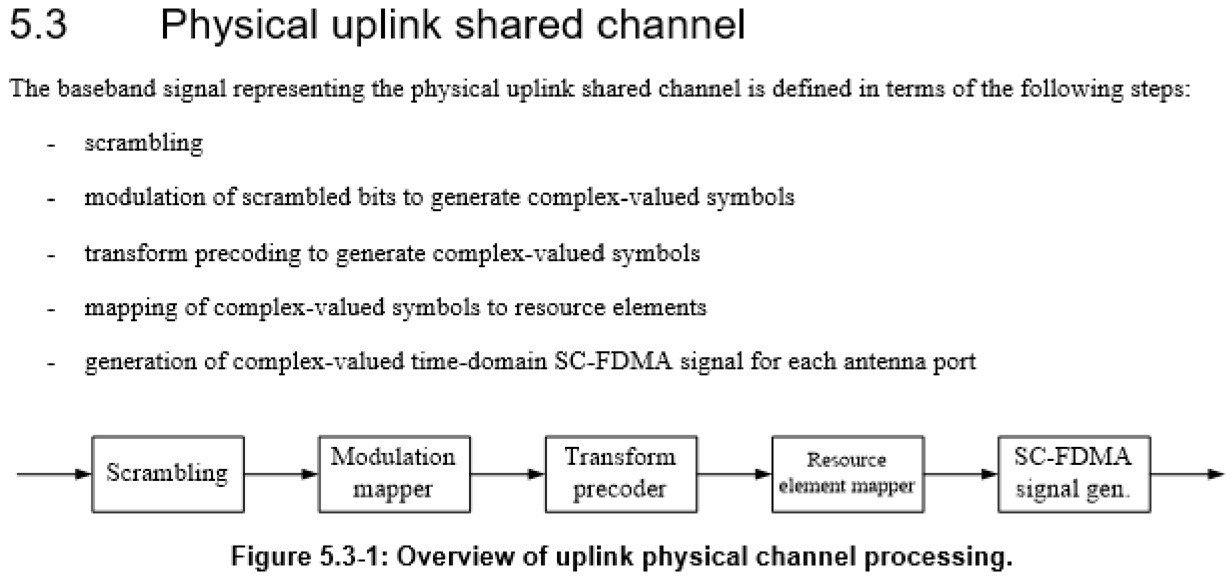
The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”



5.3 Physical uplink shared channel

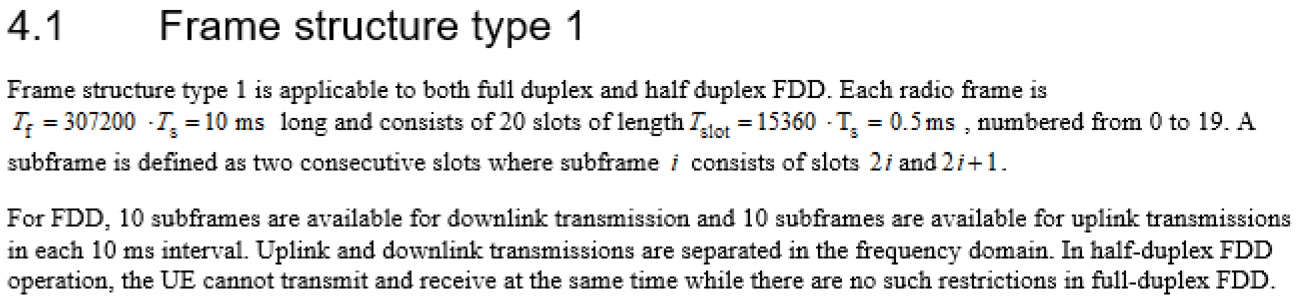
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\ \text{ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\ \text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

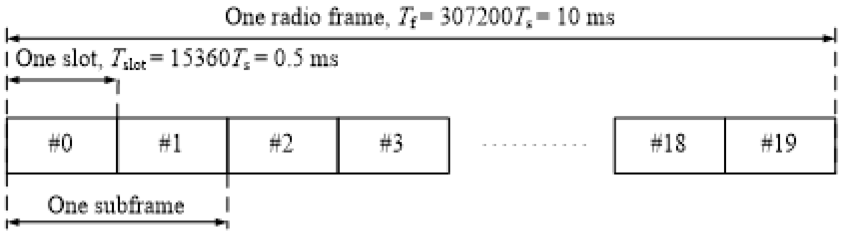
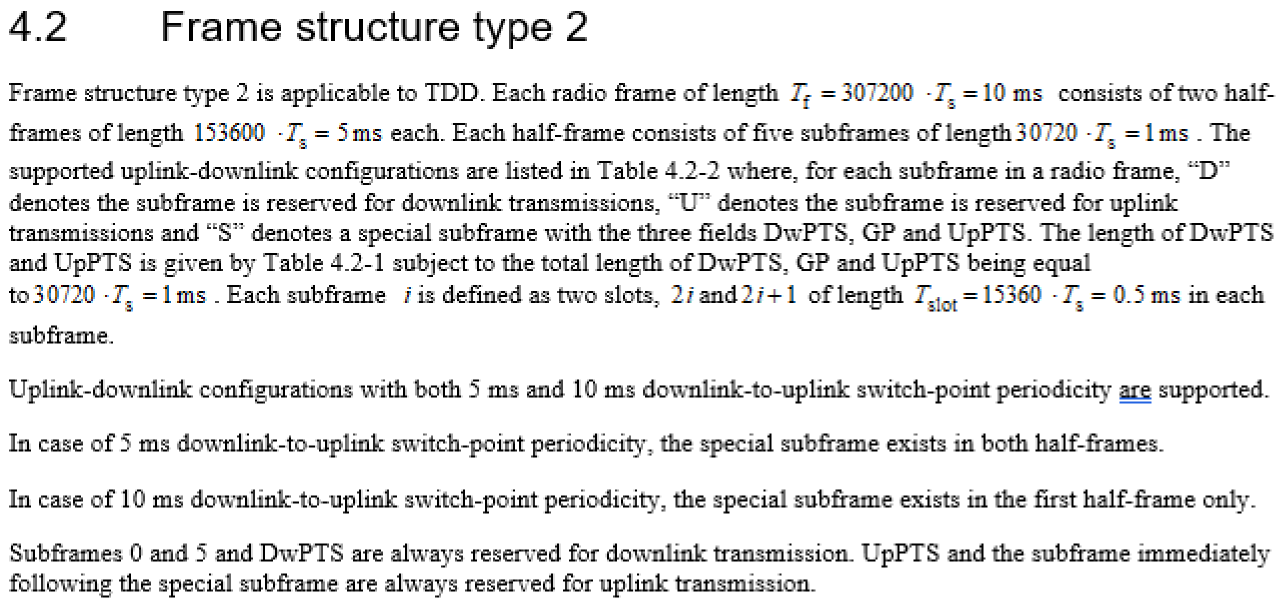


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

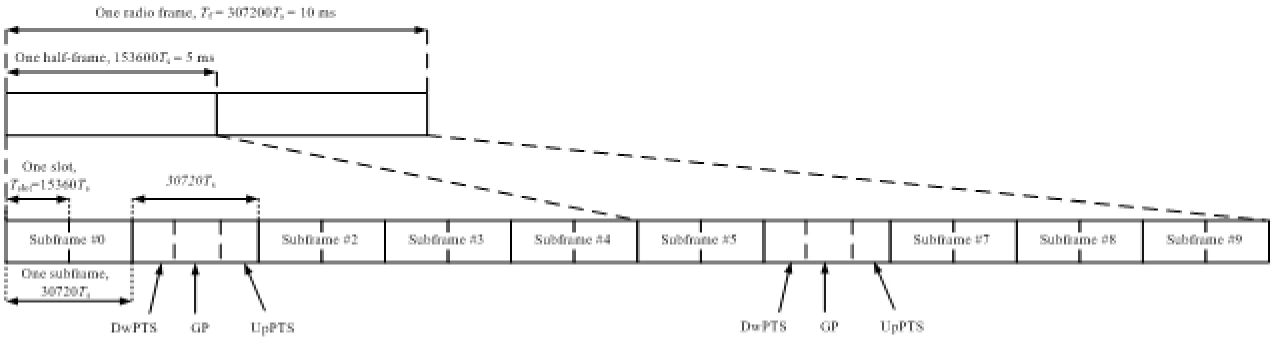
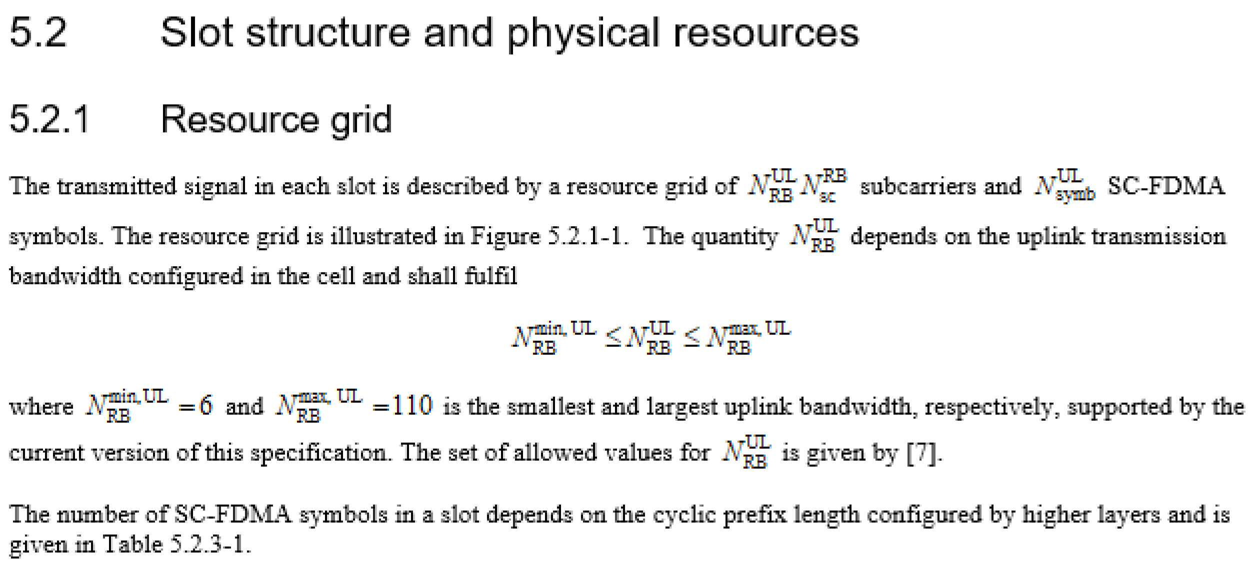


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{RB}^{UL} N_{sc}^{RB}$ subcarriers and N_{symb}^{UL} SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity N_{RB}^{UL} depends on the uplink transmission bandwidth configured in the cell and shall fulfil

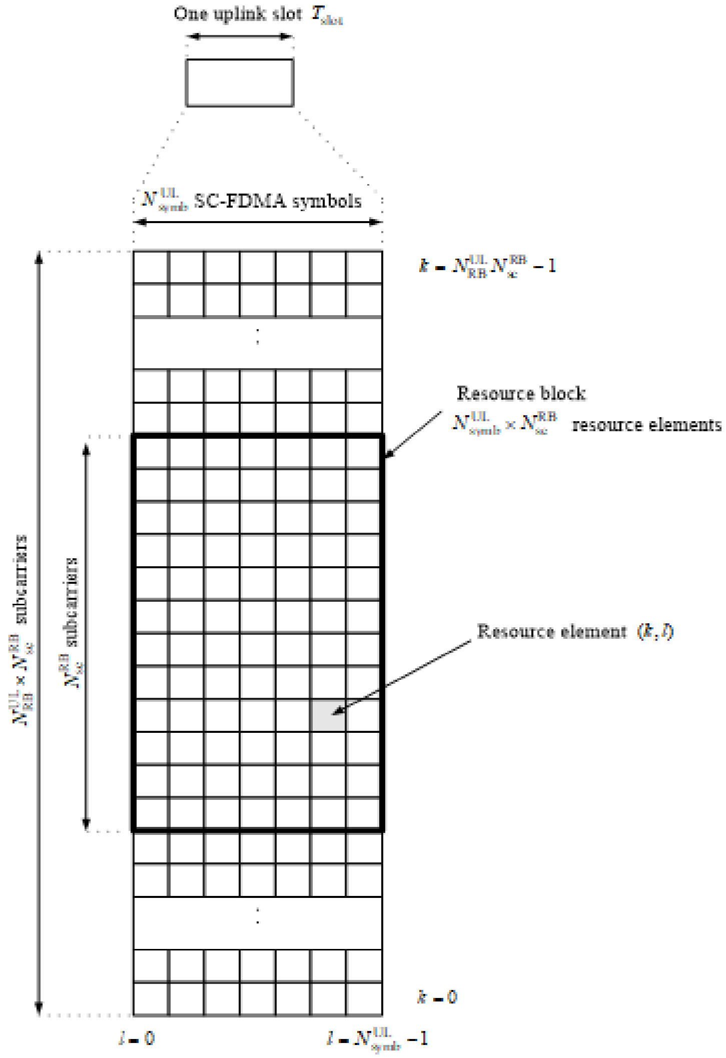
$$N_{RB}^{min,UL} \leq N_{RB}^{UL} \leq N_{RB}^{max,UL}$$

where $N_{RB}^{min,UL} = 6$ and $N_{RB}^{max,UL} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for N_{RB}^{UL} is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

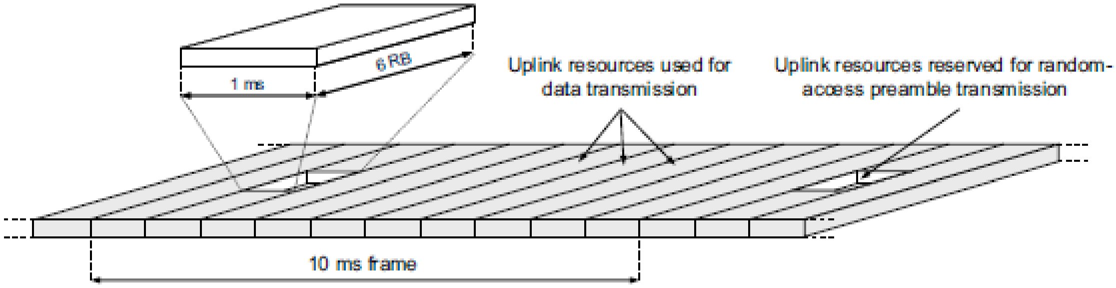
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 1(b)

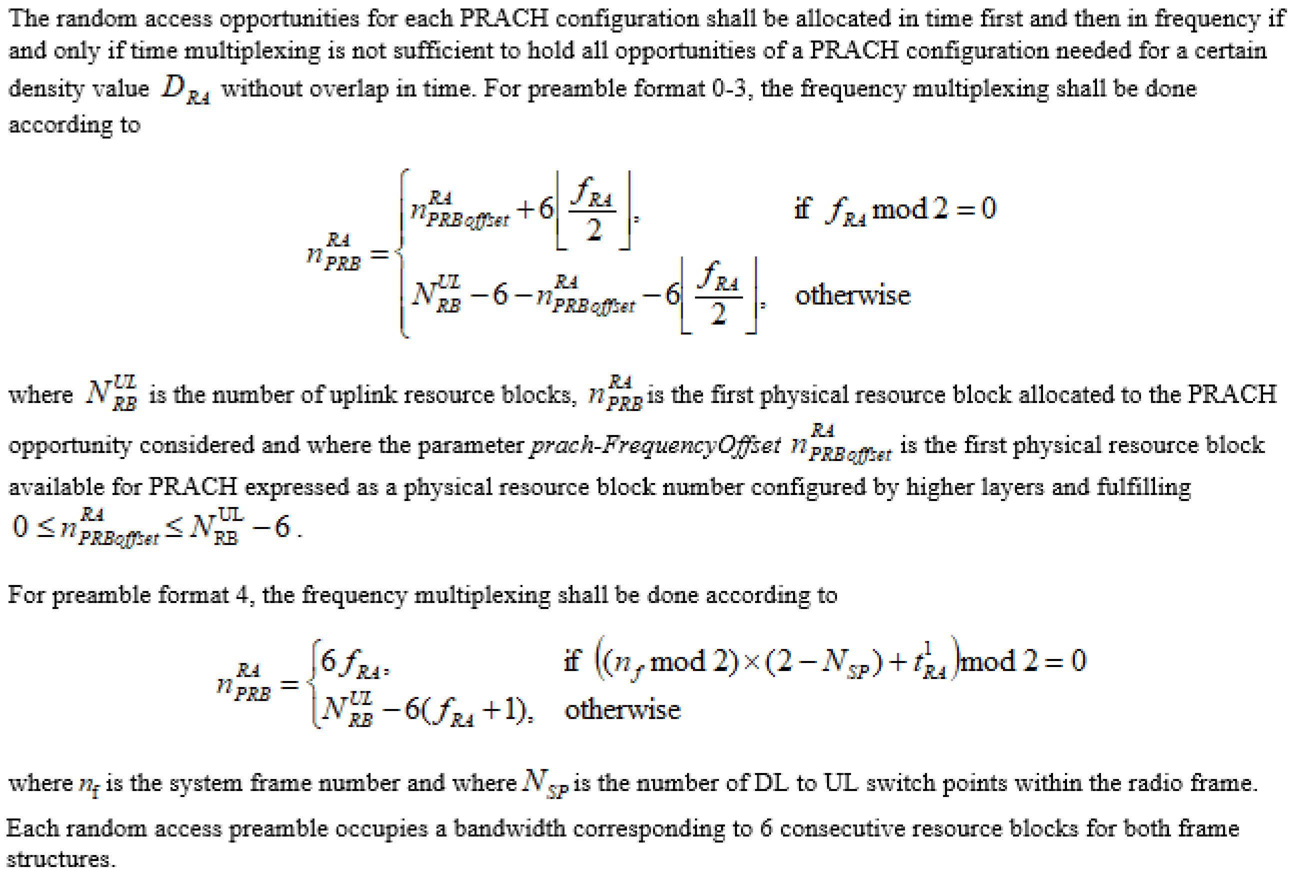
"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	Ford’s Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks. 5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

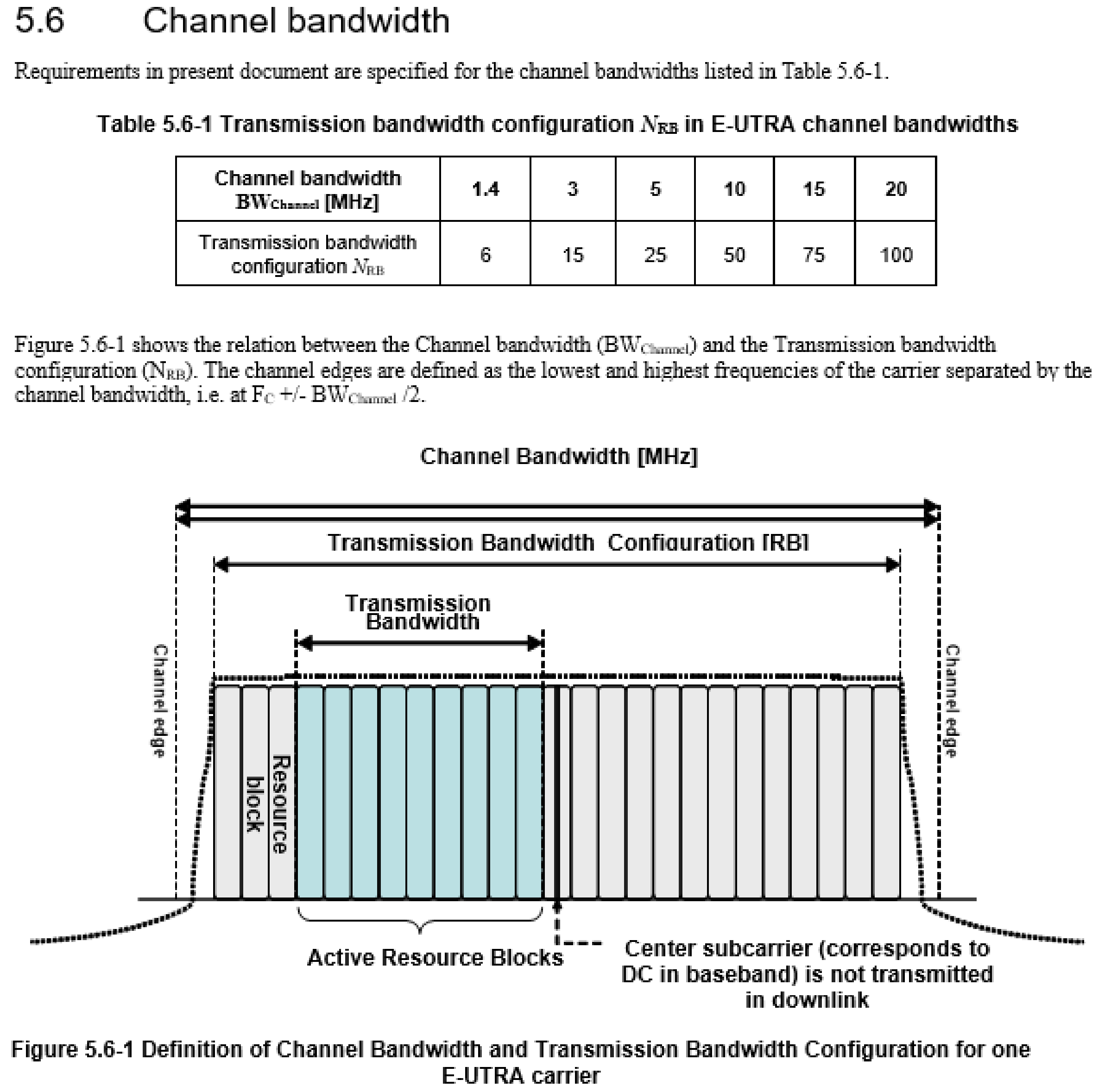
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

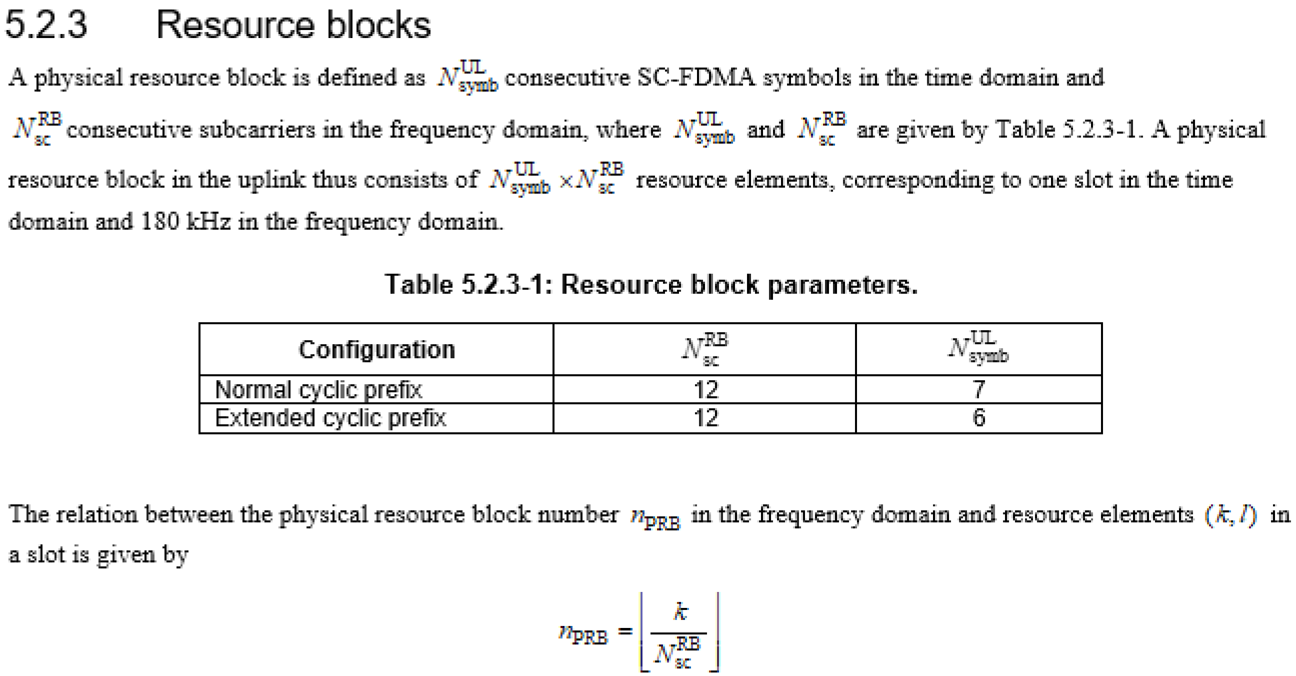
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

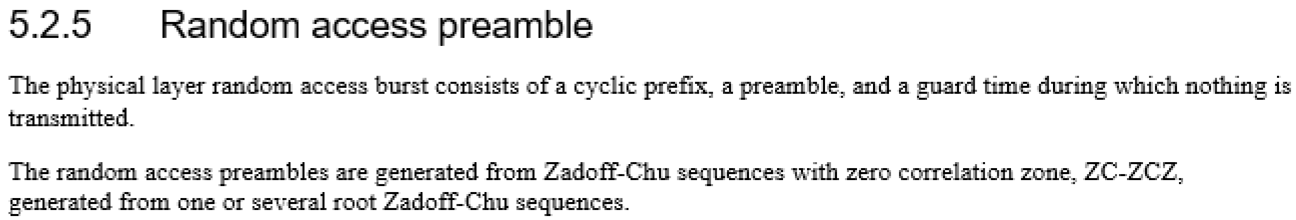
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

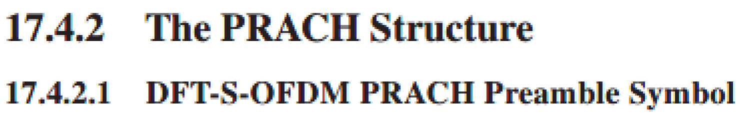


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.



17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

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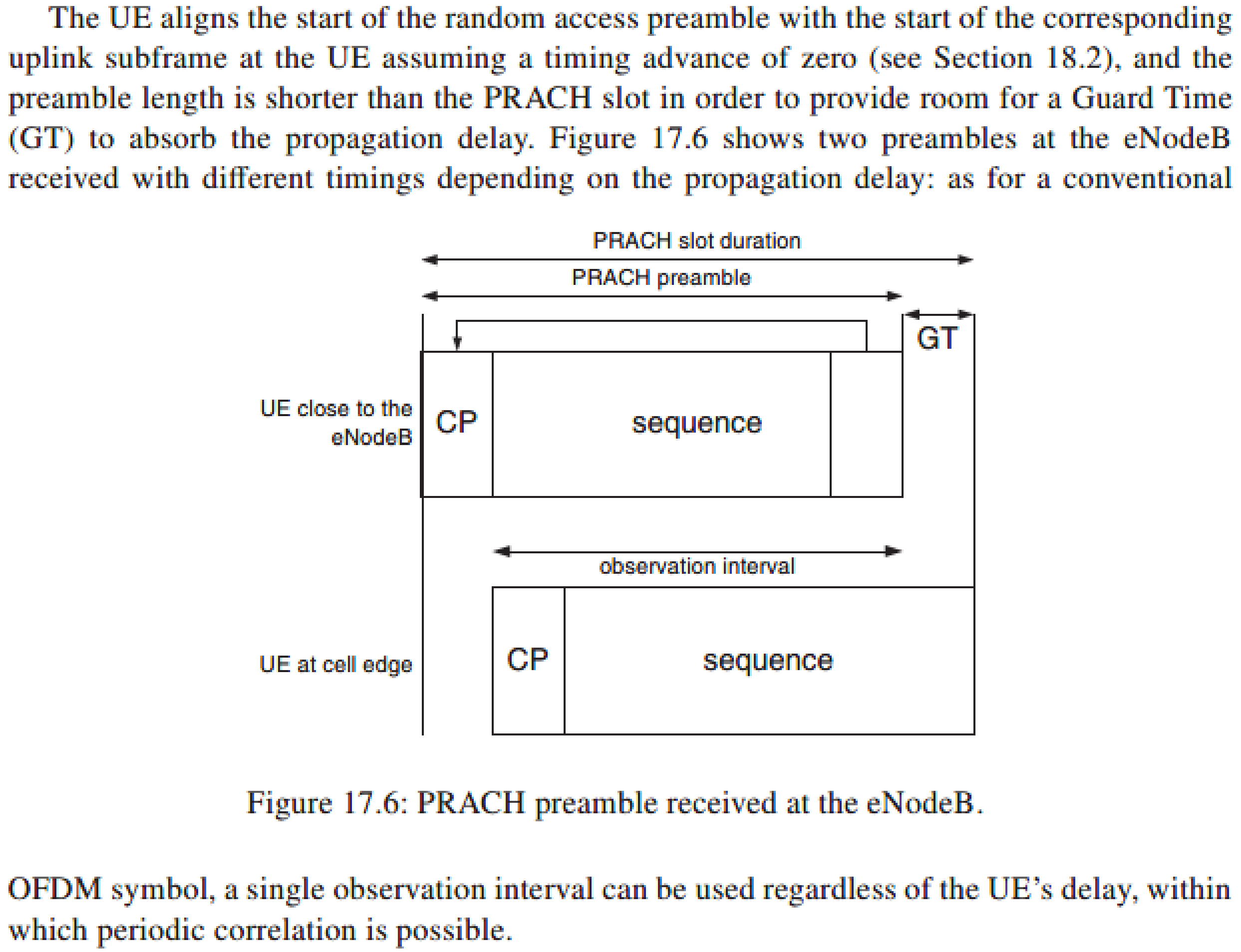
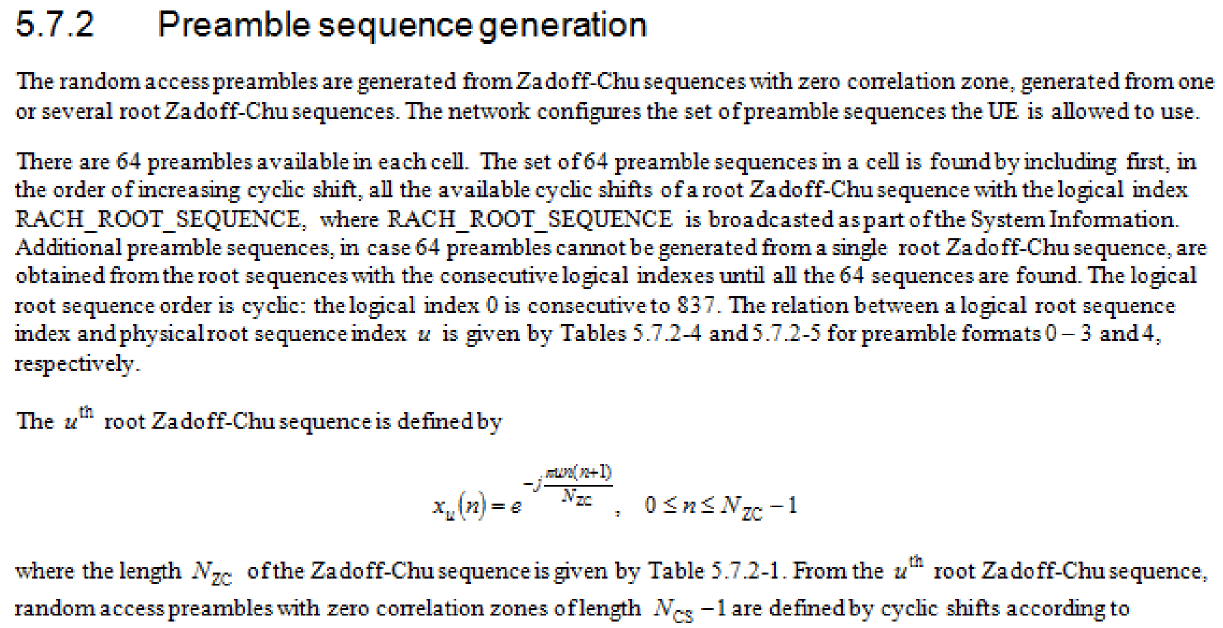
US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

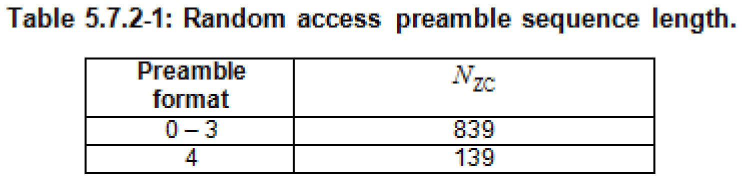
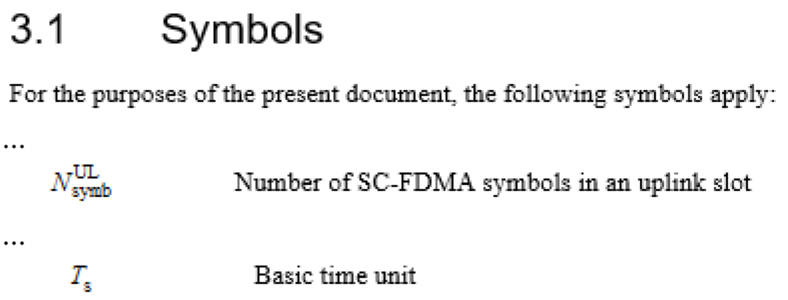
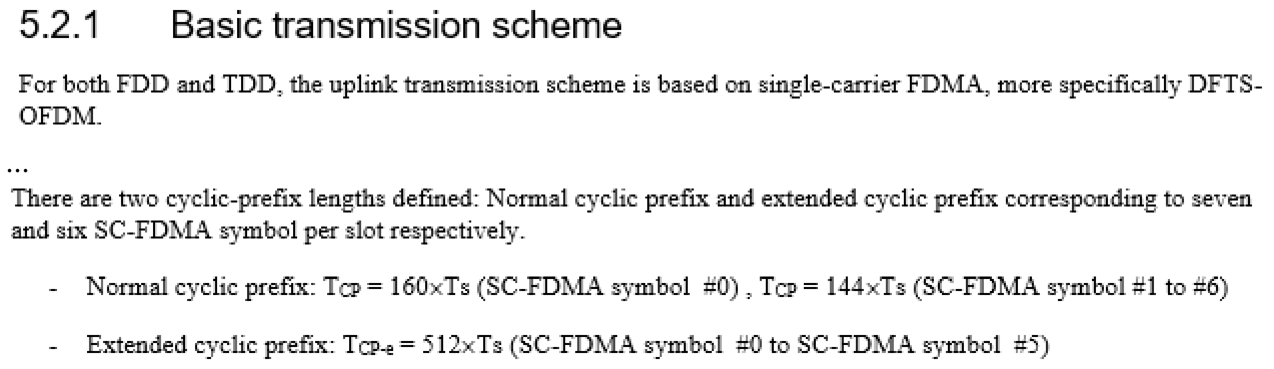


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using Ford's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP-e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

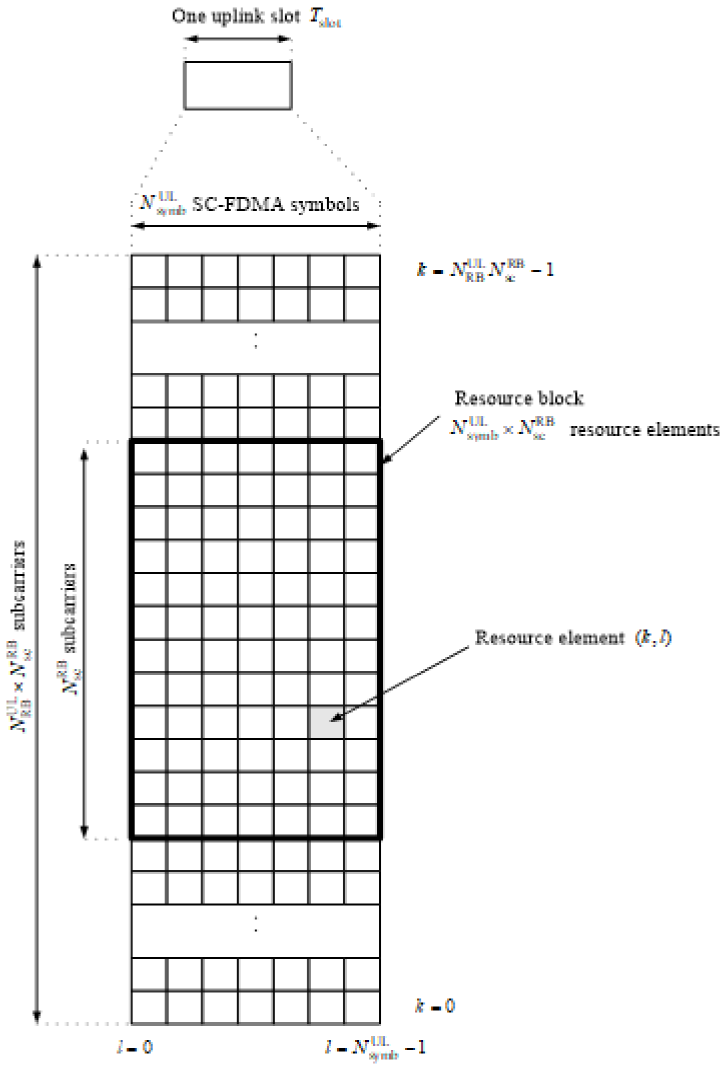
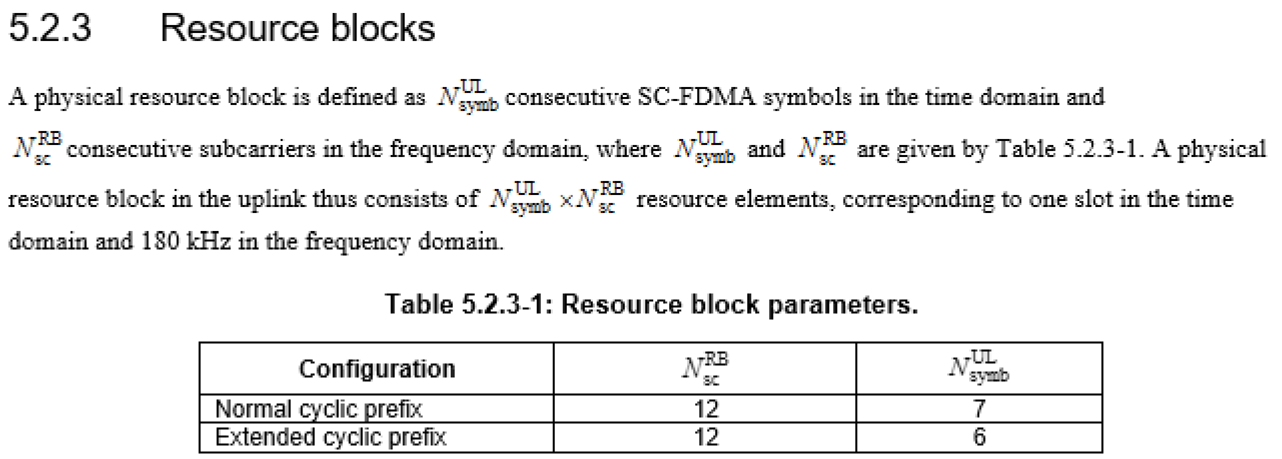


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

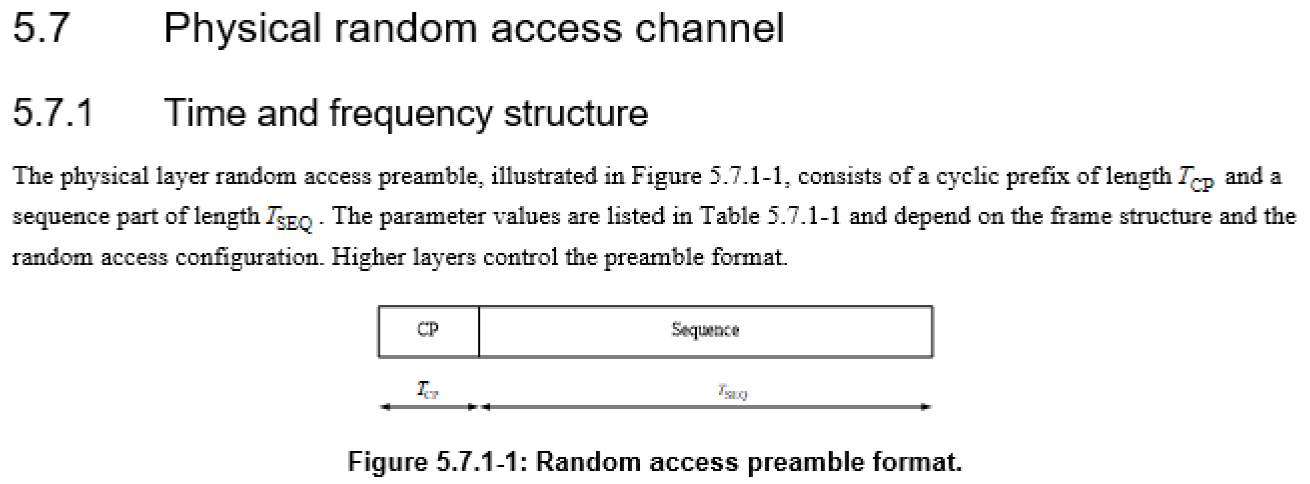
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

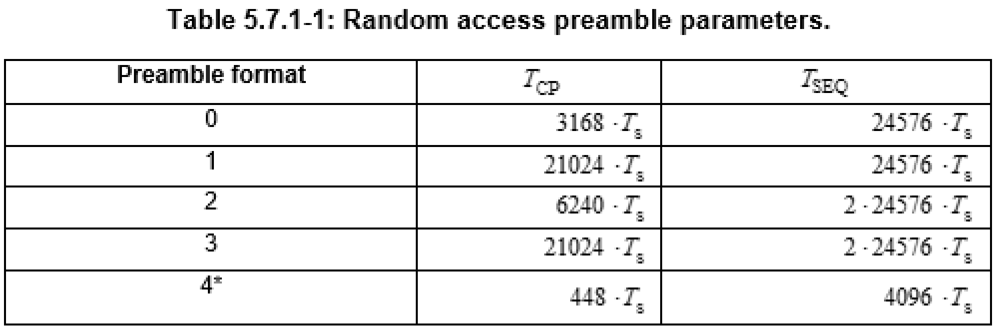
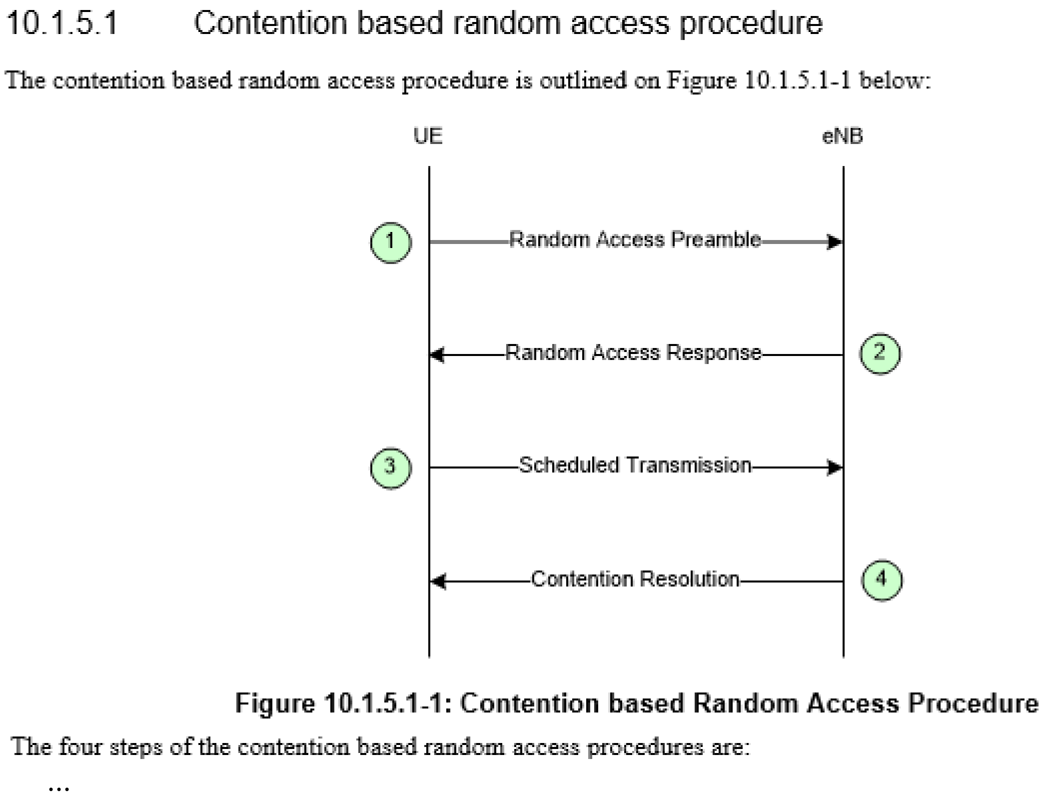


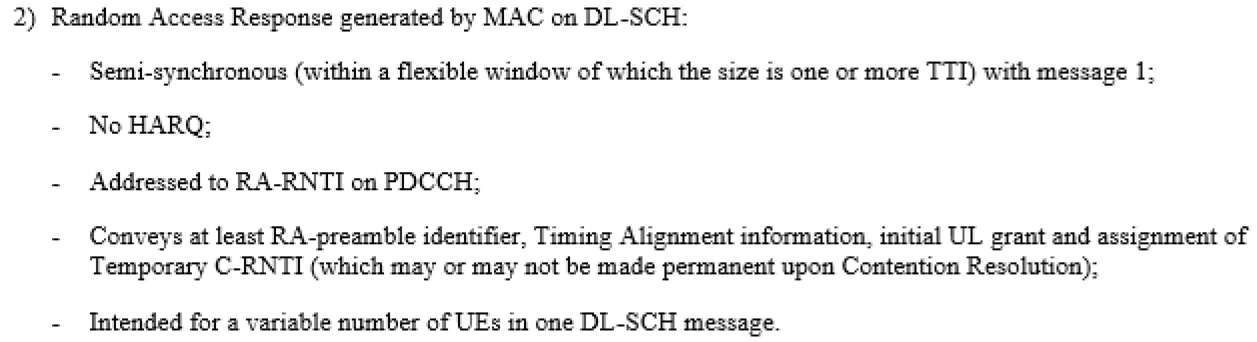
Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

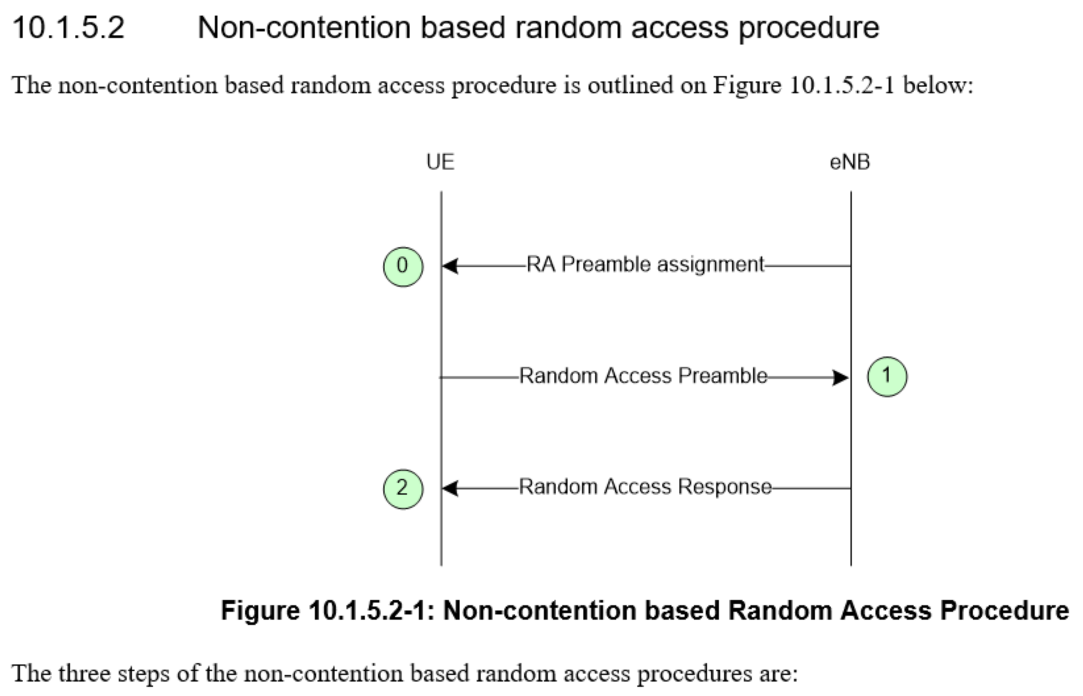
a receiver configured to receive, from the base station, a response message.	Ford’s Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



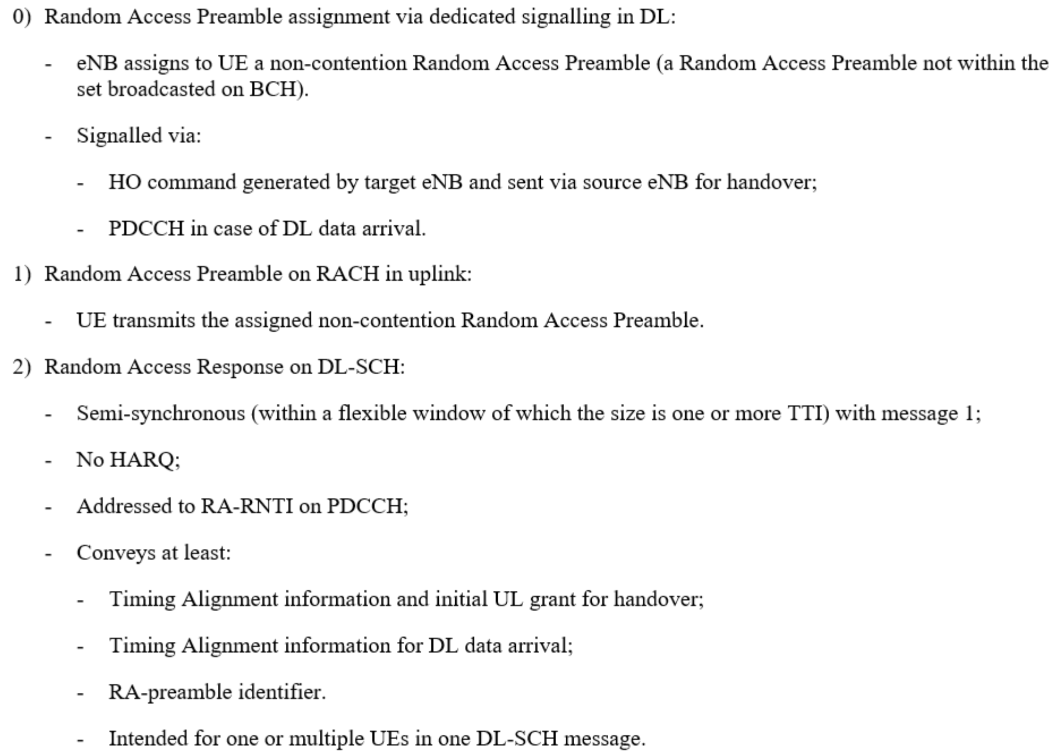
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

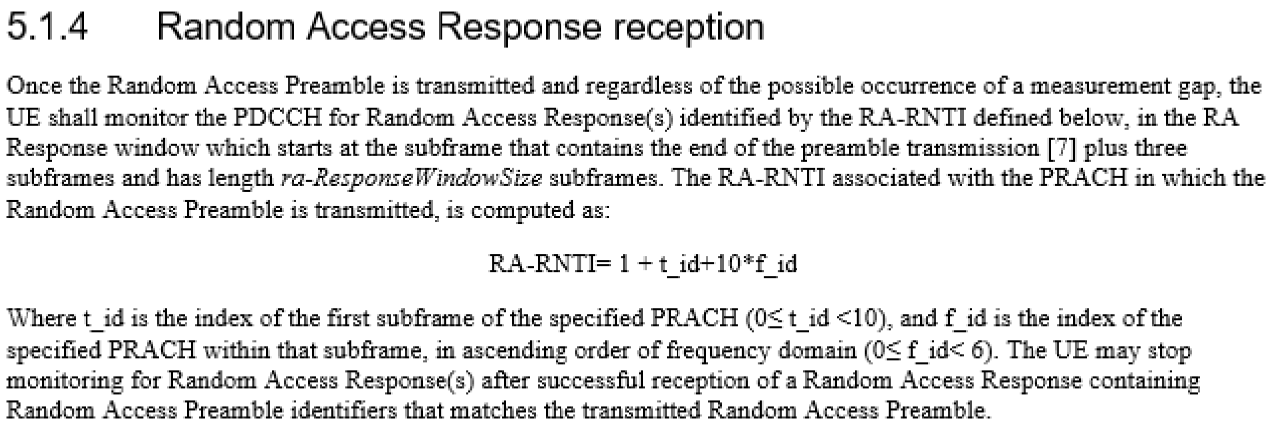
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

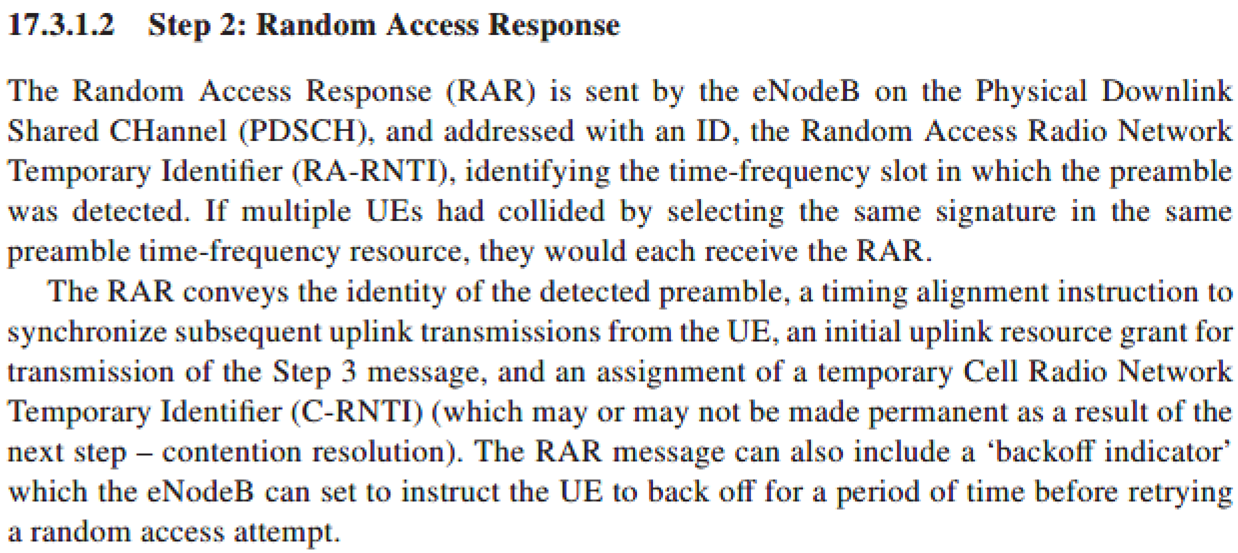
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

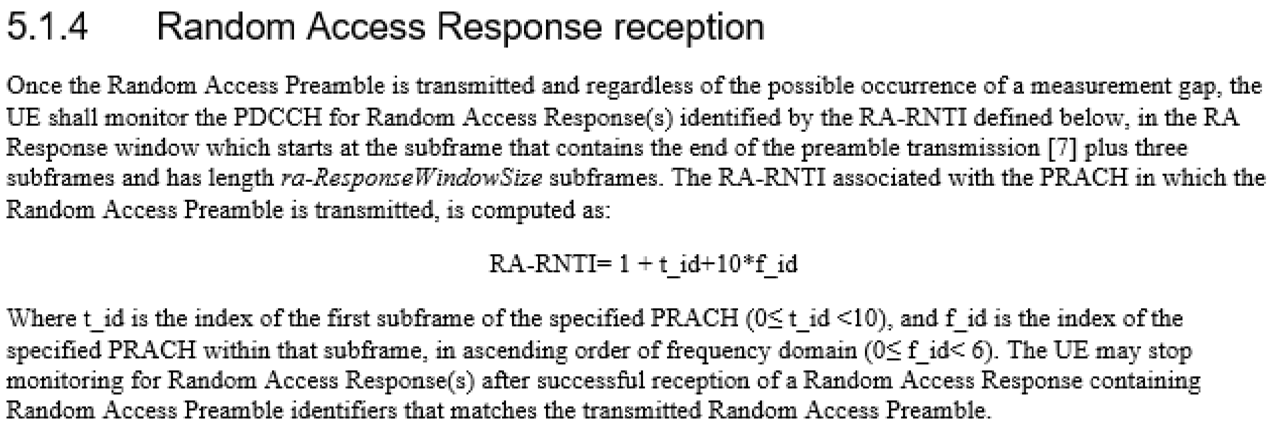
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

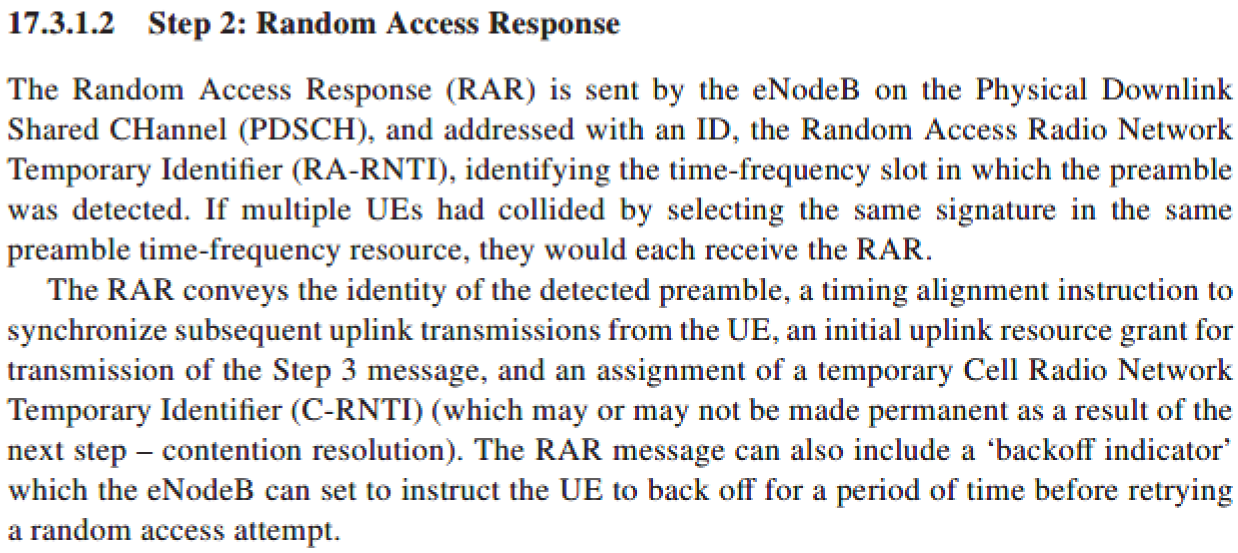
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

US Patent No. 10,833,908: Claim 2(b)
"the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and"

the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of Ford's Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $RA\text{-}RNTI= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”



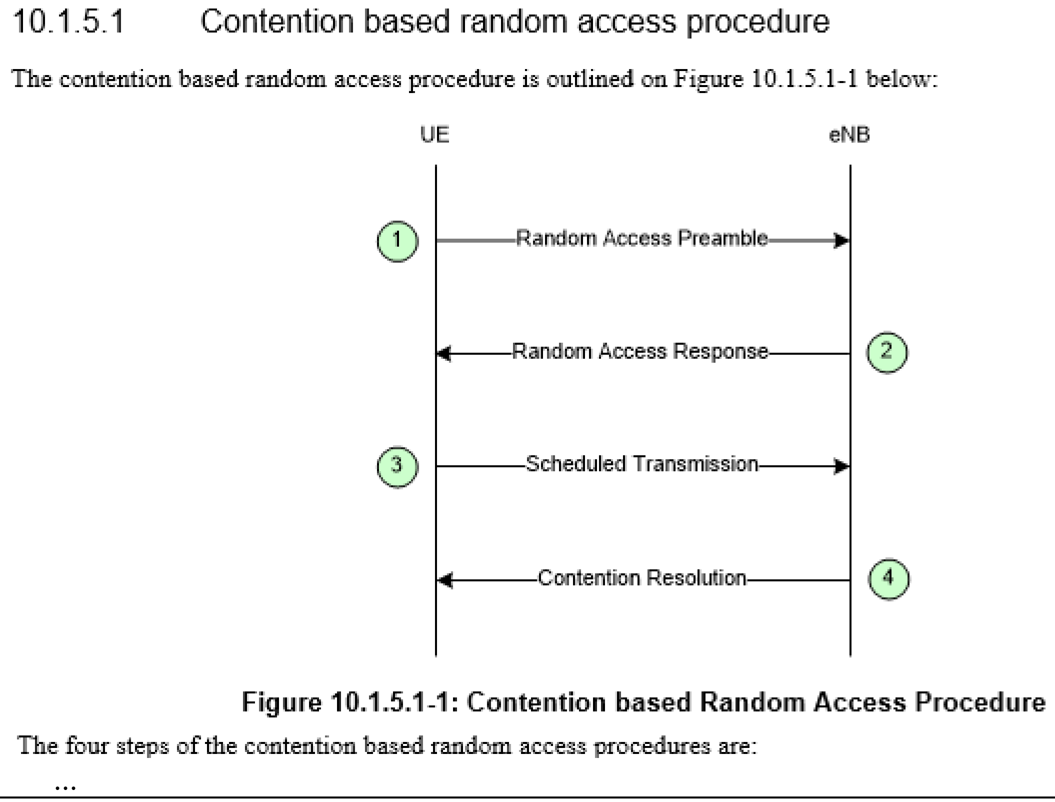
17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

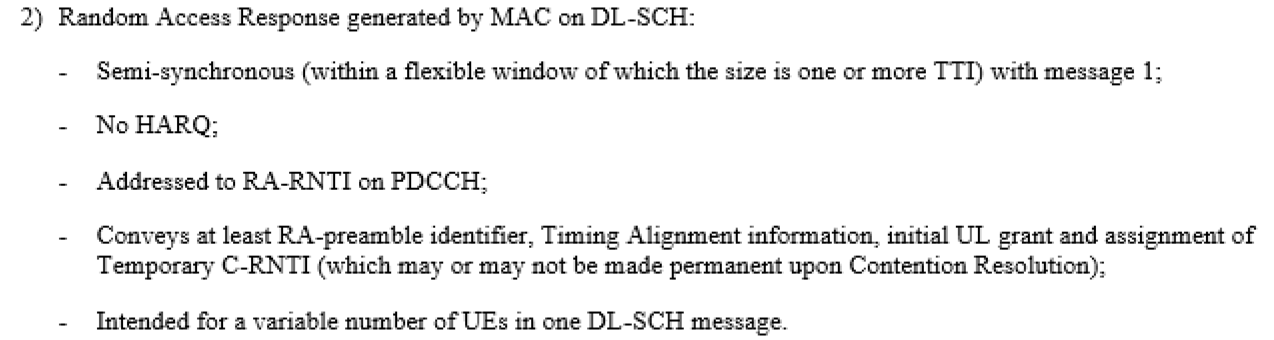
The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in Ford's Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

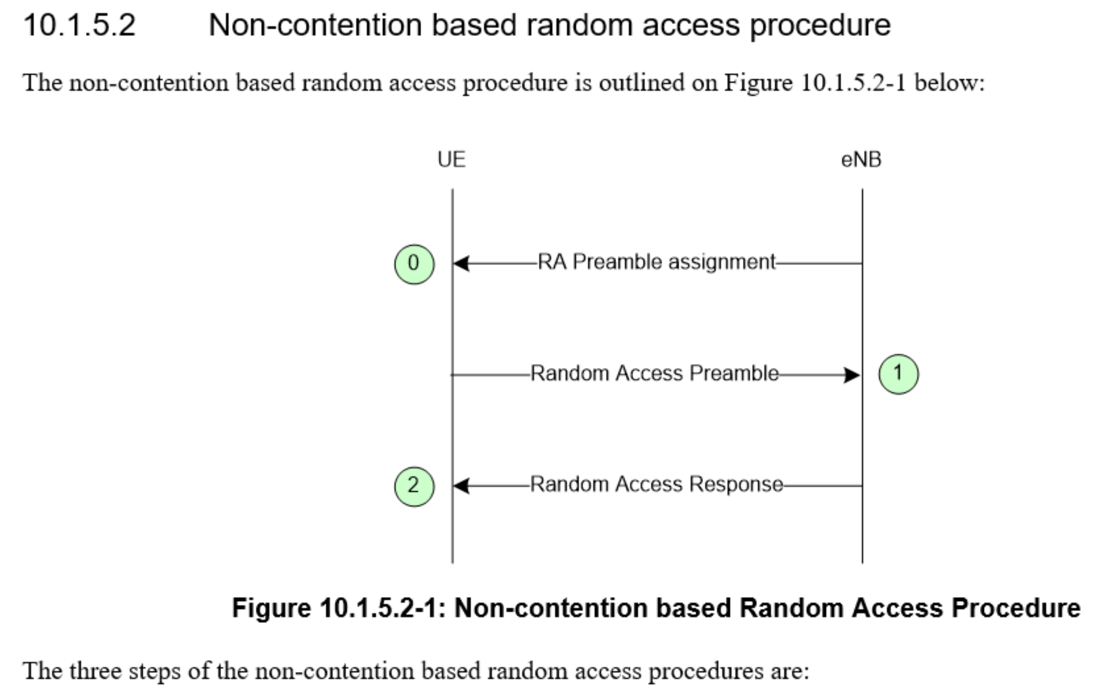
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



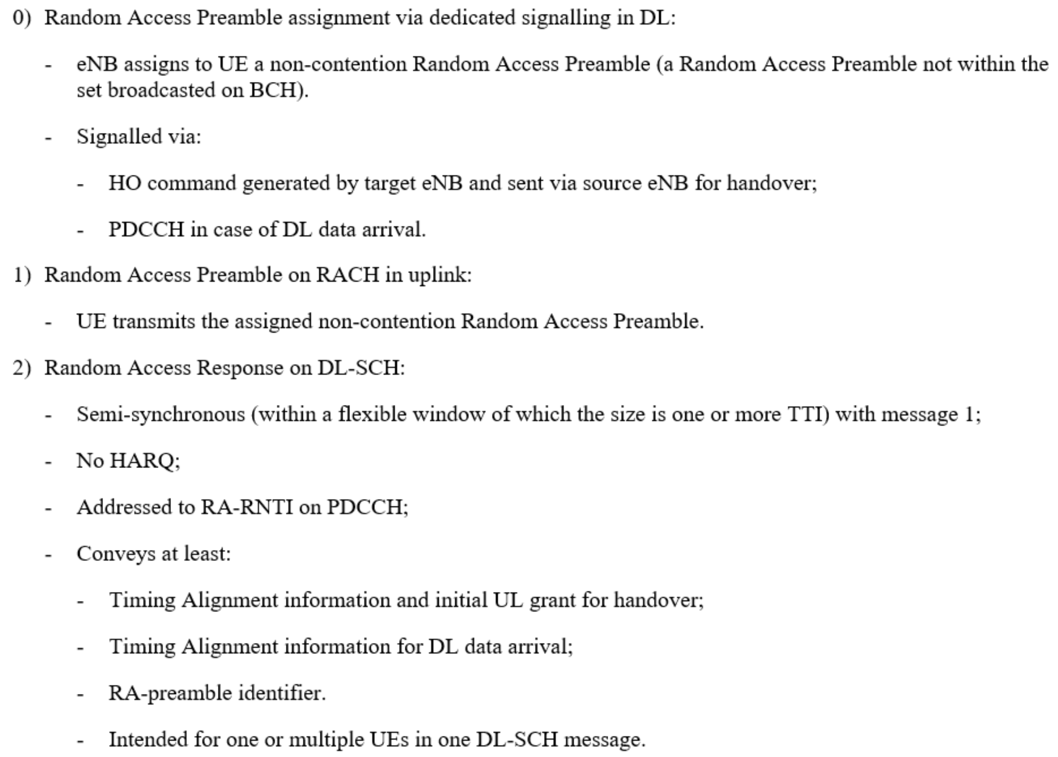
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

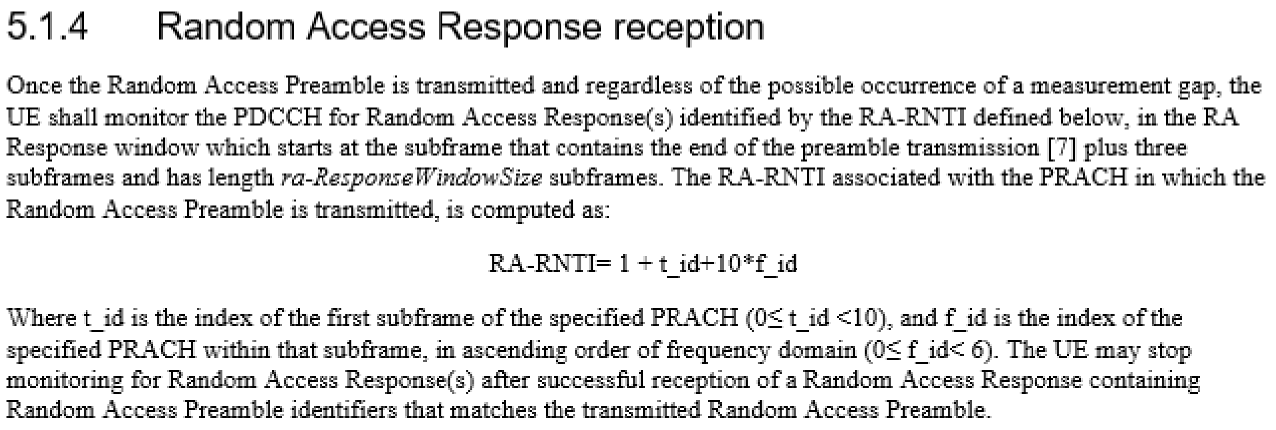
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

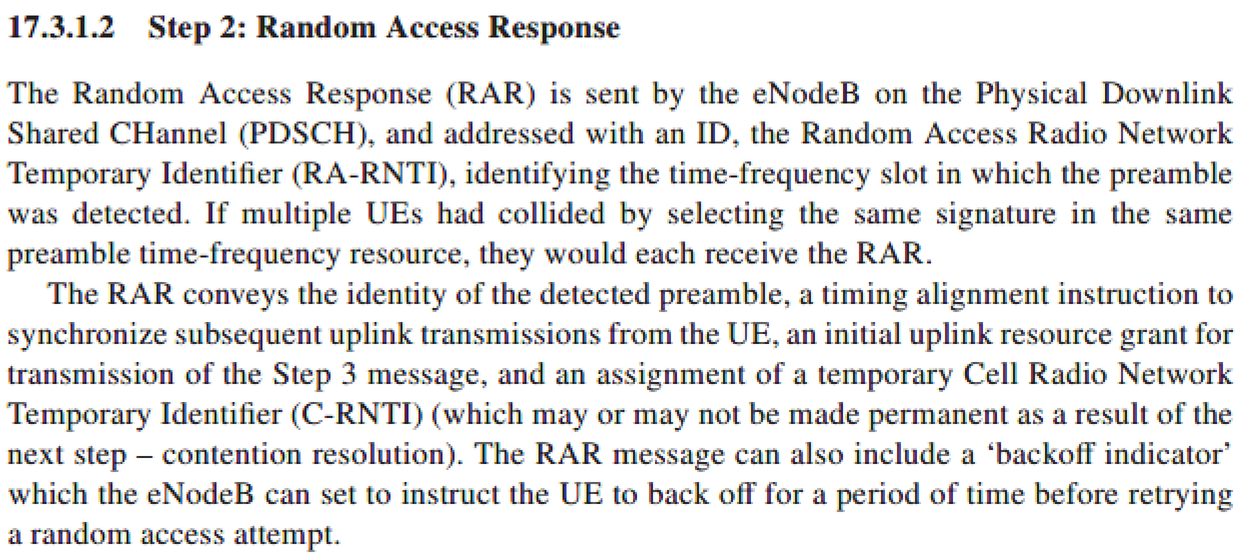
RA-RNTI= 1 + t_id+10*f_id

Where t_id is the index of the first subframe of the specified PRACH ($0\leq$ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq$ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

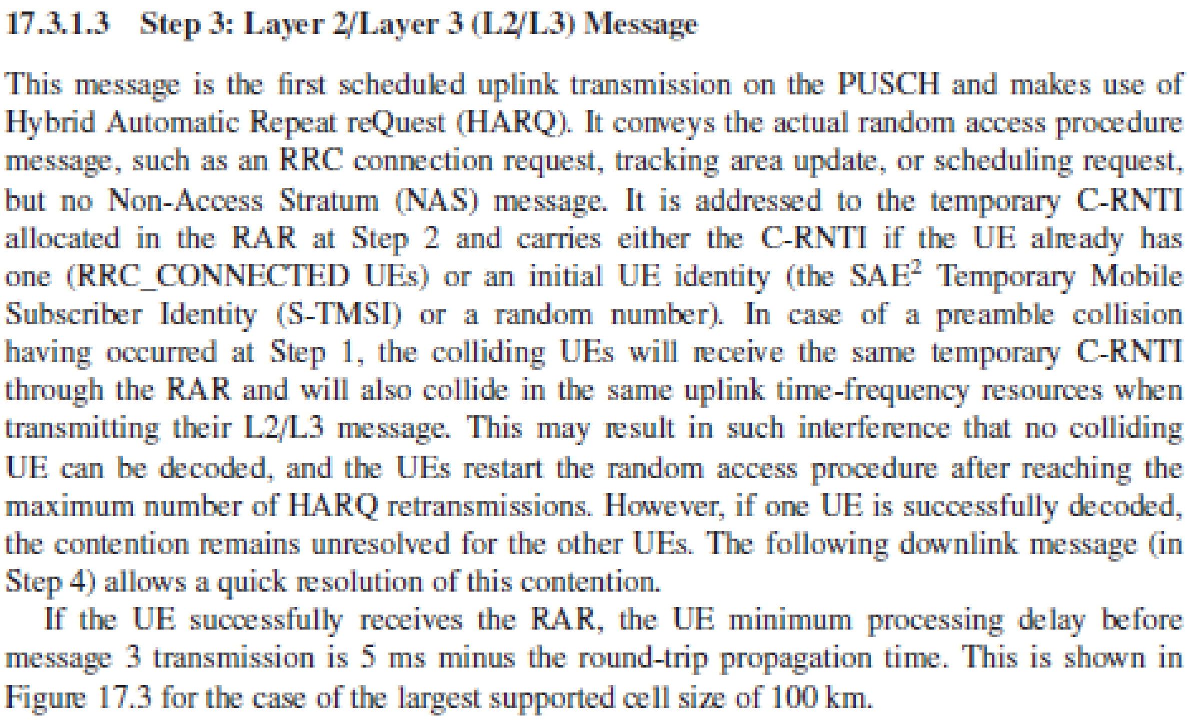
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 2(c)

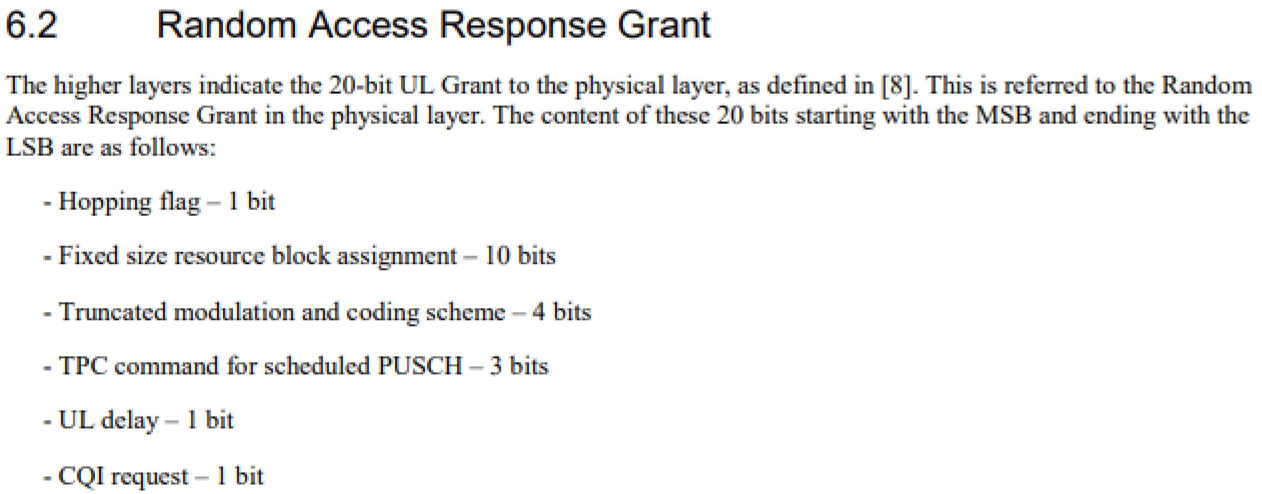
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

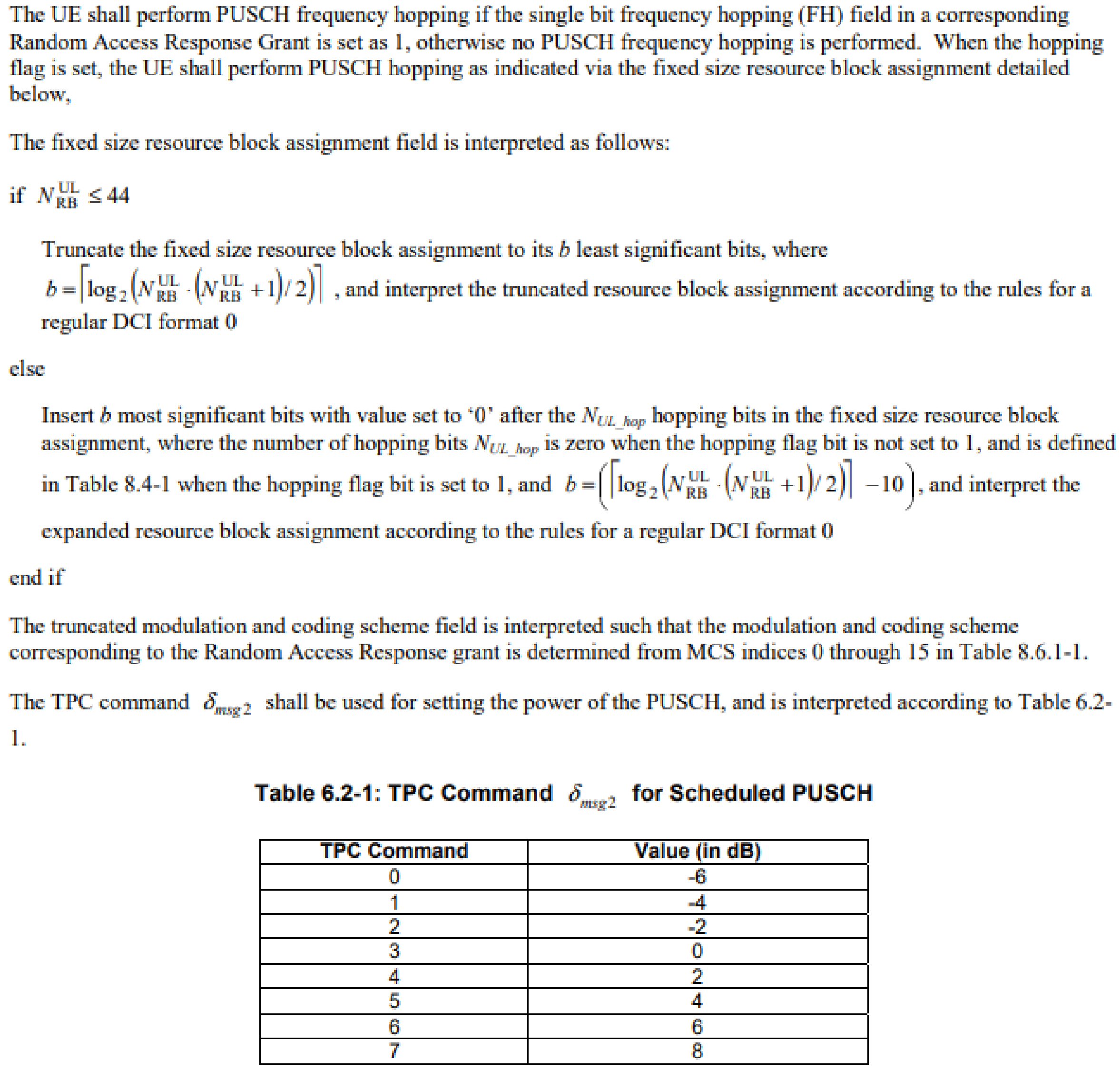
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of Ford's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

```
if $N_{RB}^{UL} \le 44$
    Truncate the fixed size resource block assignment to its $b$ least significant bits, where $b = \left\lceil \log_2\left(N_{RB}^{UL} \cdot \left(N_{RB}^{UL}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0
else
    Insert $b$ most significant bits with value set to '0' after the $N_{UL\_hop}$ hopping bits in the fixed size resource block assignment, where the number of hopping bits $N_{UL\_hop}$ is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{RB}^{UL} \cdot \left(N_{RB}^{UL}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0
end if
```

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

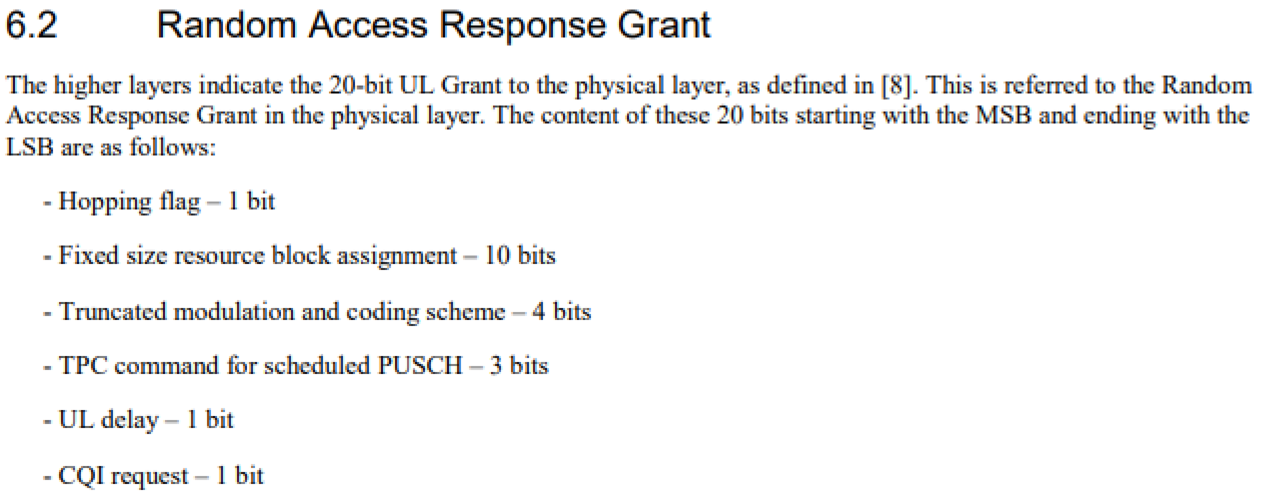
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

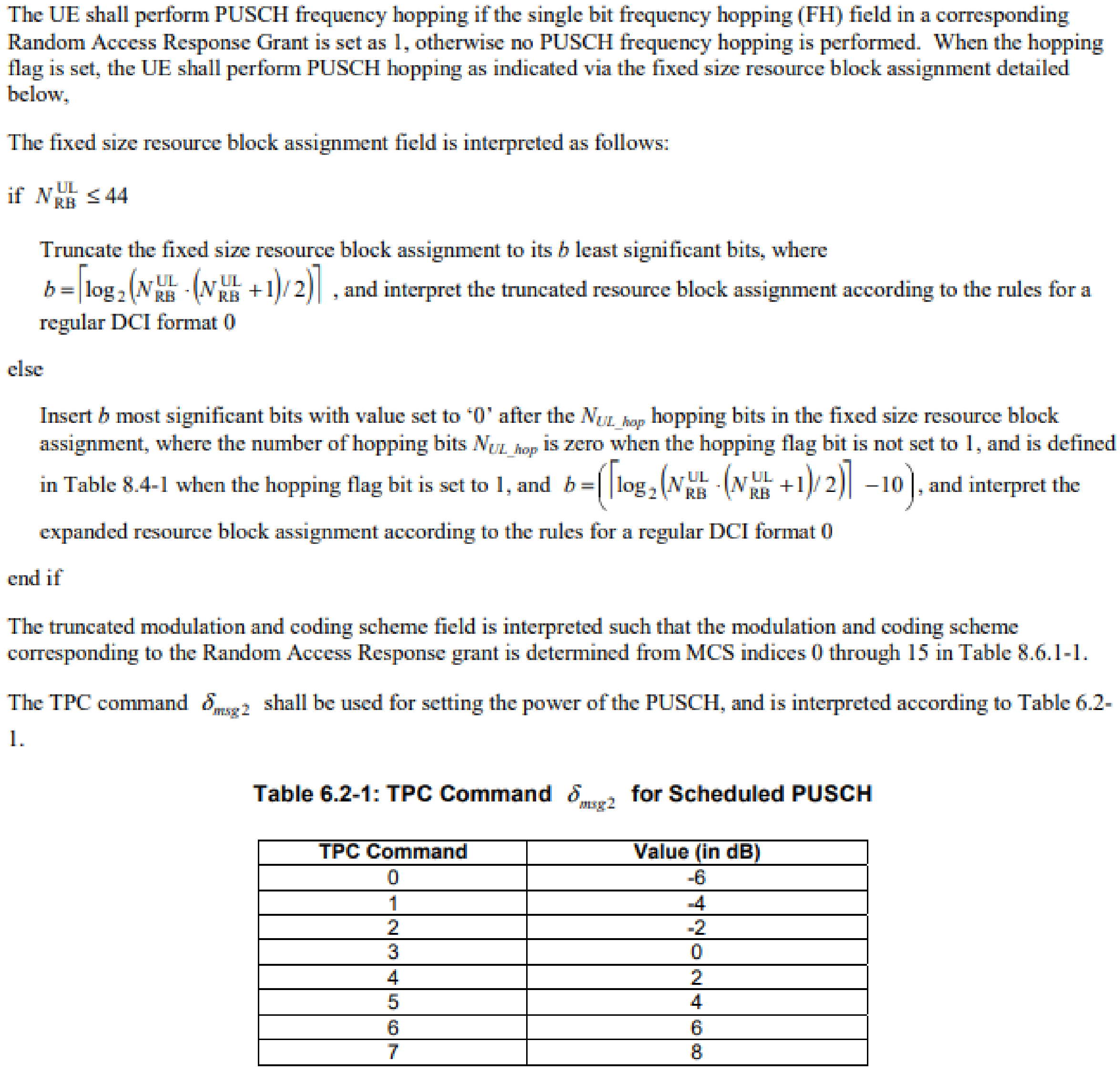
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of Ford’s Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)

"wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
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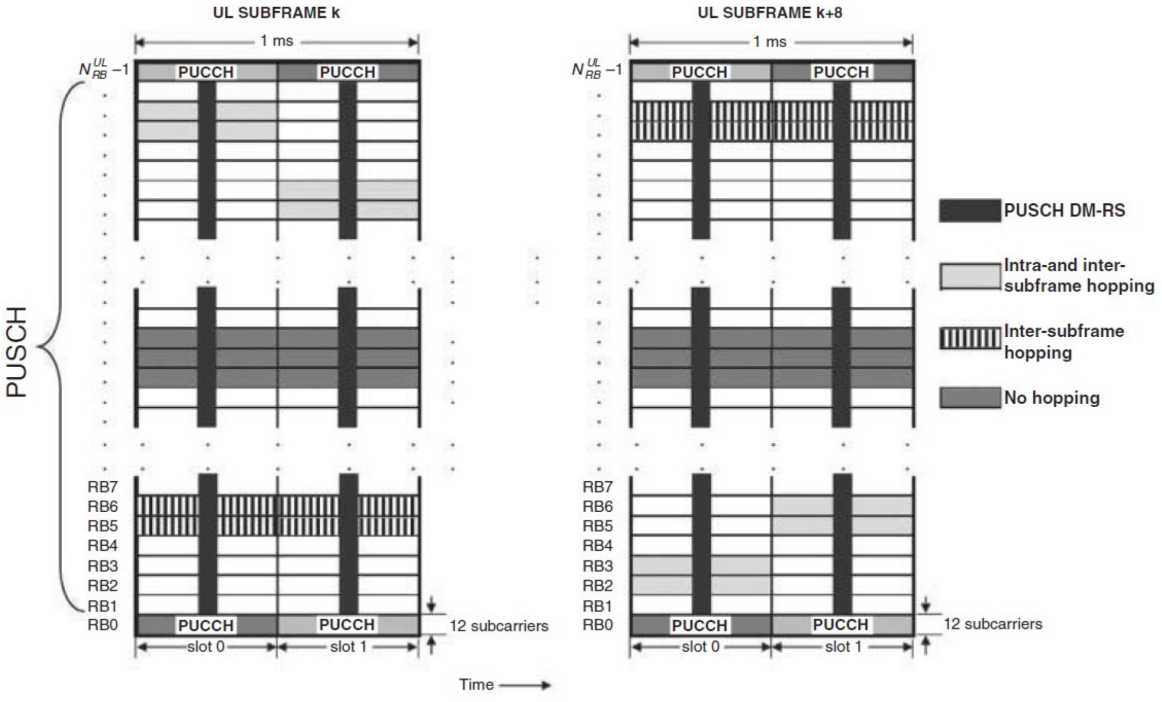
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of Ford's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure"). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

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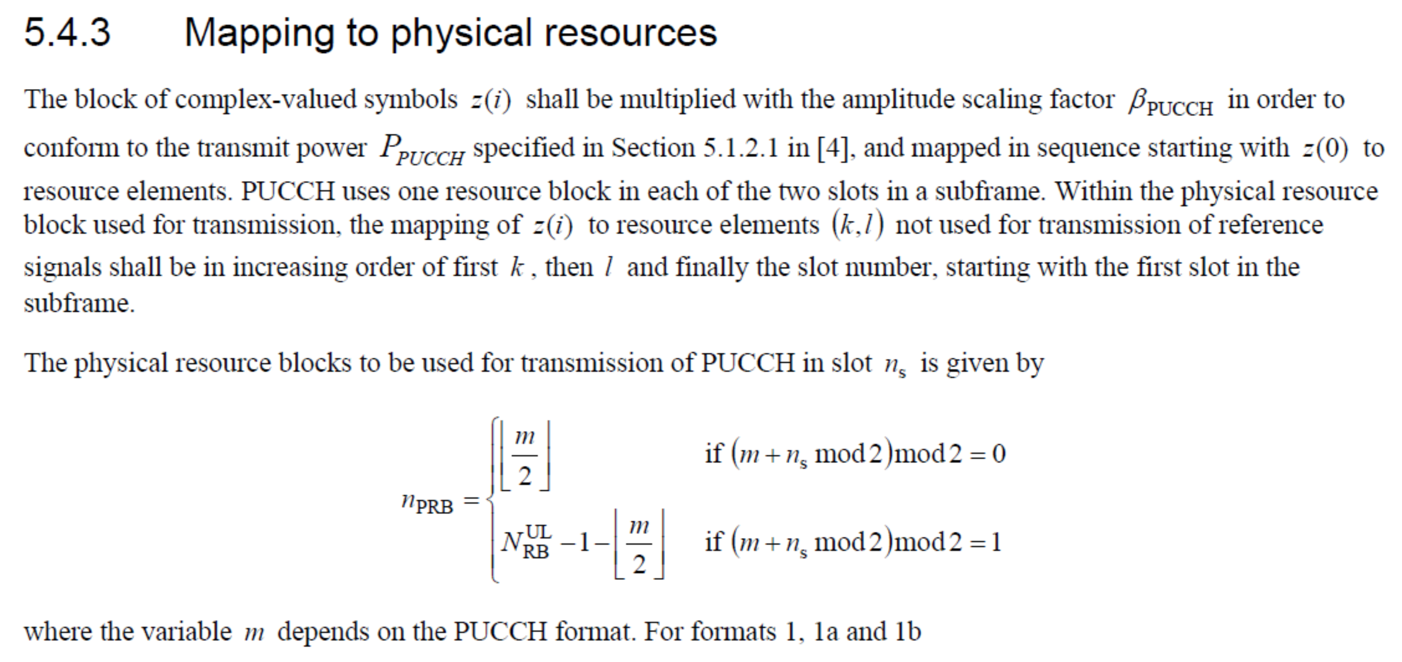

5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

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US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

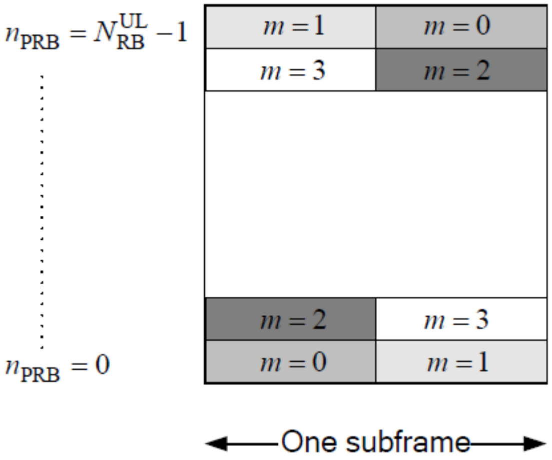
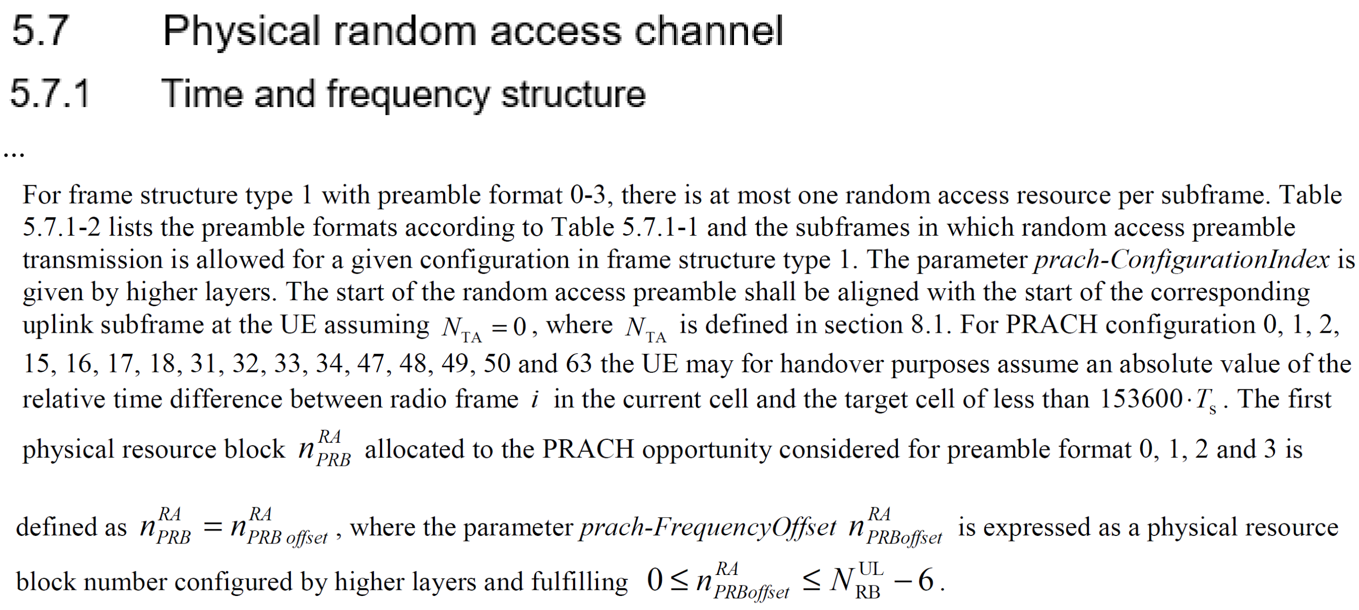


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure ... For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

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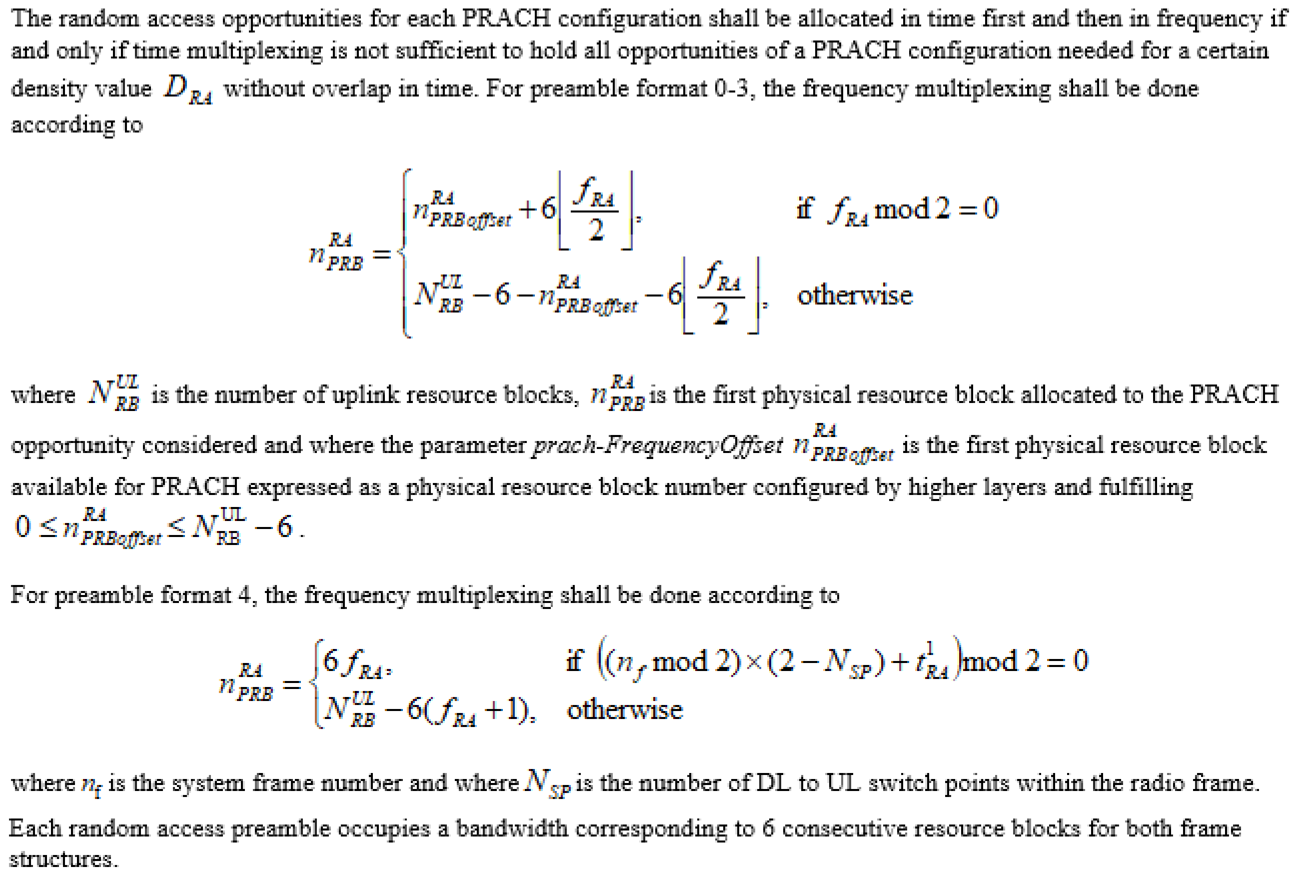

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

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US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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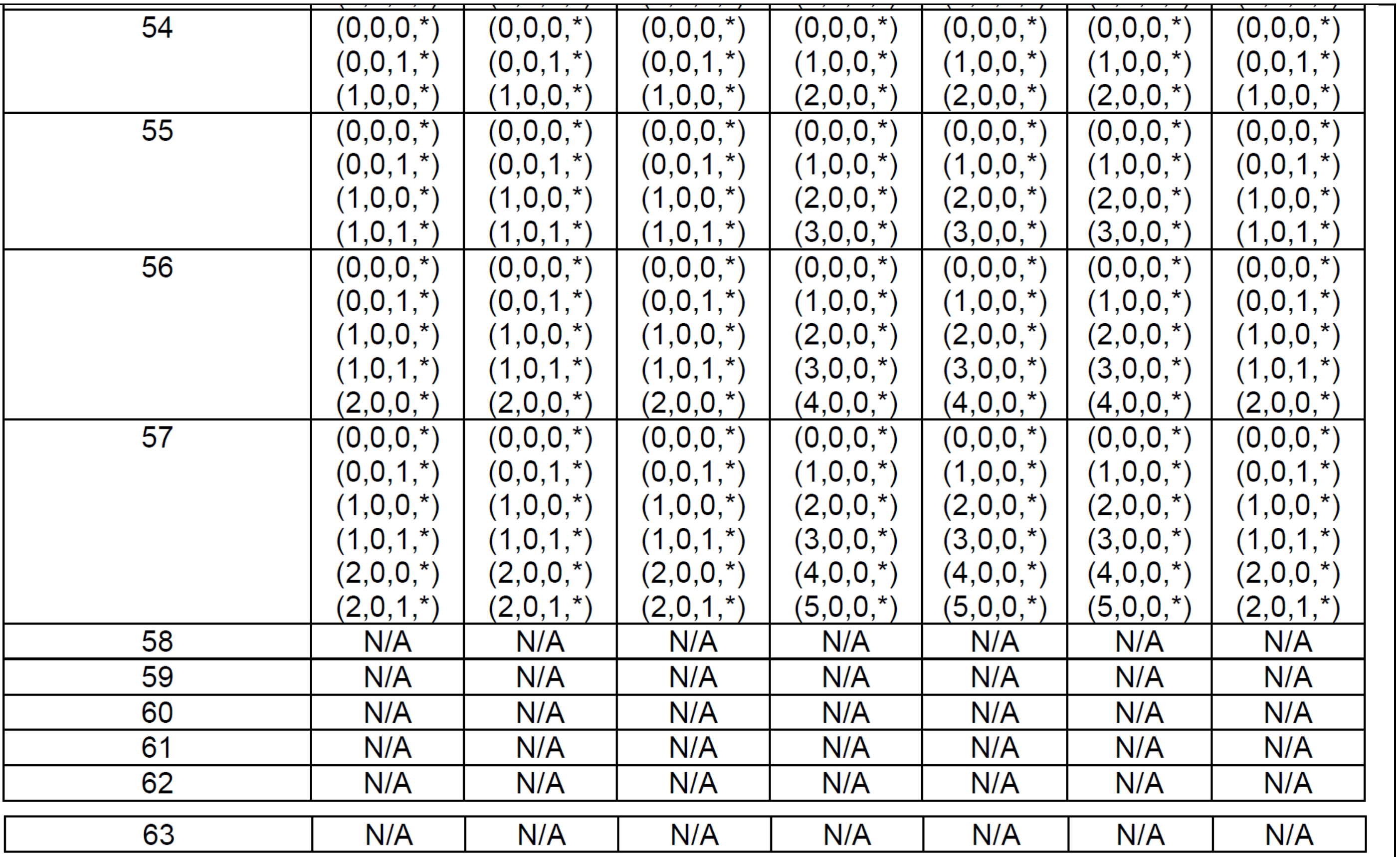
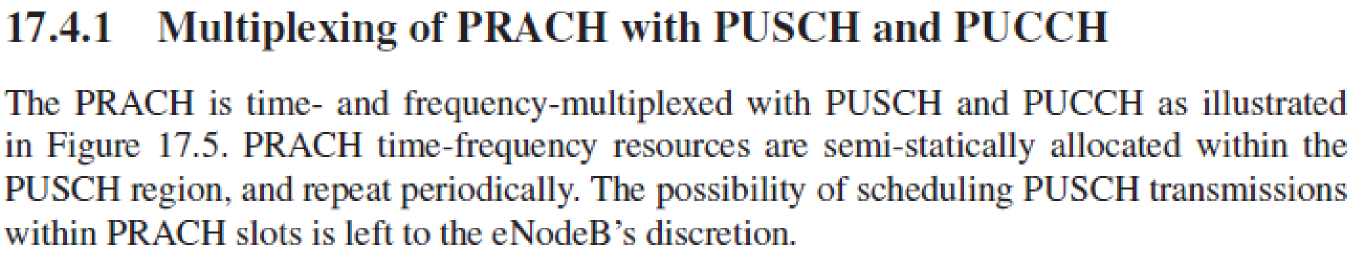


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

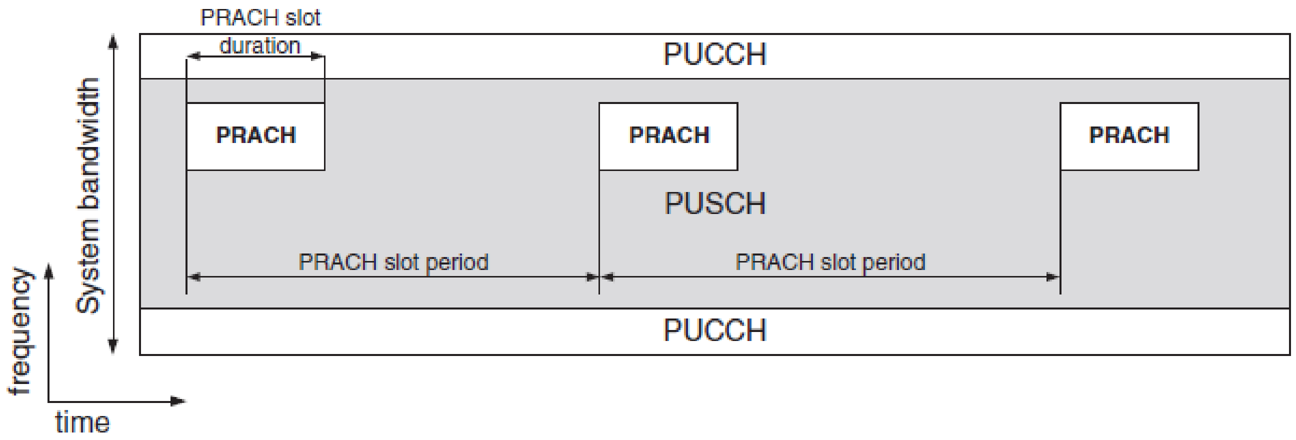
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

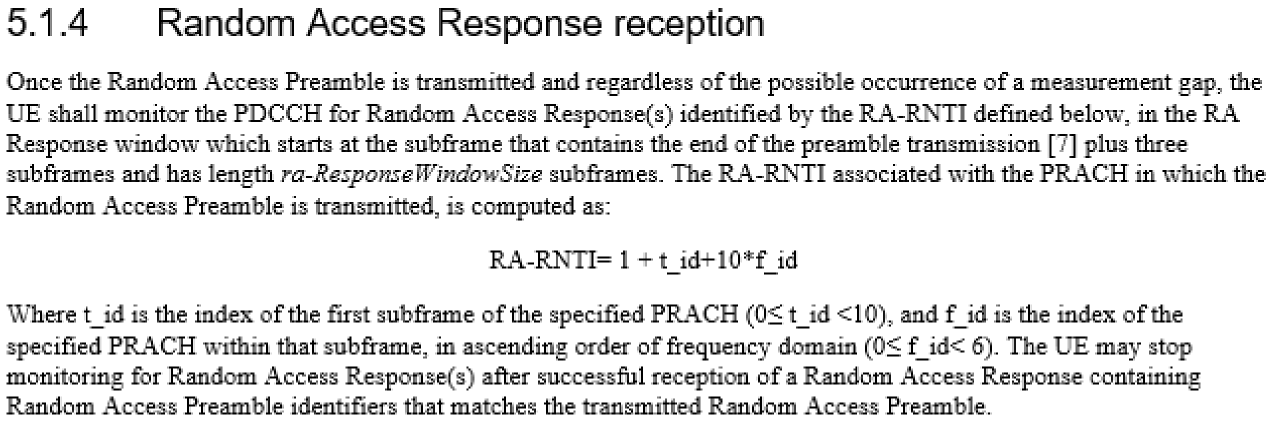
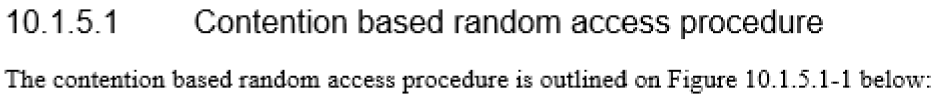
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

US Patent No. 10,833,908: Claim 5

"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Ford's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

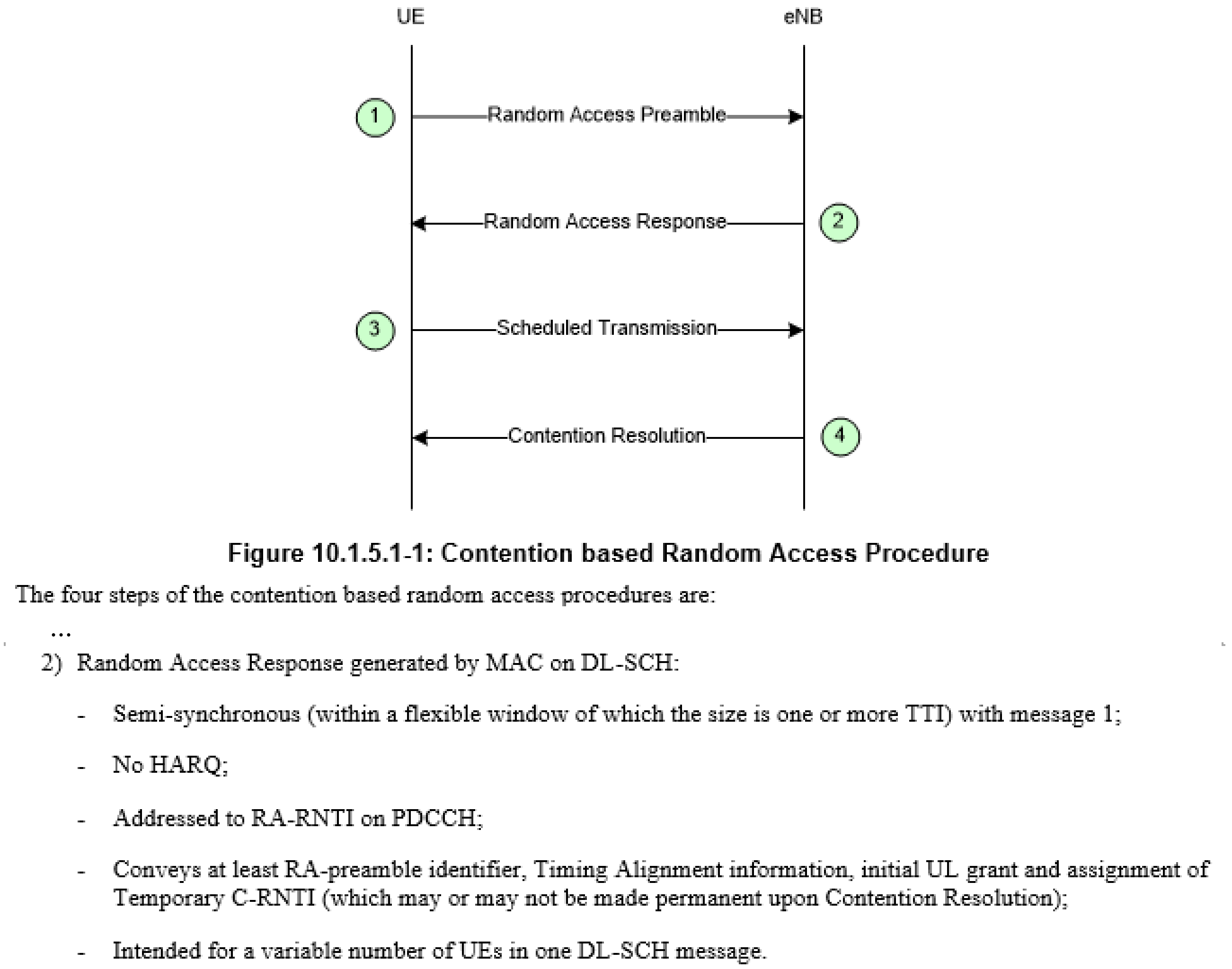


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

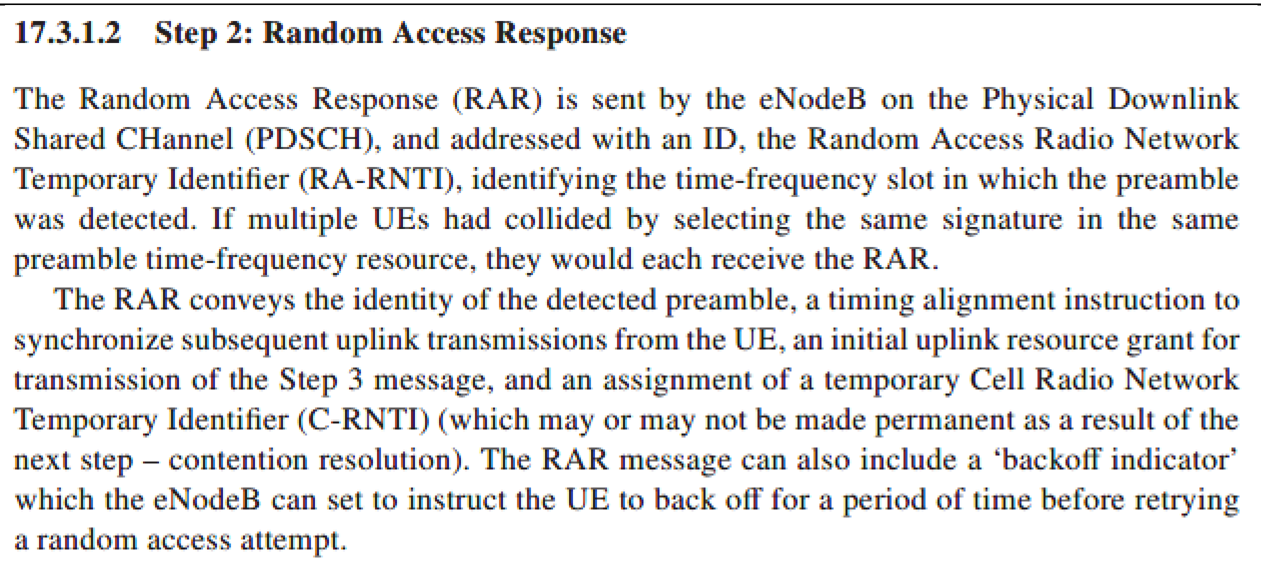
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

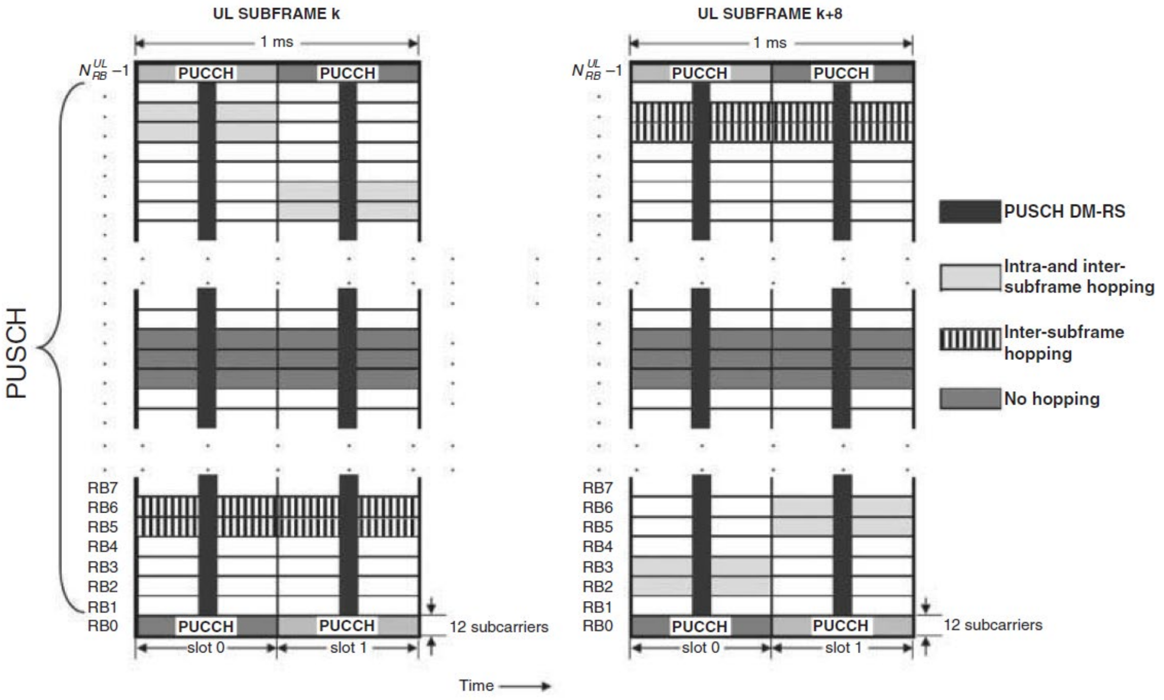
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 6

"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Ford's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

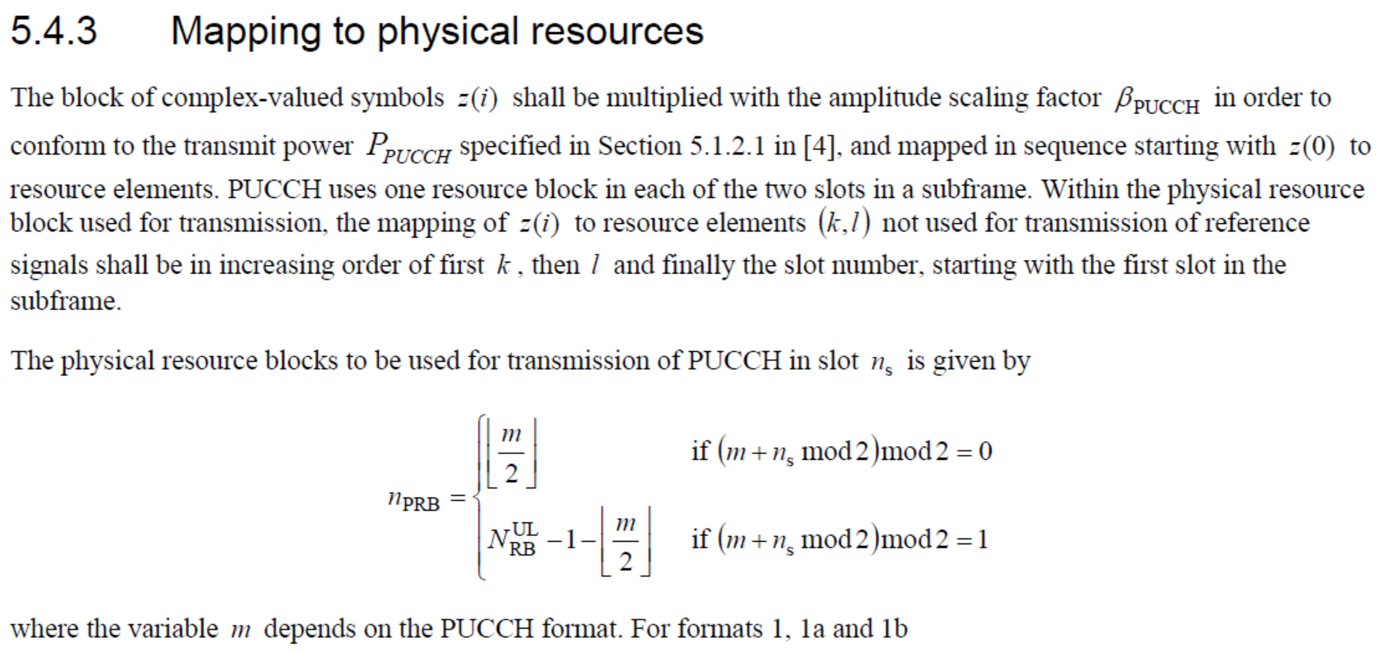
US Patent No. 10,833,908: Claim 7
“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Ford’s Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

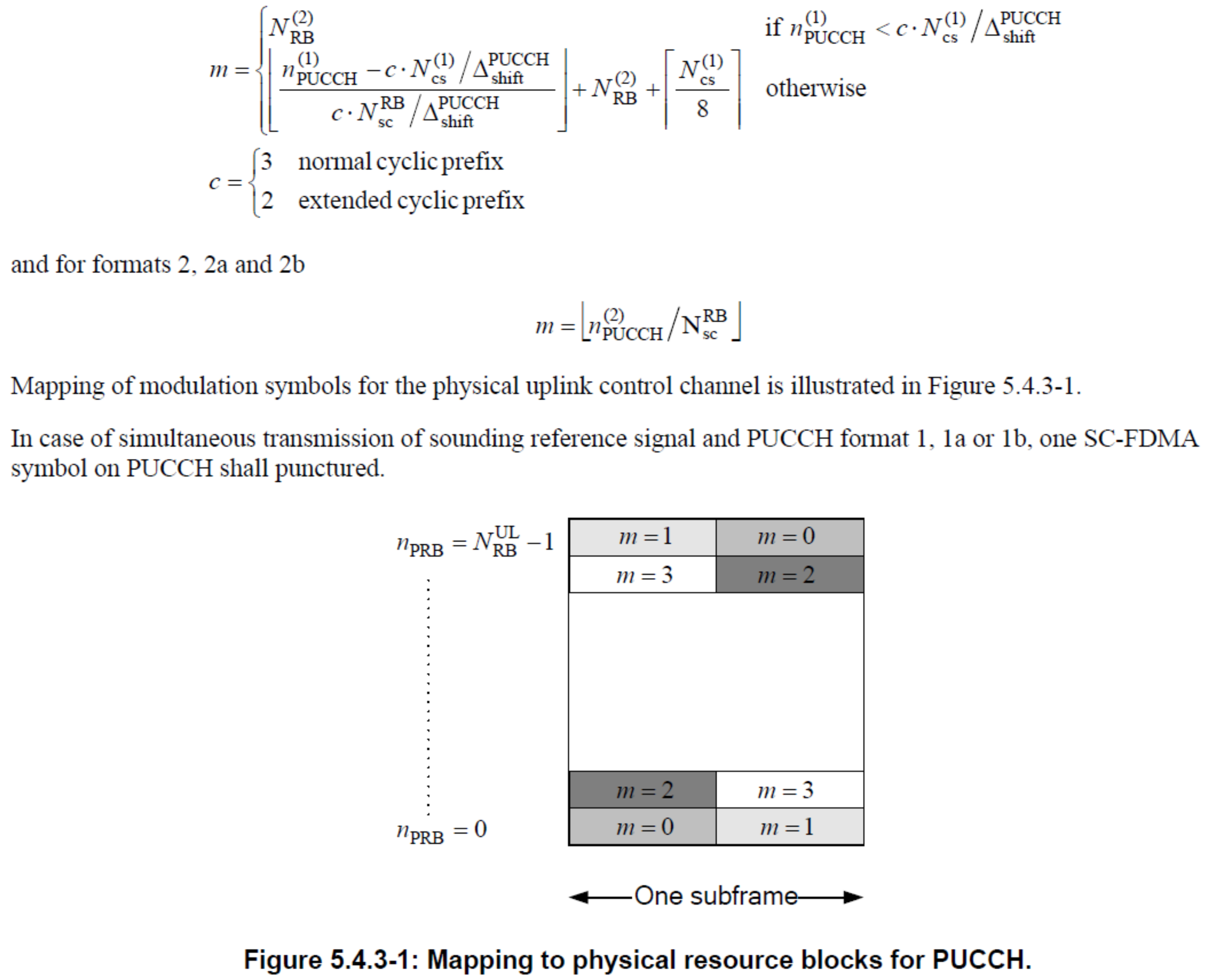
The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_\mathrm{s} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_\mathrm{s} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m=\begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c\cdot N_{\mathrm{cs}}^{(1)}/\Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c\cdot N_{\mathrm{cs}}^{(1)}/\Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c\cdot N_{\mathrm{sc}}^{\mathrm{RB}}/\Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c=\begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m=\left\lfloor n_{\mathrm{PUCCH}}^{(2)}/\mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

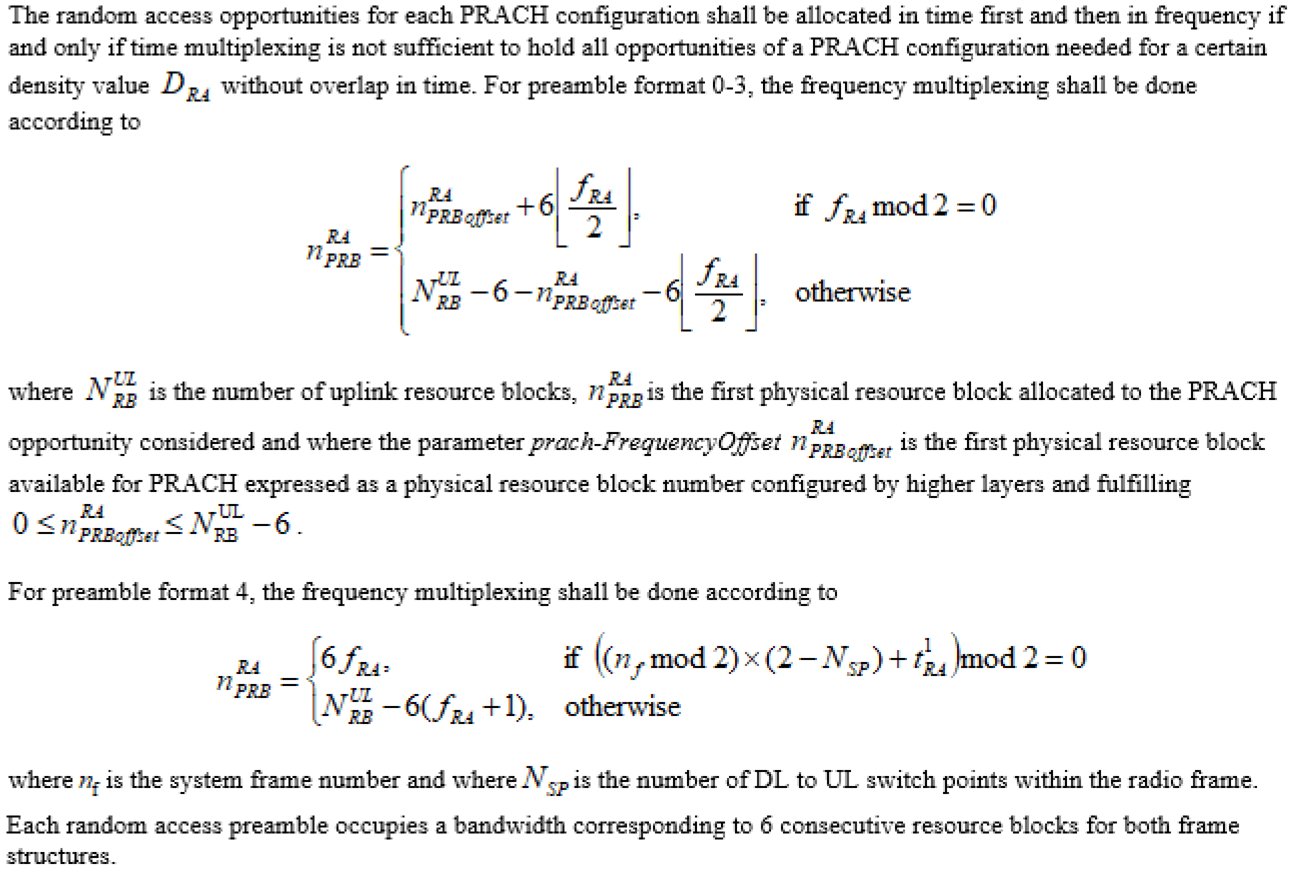
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH. 5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\ offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

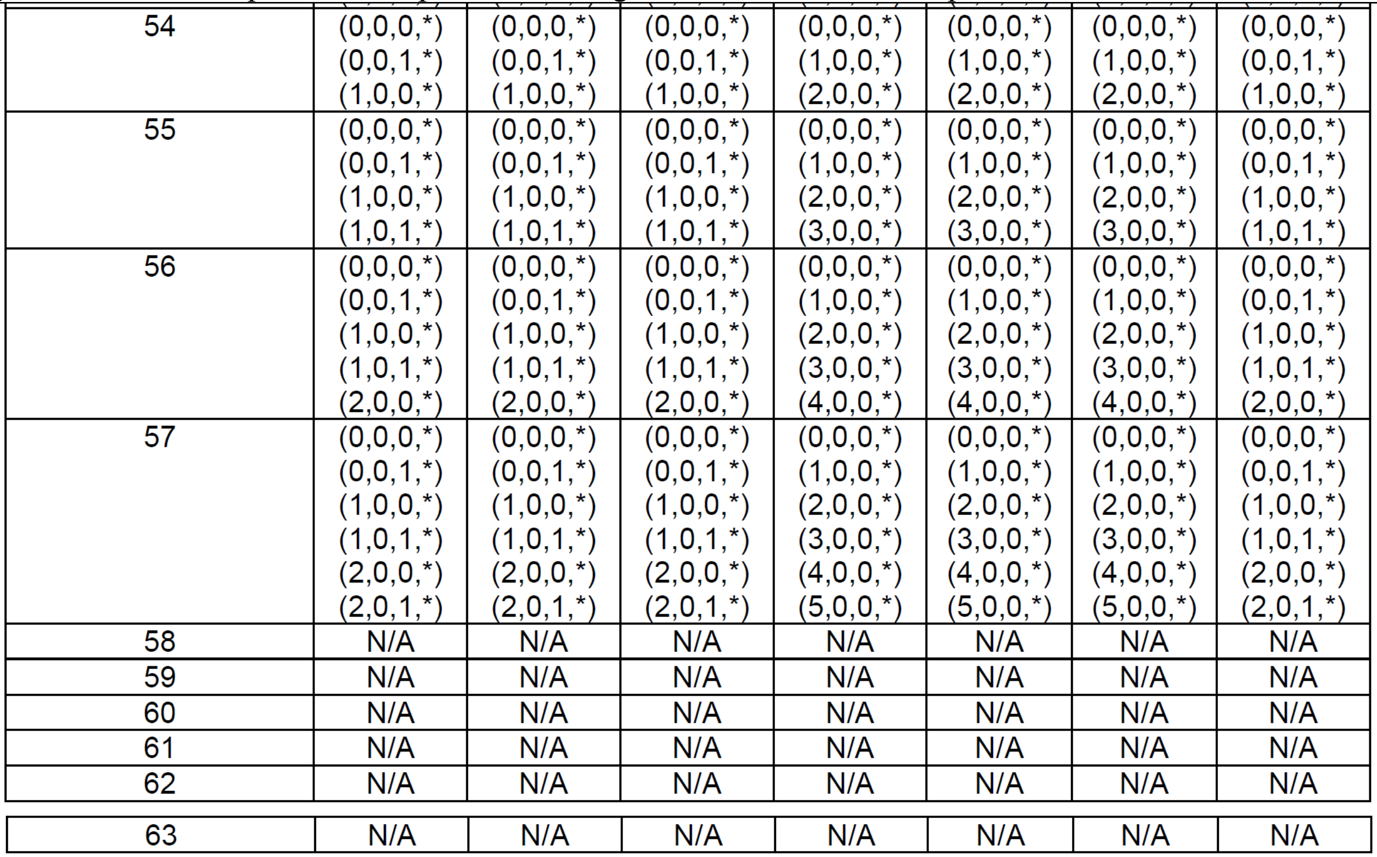
Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.
.
.

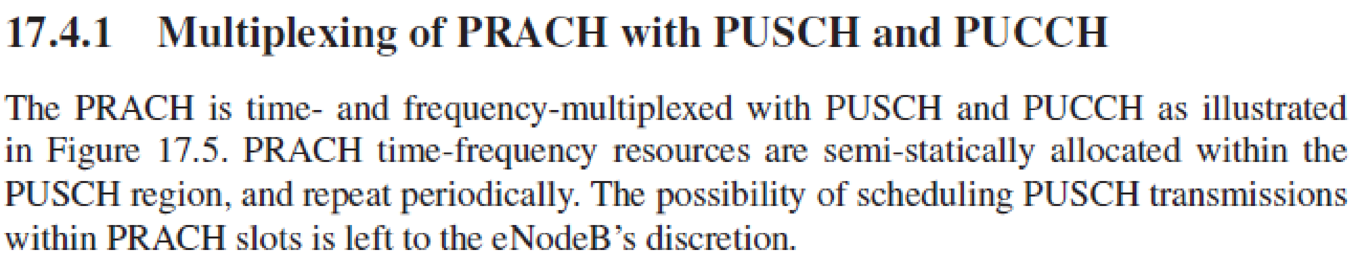
US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

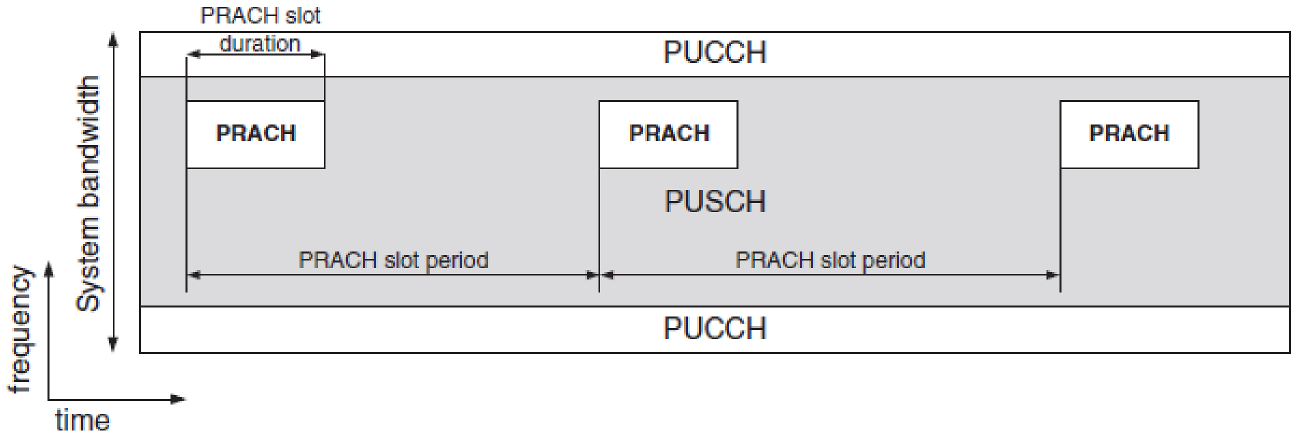
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



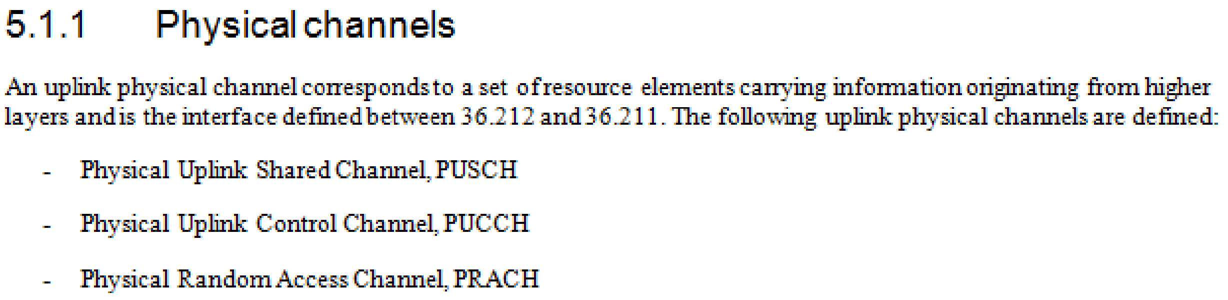
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

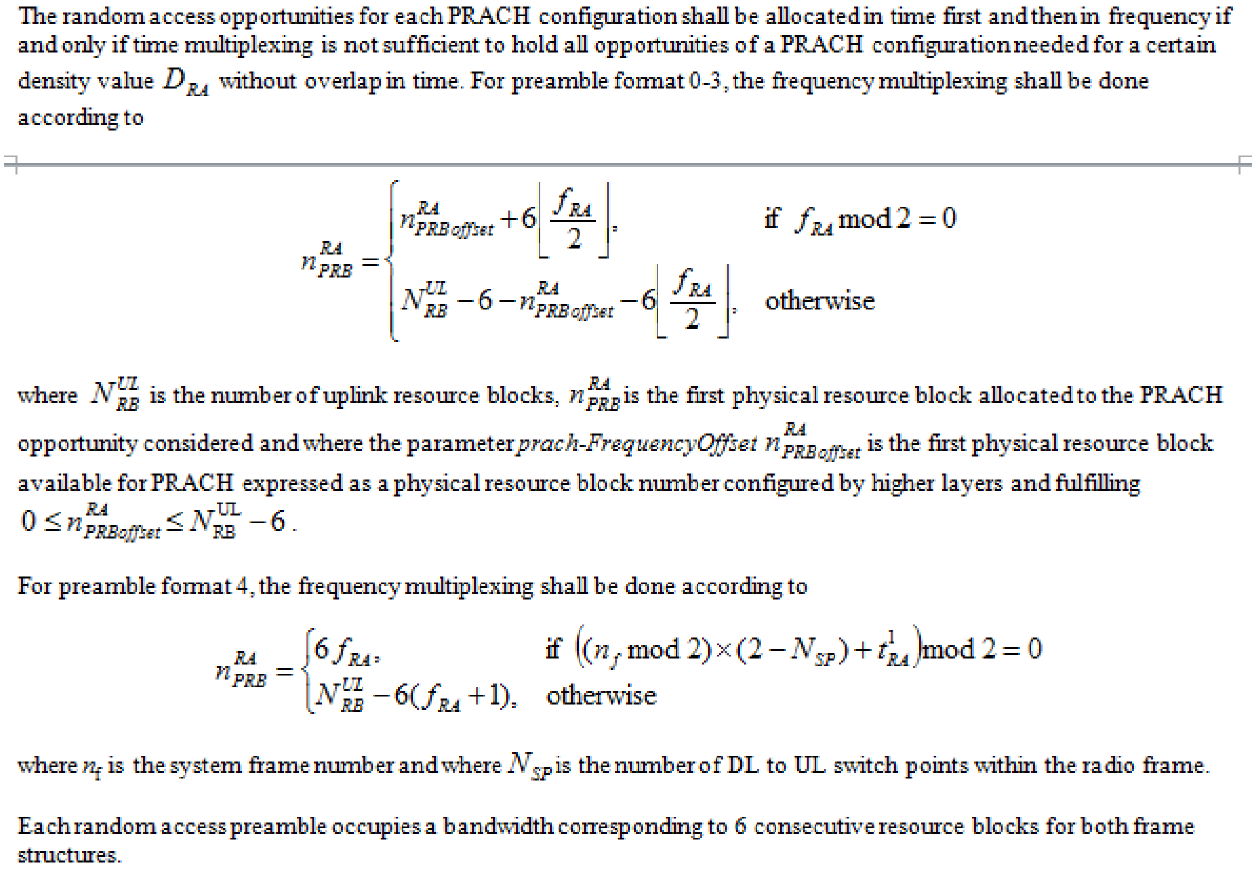
US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

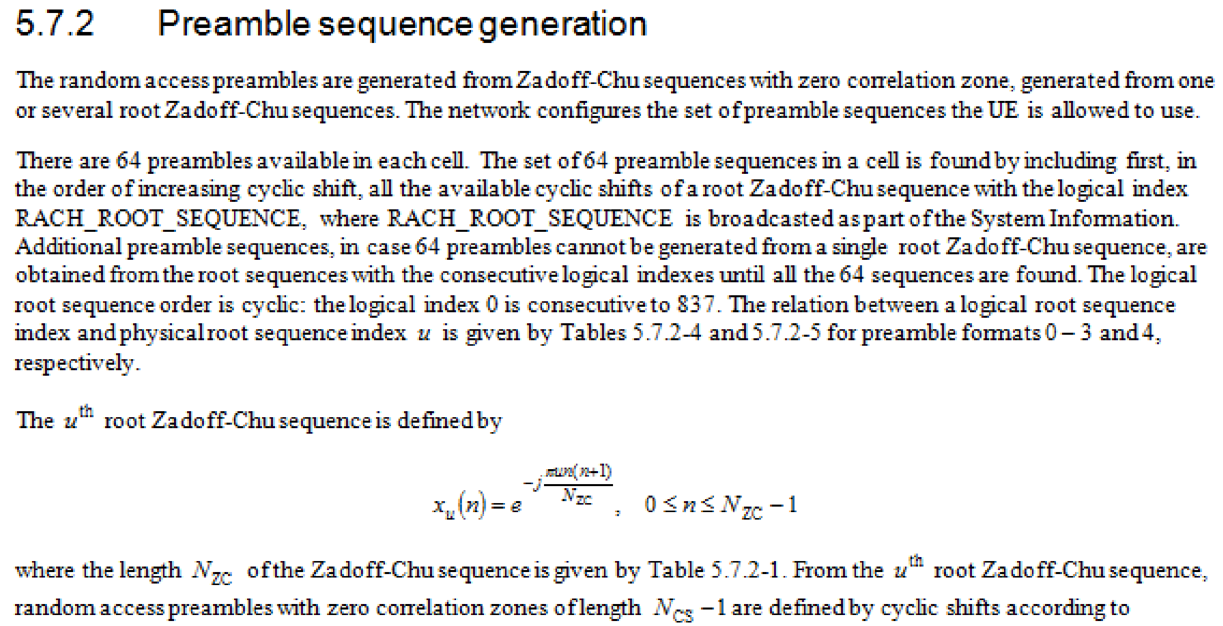
US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Ford's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB. 5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

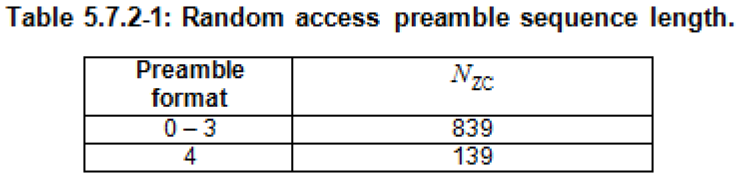


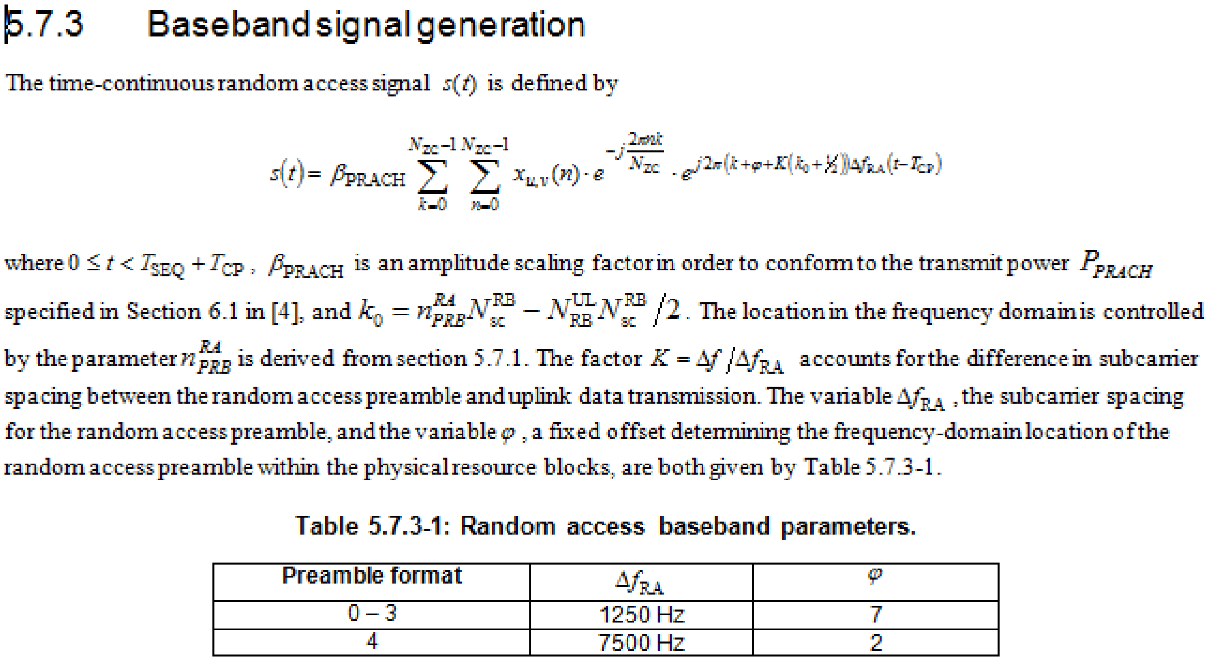
Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8

"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

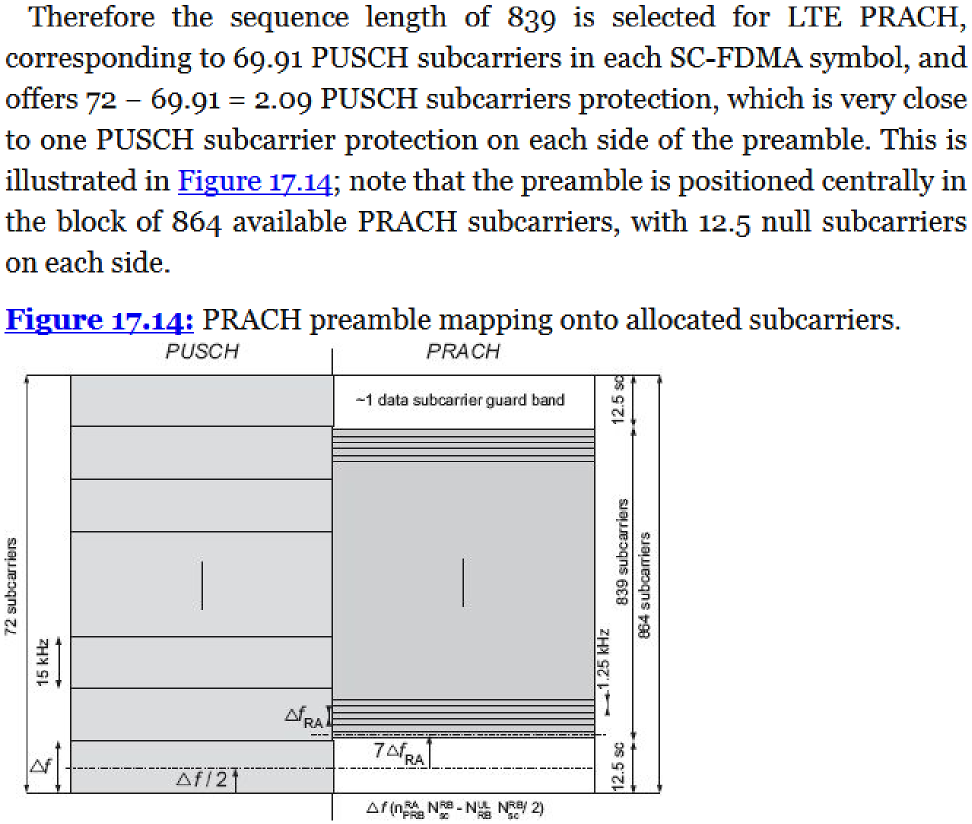
$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

where $0 \le t < T_{\mathrm{SEQ}} + T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\mathrm{sc}}^{\mathrm{RB}} - N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}} / 2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

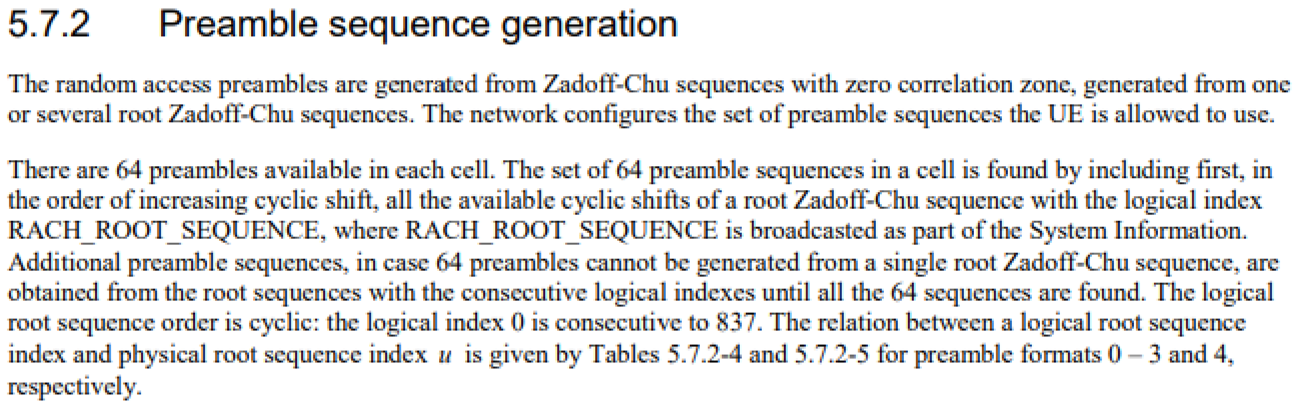
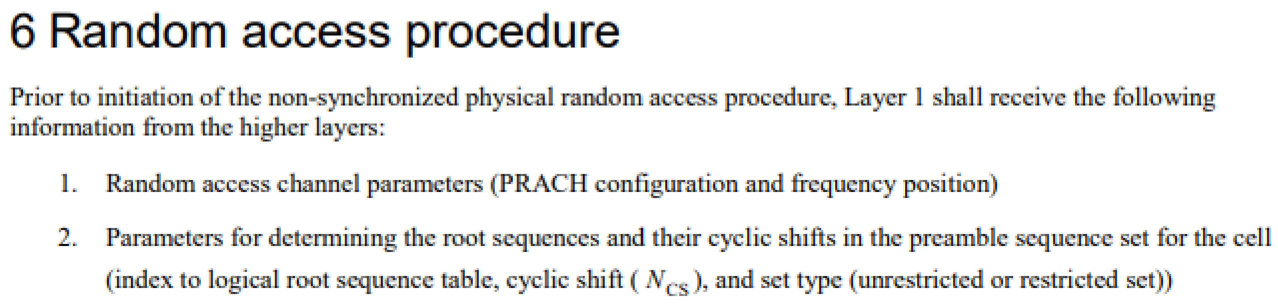
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

	 Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Ford's Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

US Patent No. 10,833,908: Claim 9

“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

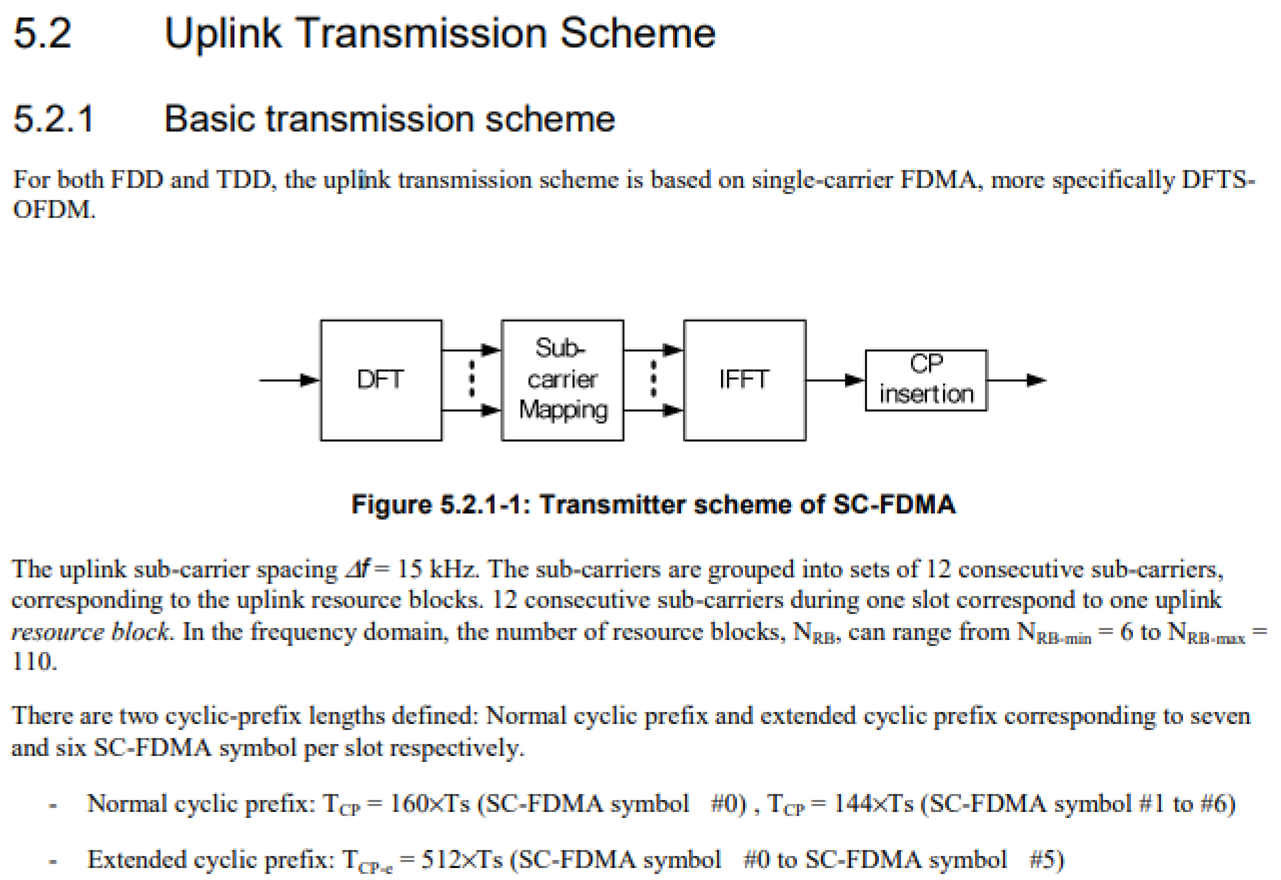
```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

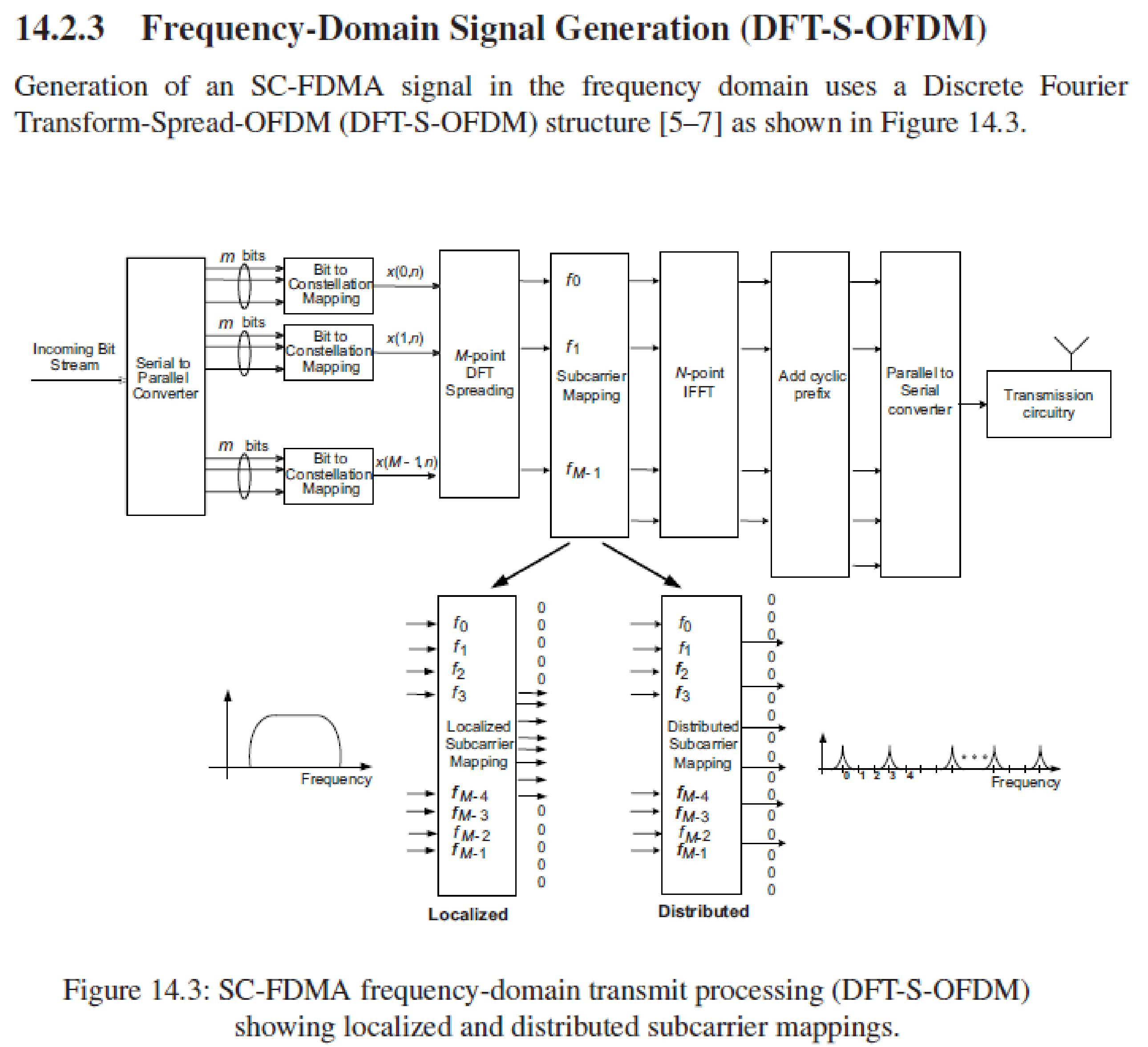
US Patent No. 10,833,908: Claim 10

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 1. Ford's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Ford's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 10

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."



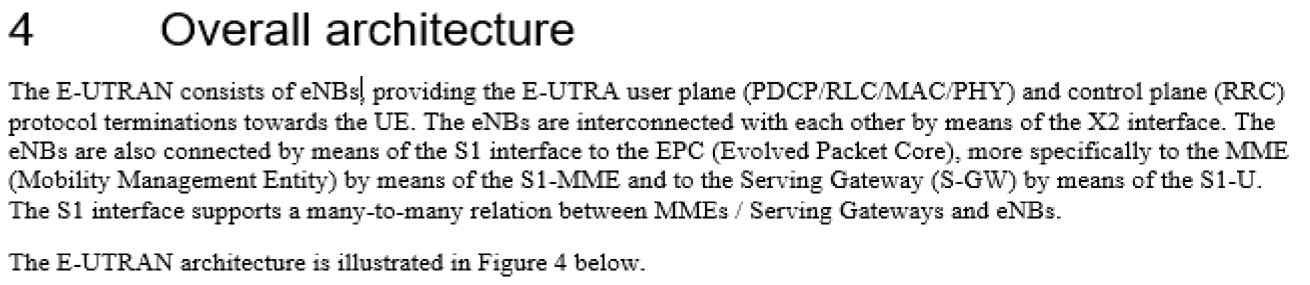
14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, Ford's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* Ford's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Ford offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

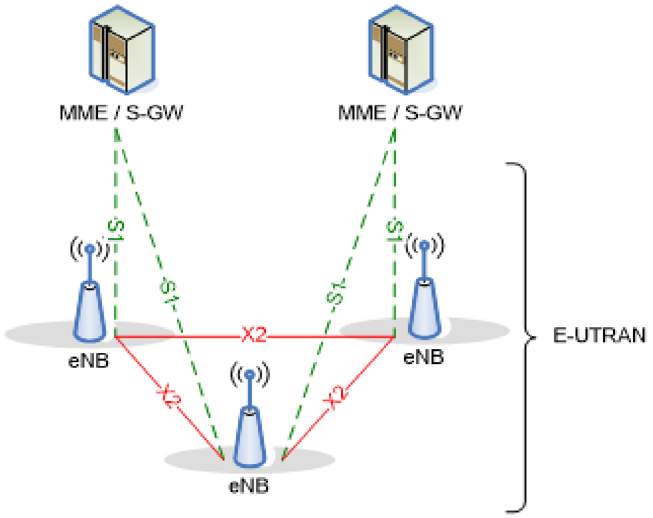


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

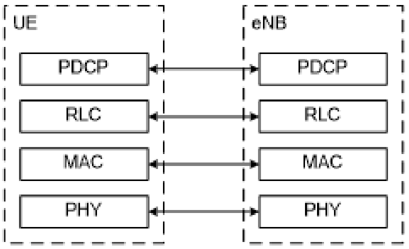
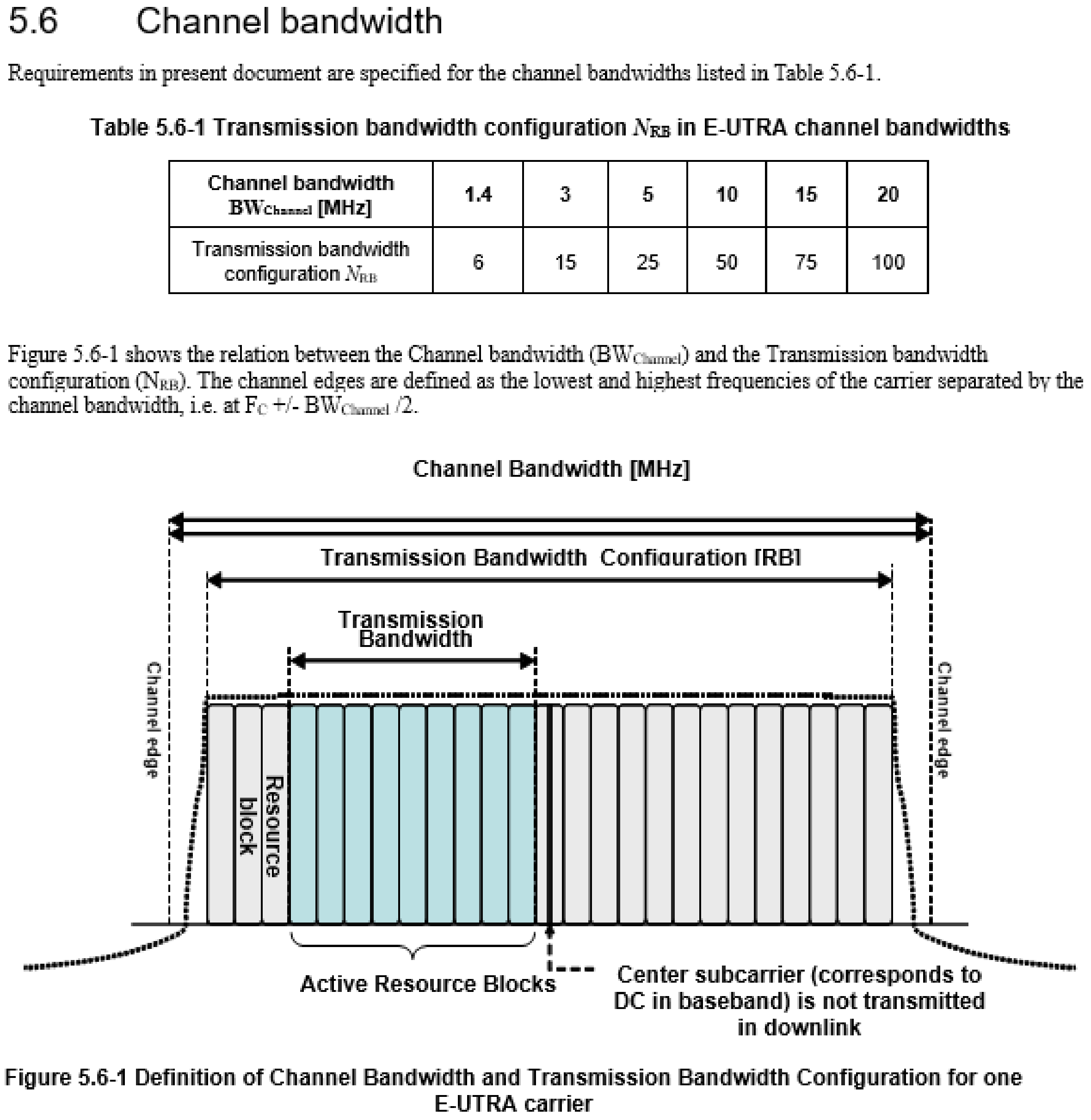


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Ford’s Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

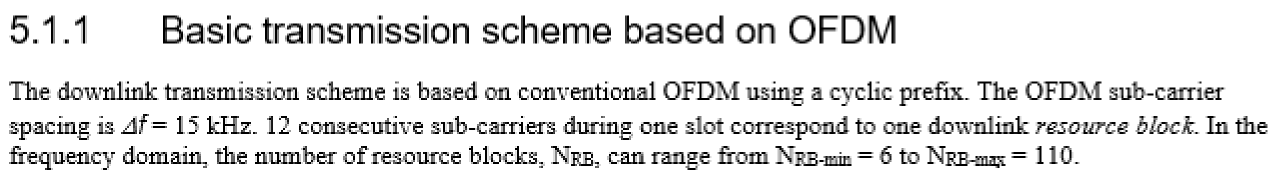
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

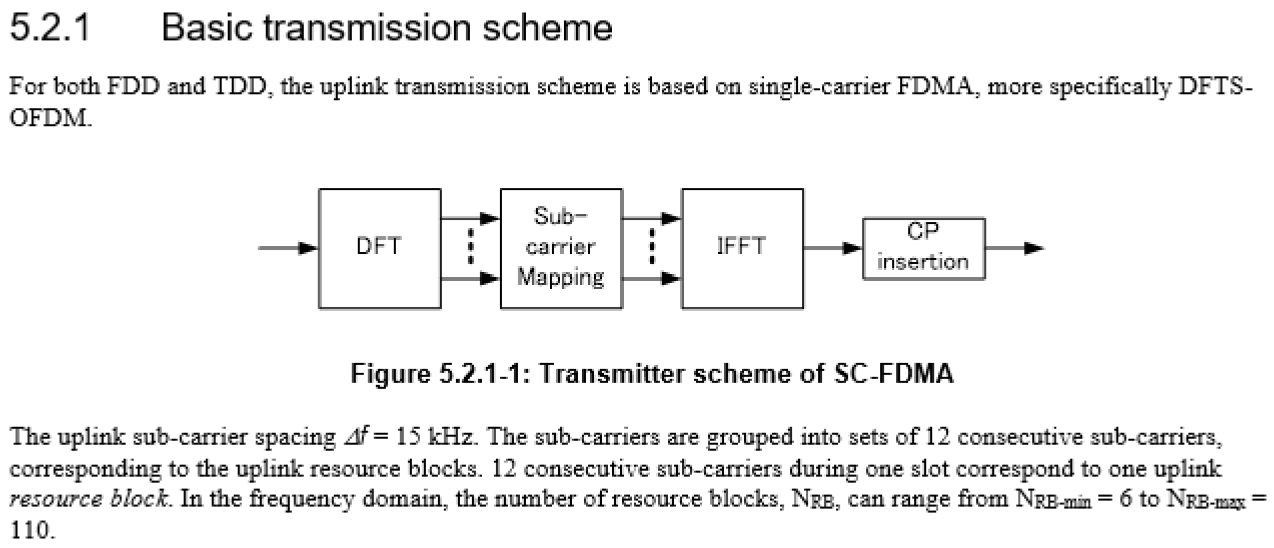
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

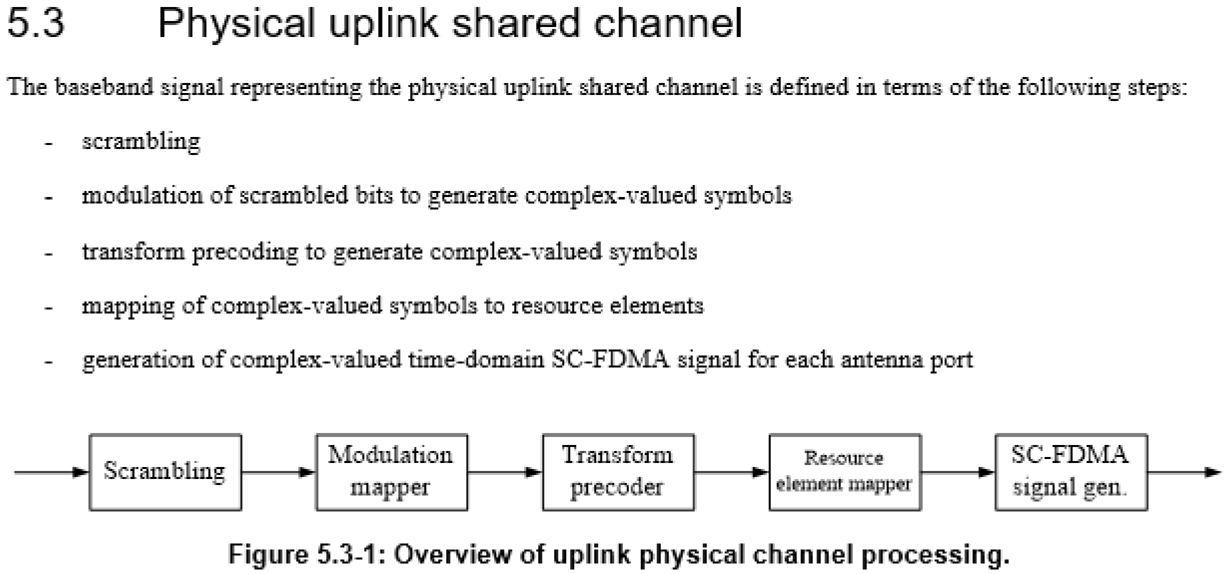
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

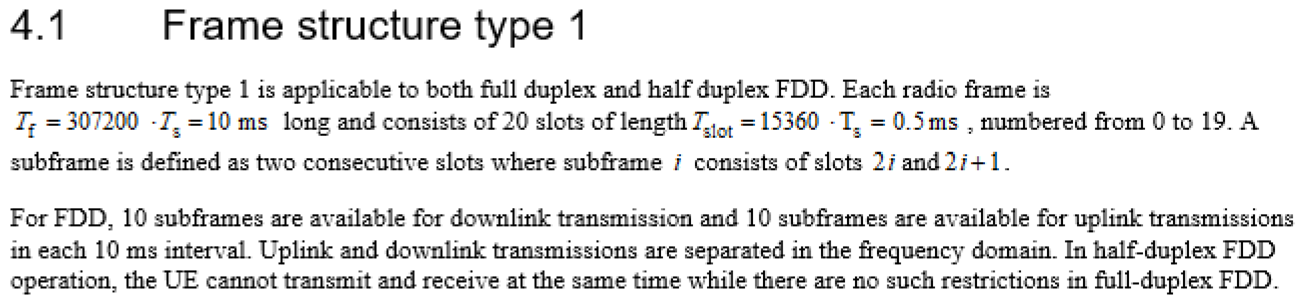
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\ \text{ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\ \text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

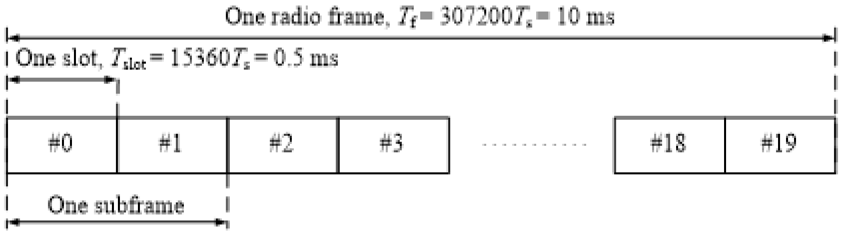
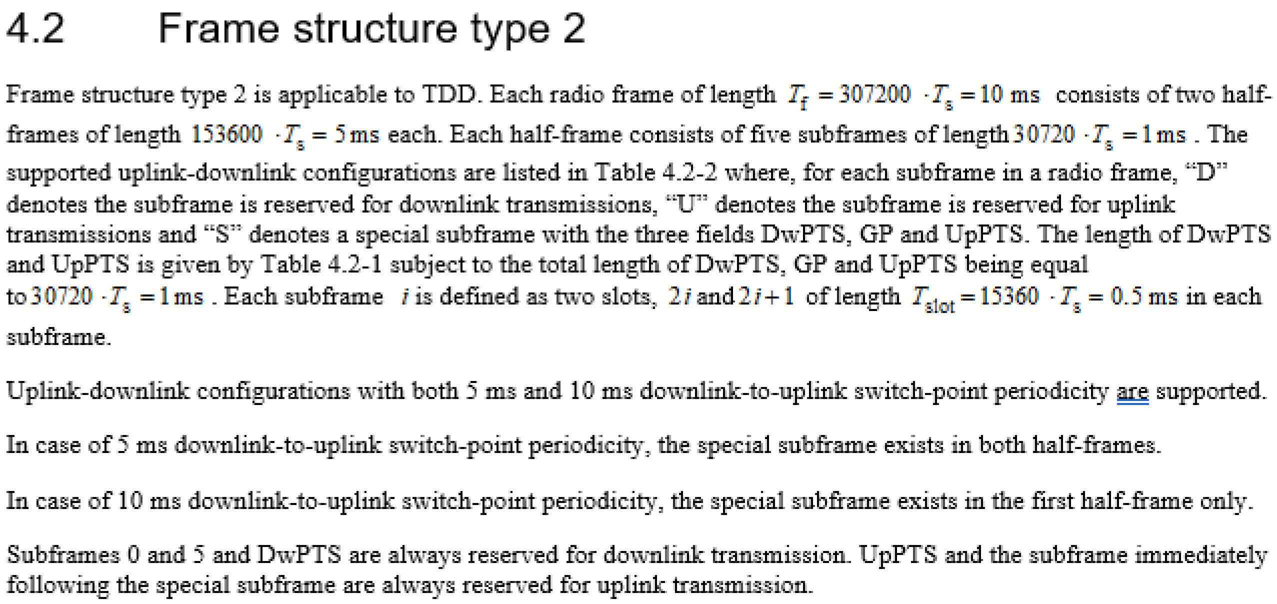


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms . The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms . Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

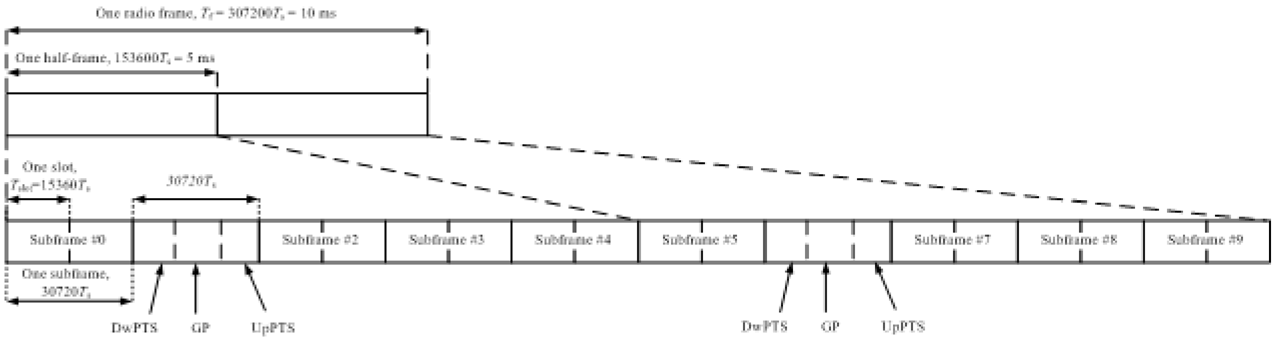
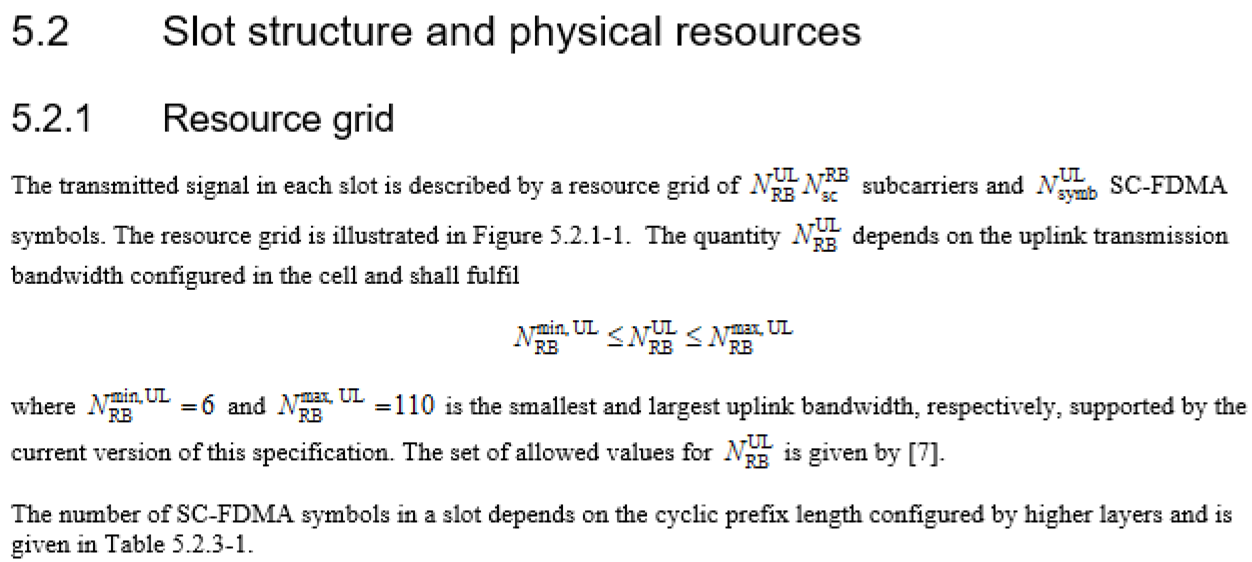


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

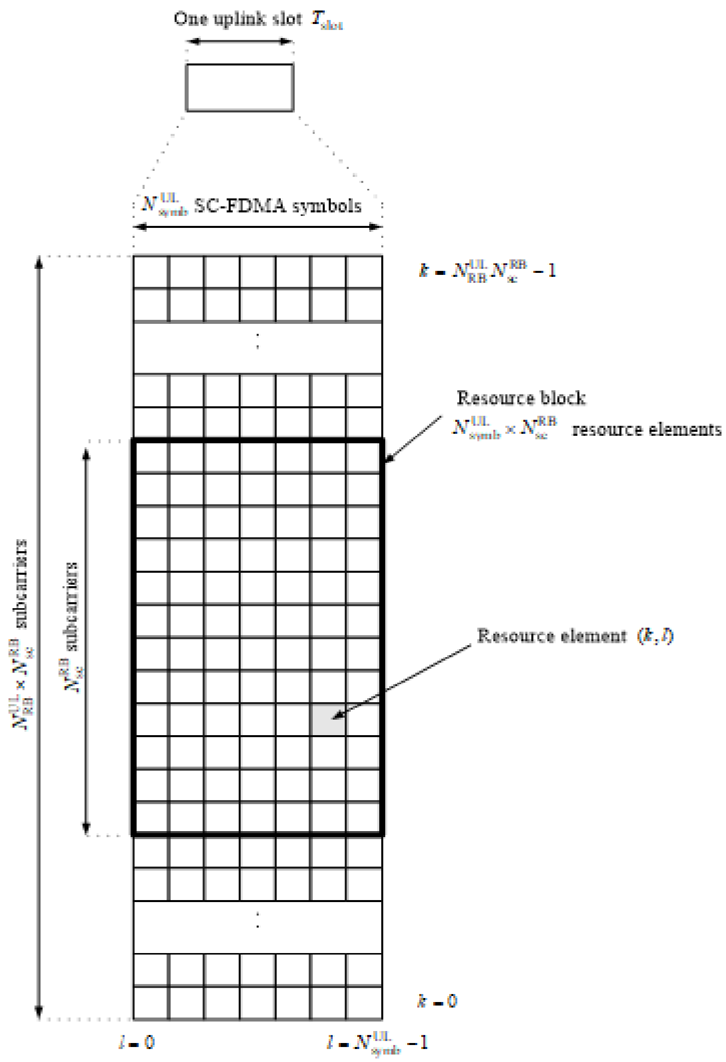
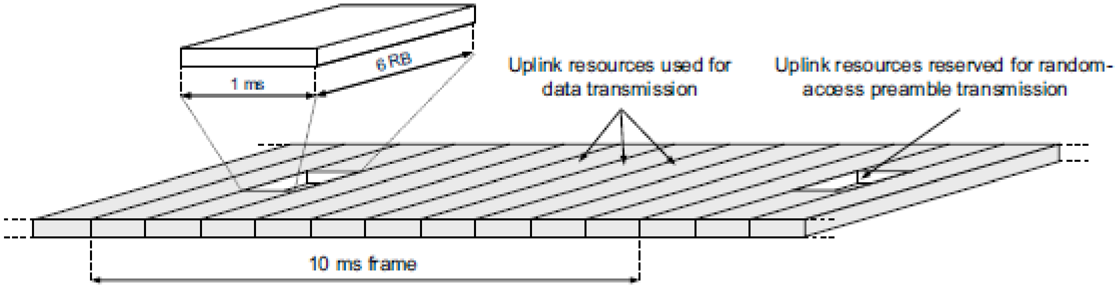


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	Ford’s Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

<table>
<tr>
<td></td>
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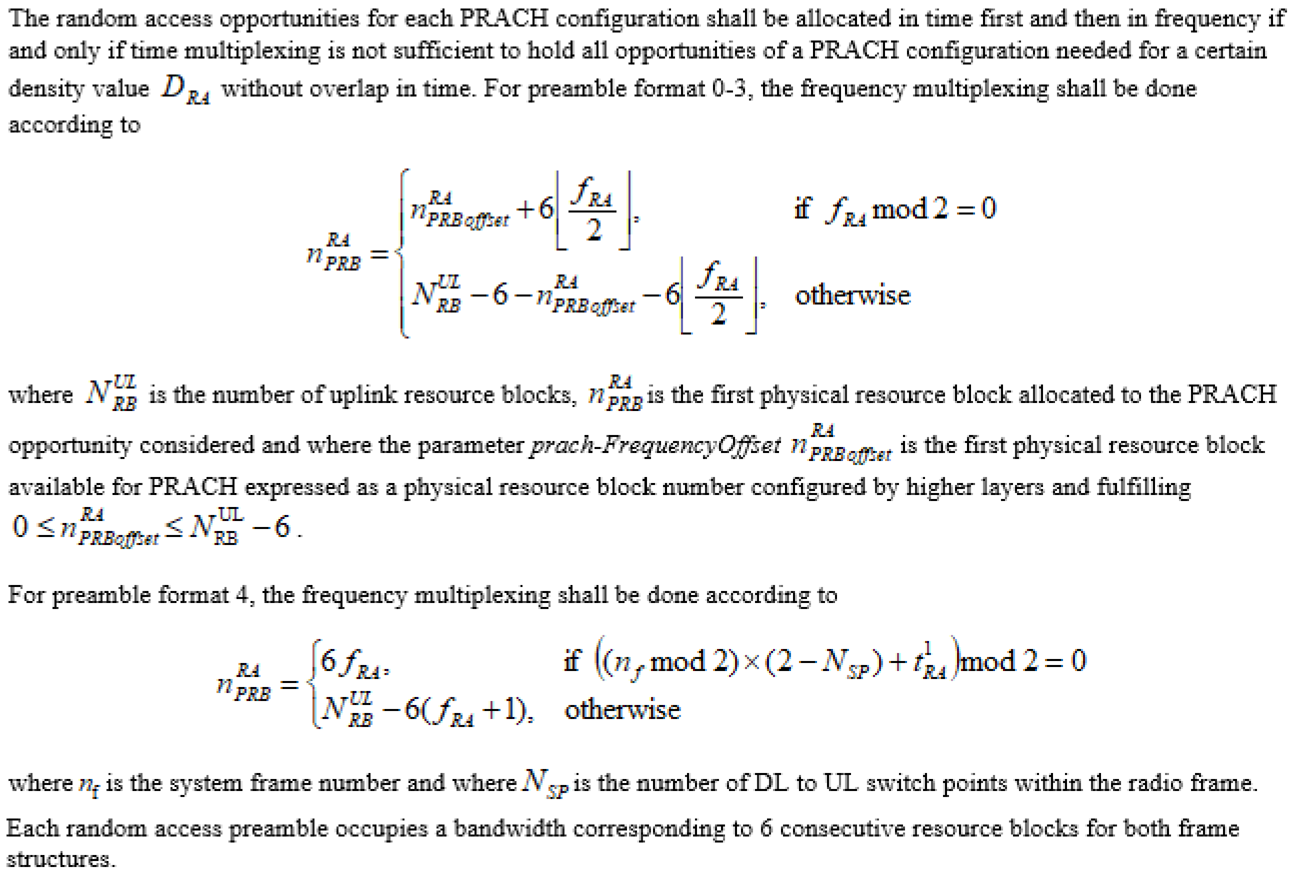


The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

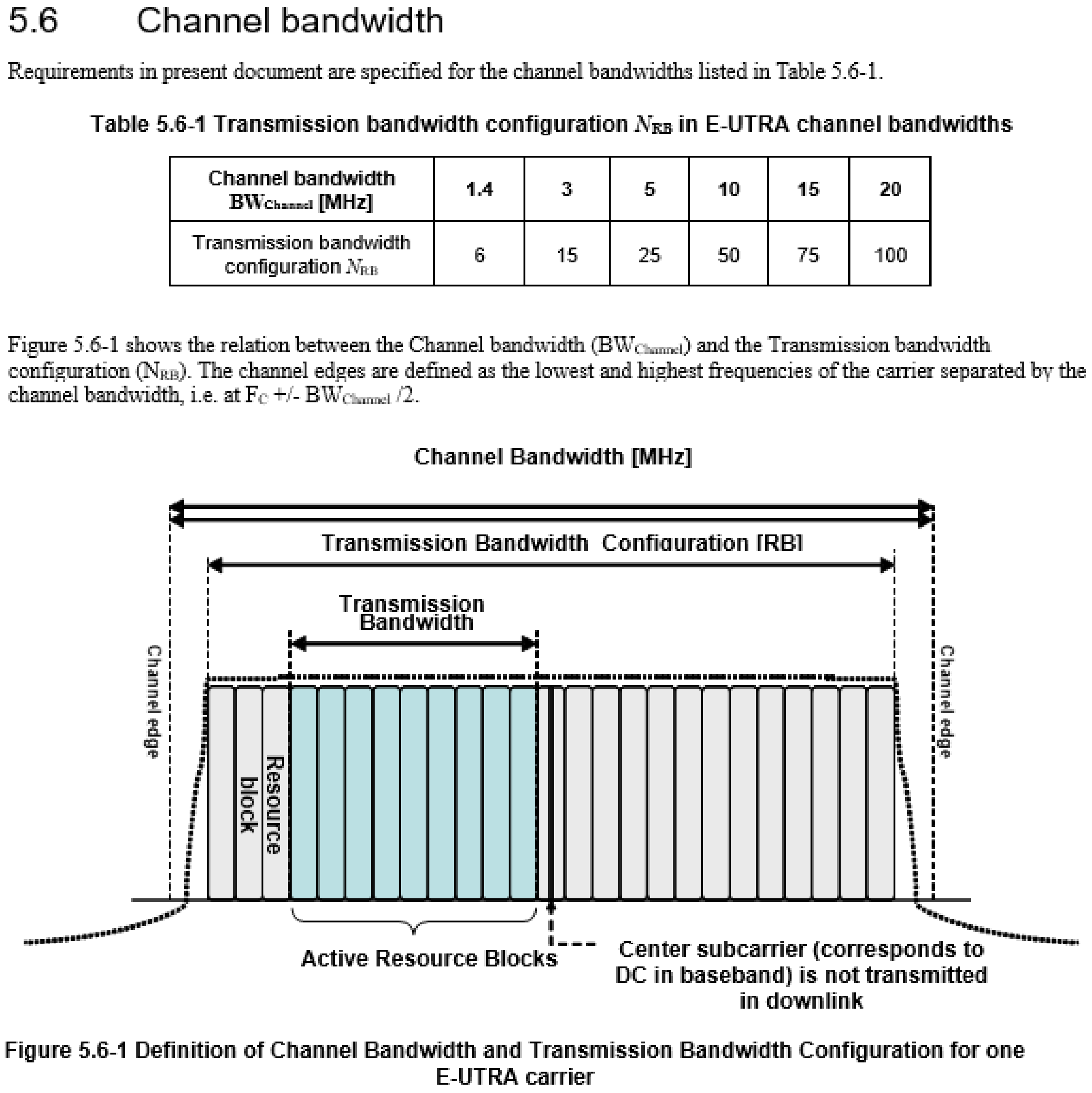
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.
</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

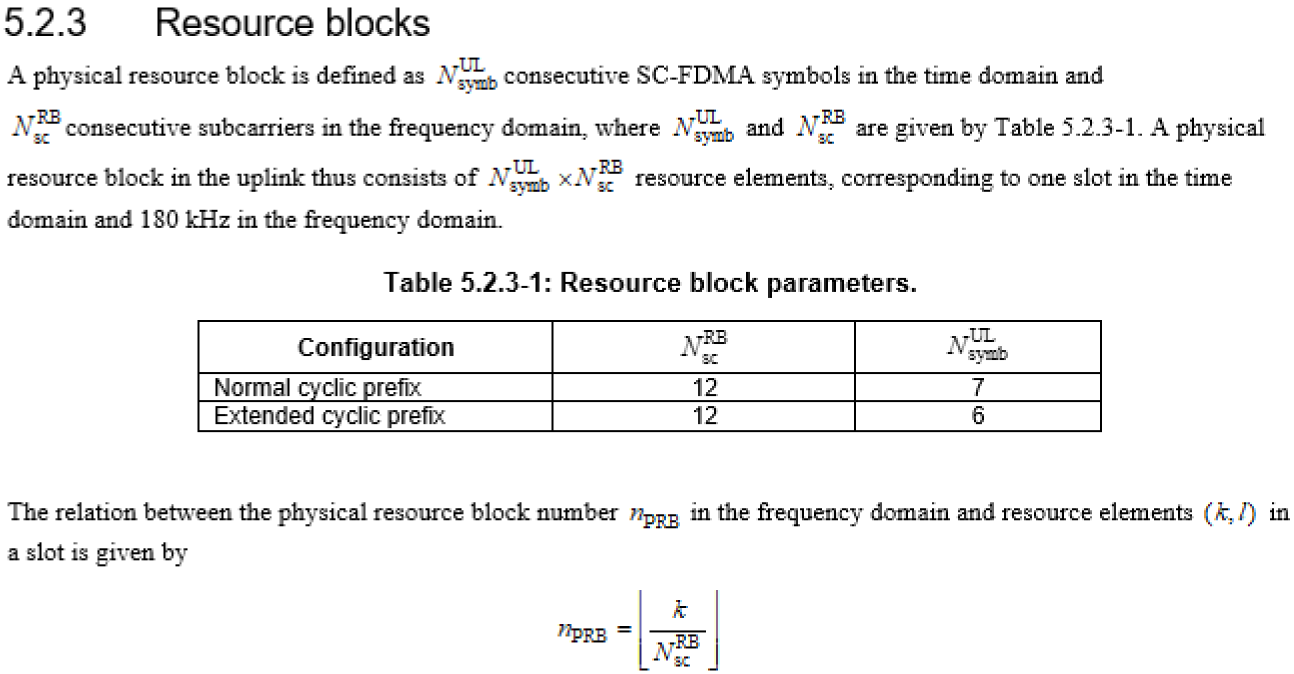
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

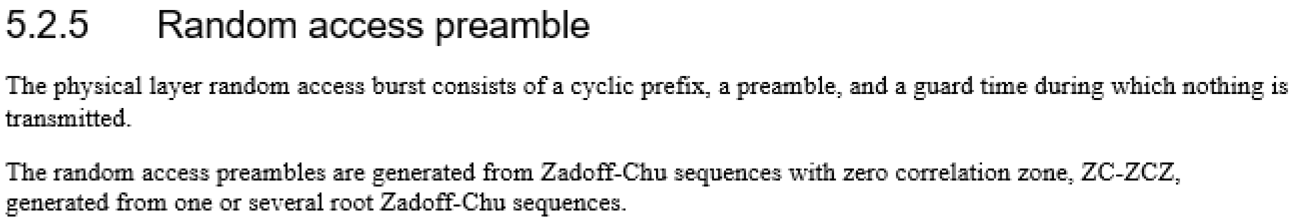
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

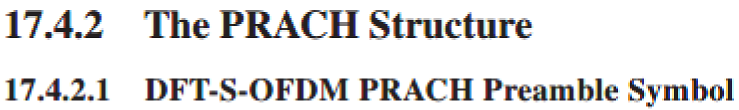


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

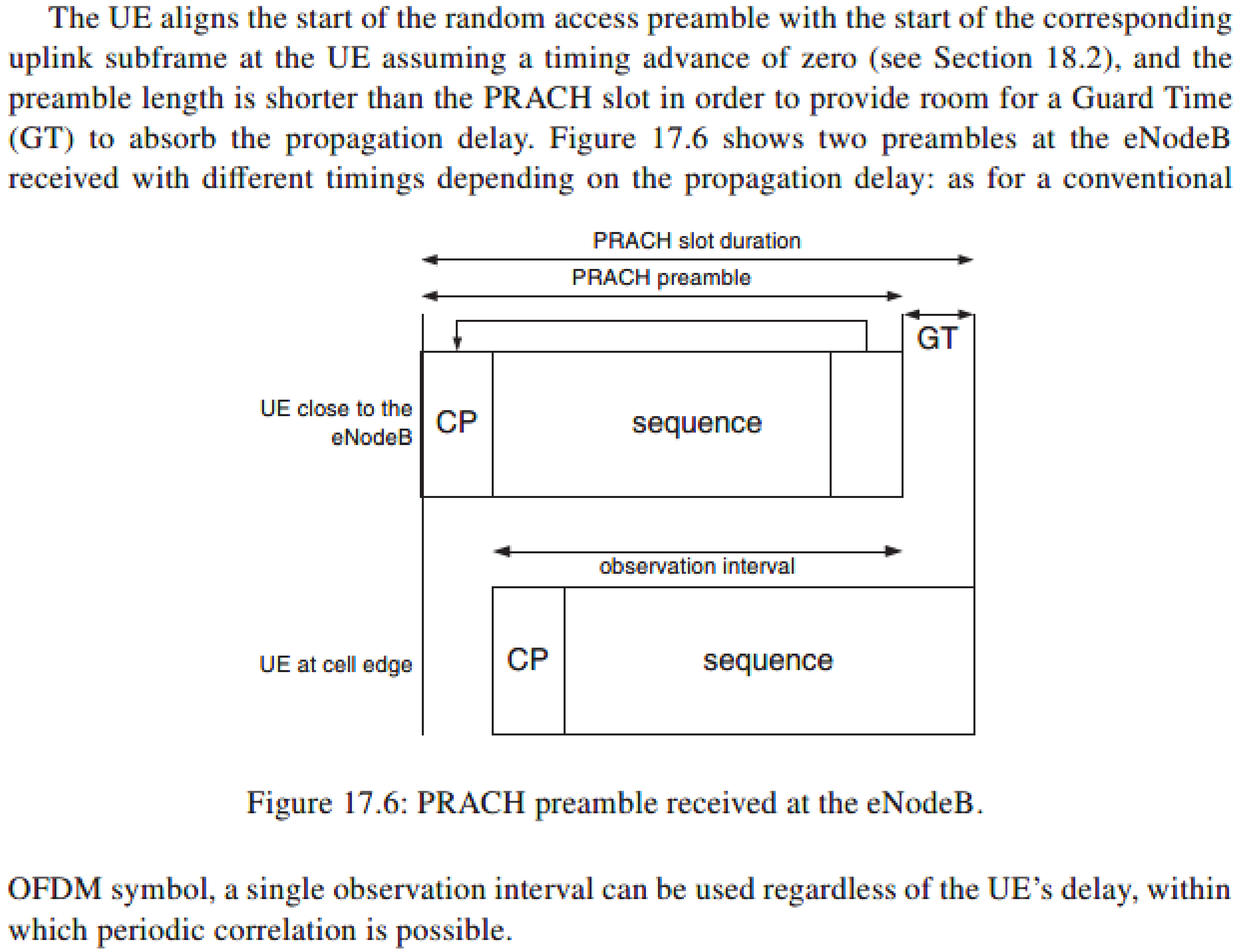


17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional

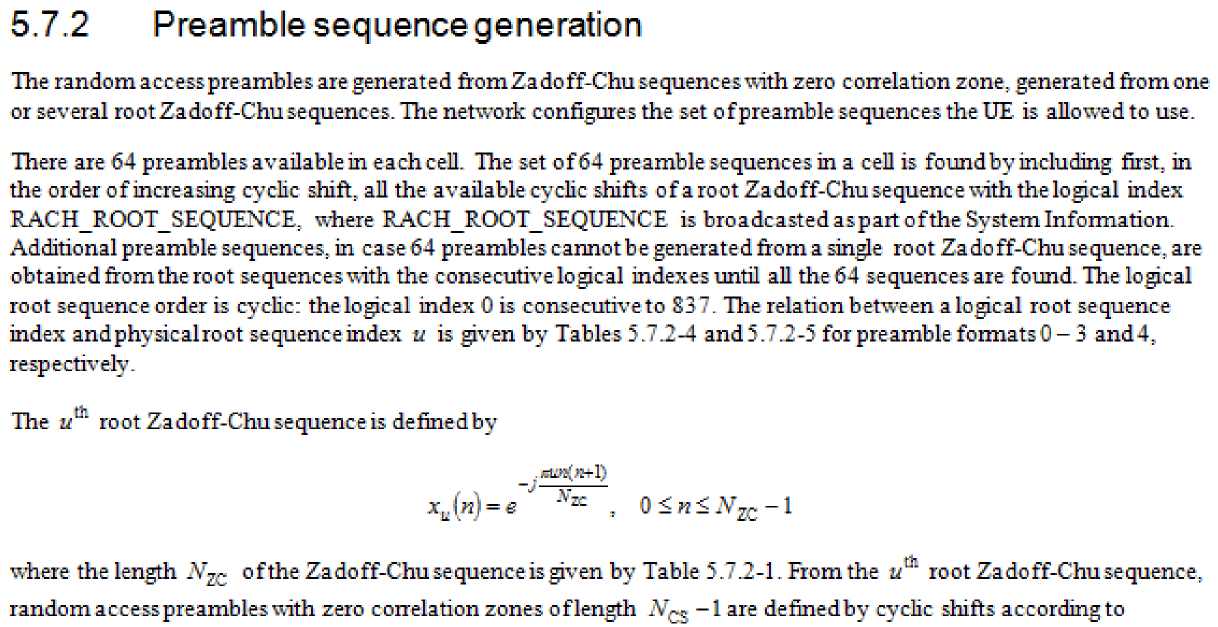
Figure 17.6: PRACH preamble received at the eNodeB.

OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378.

The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n)=e^{-j\frac{\pi u n(n+1)}{N_{ZC}}},\quad 0\le n\le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

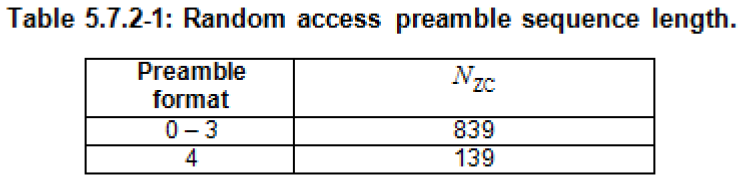
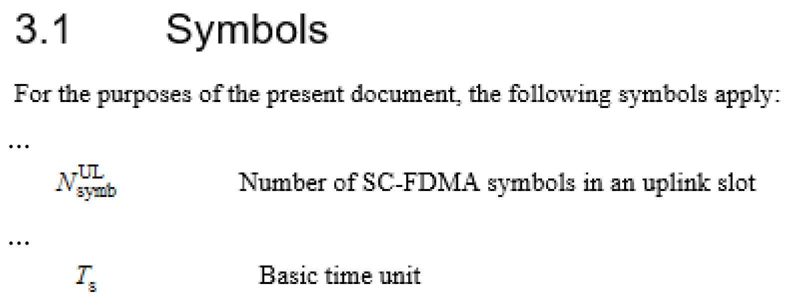
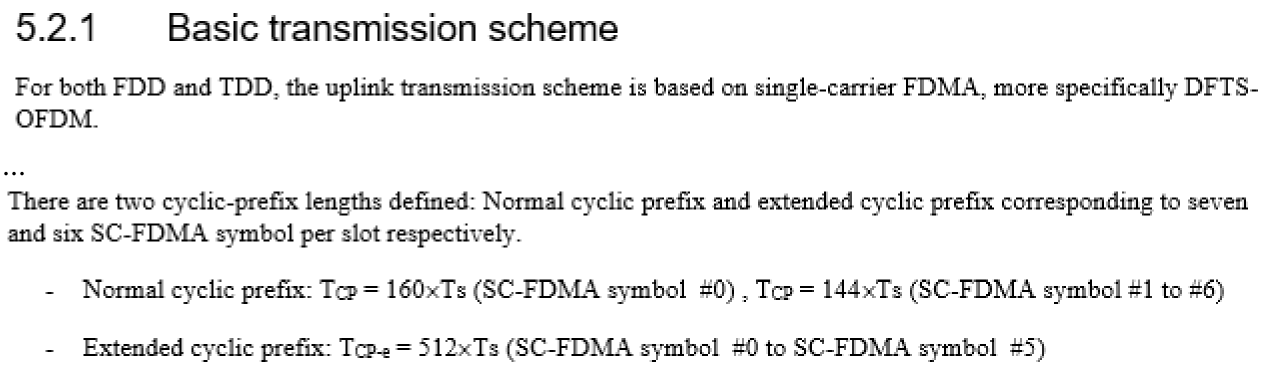


Table 5.7.2-1: Random access preamble sequence length.

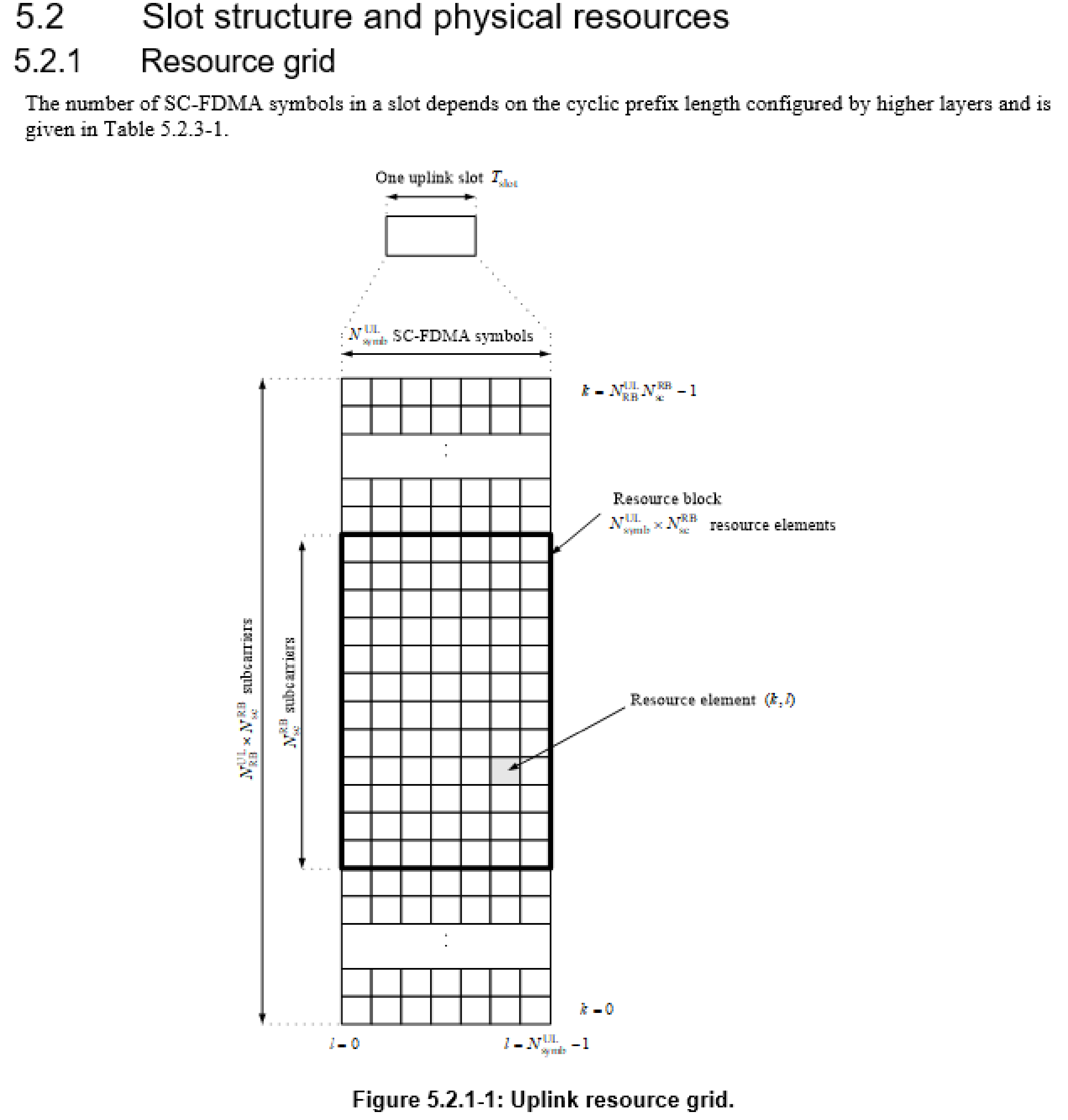
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Ford's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



5.2 Slot structure and physical resources

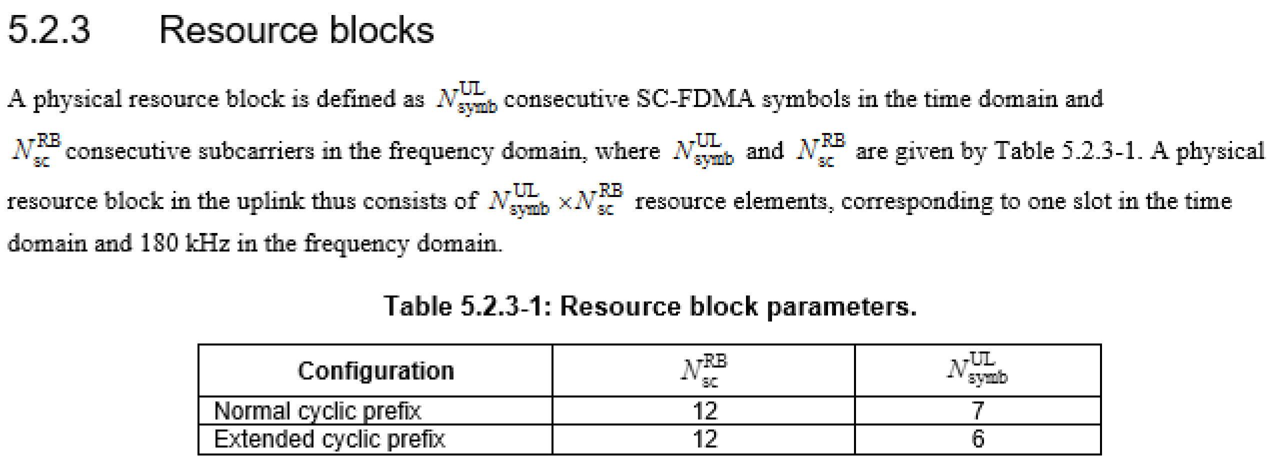
5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

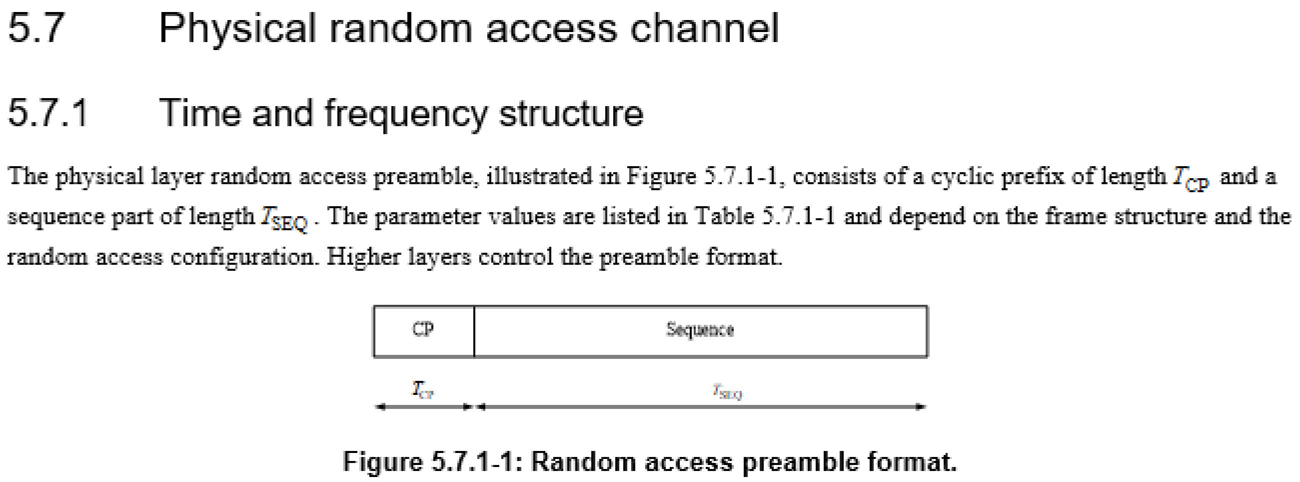
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

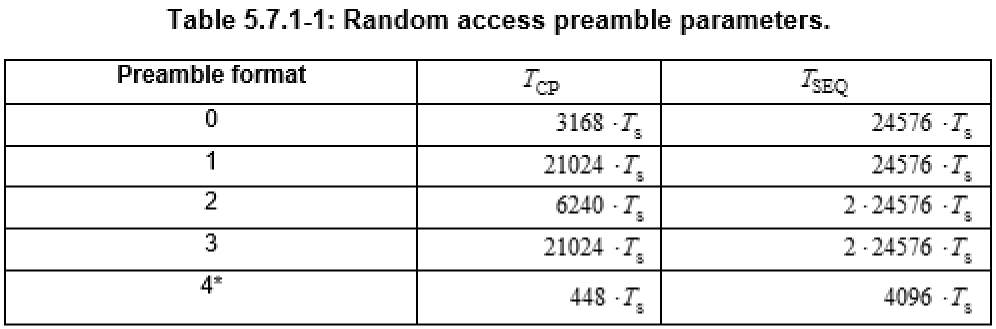
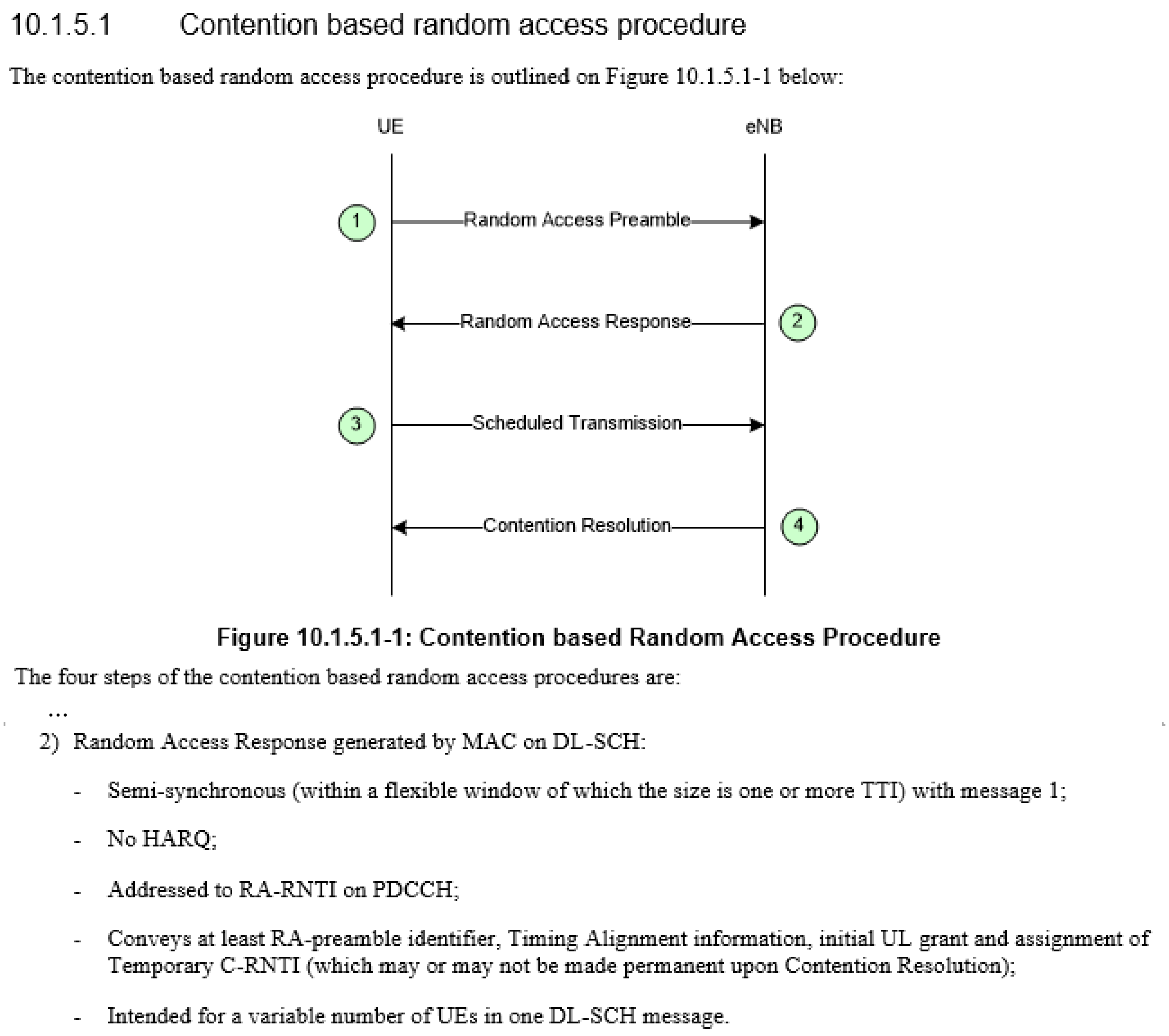


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

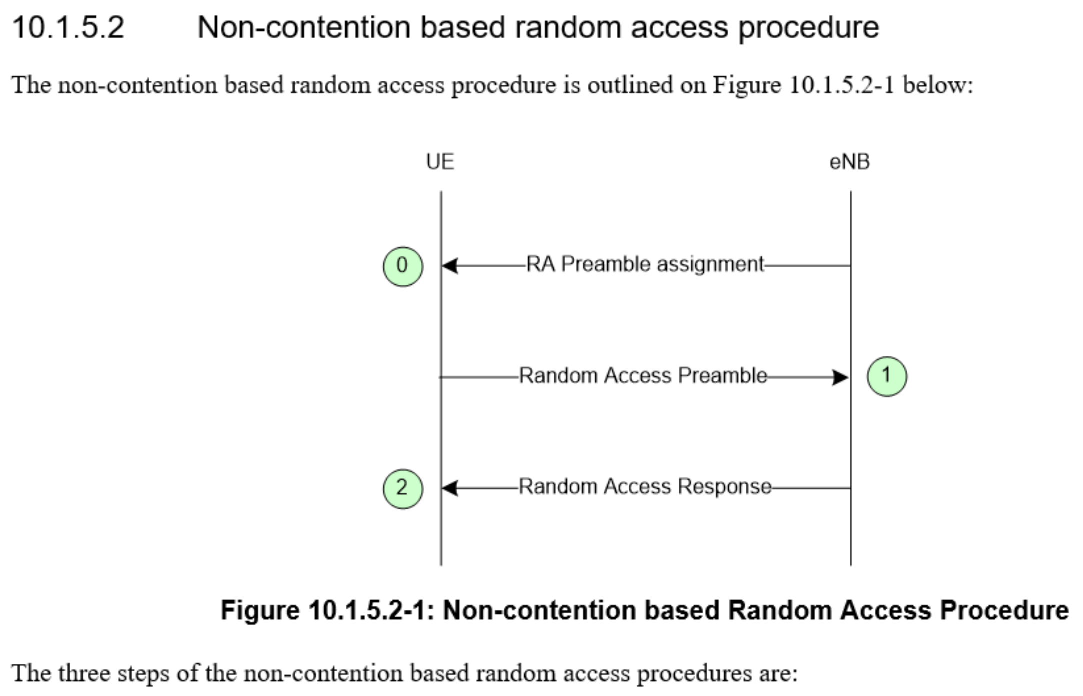
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

receiving, from the base station, a response message. ;	Ford's Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



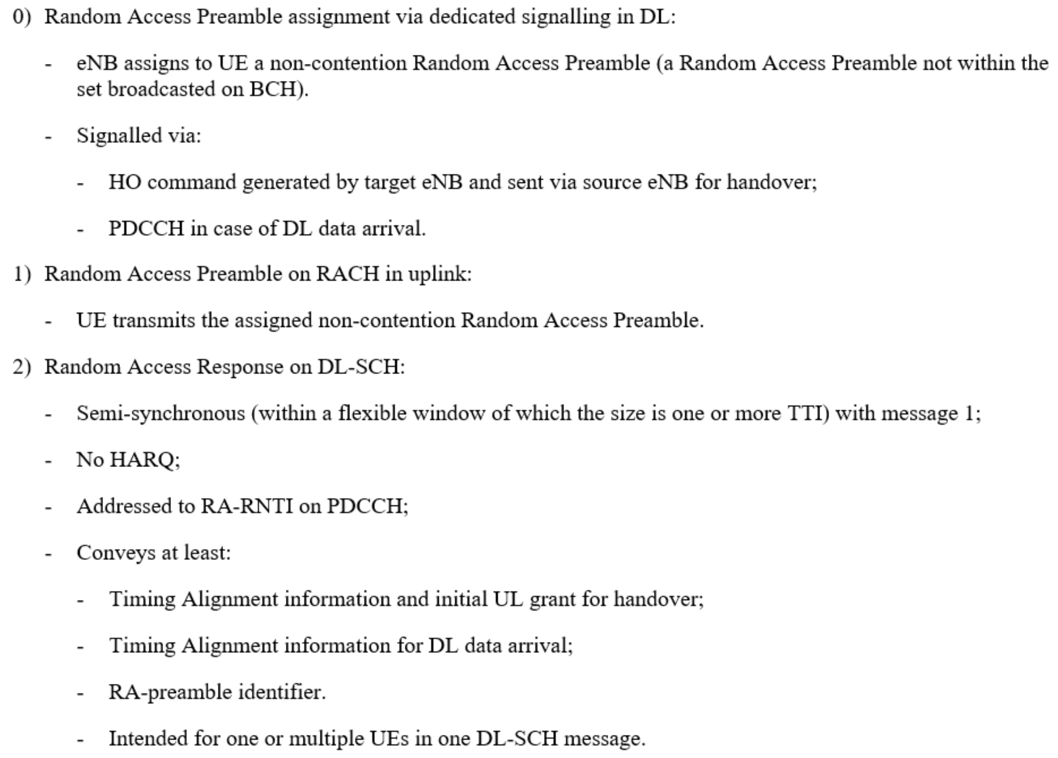
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

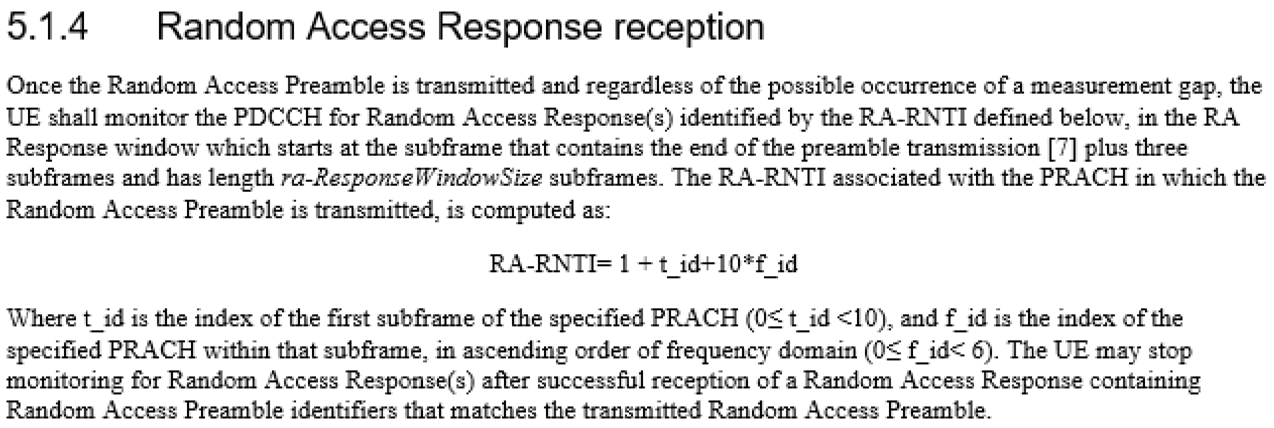
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

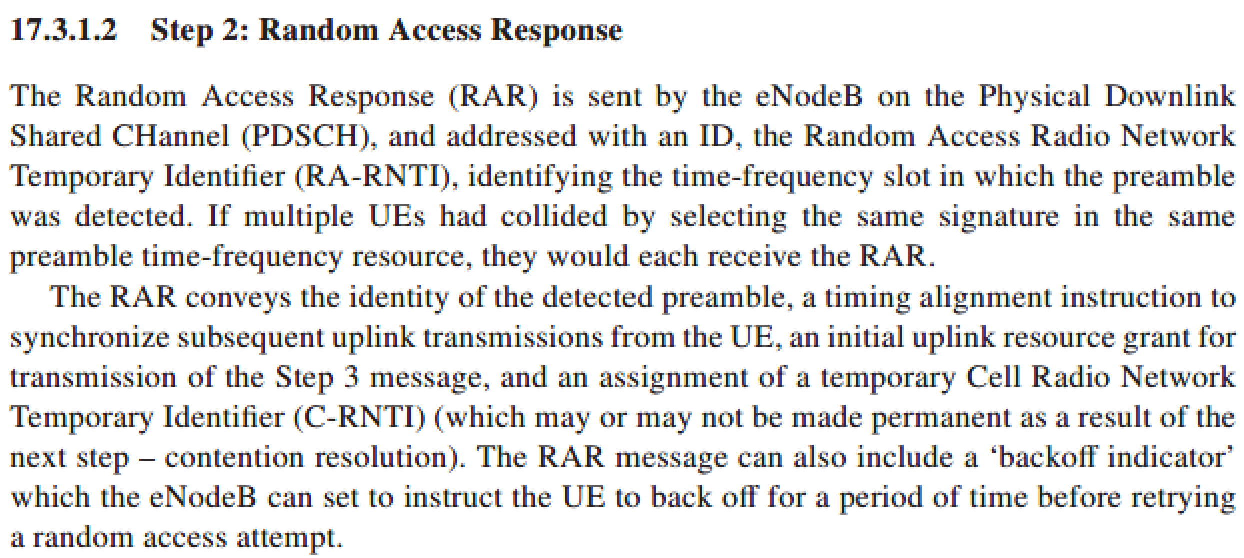
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

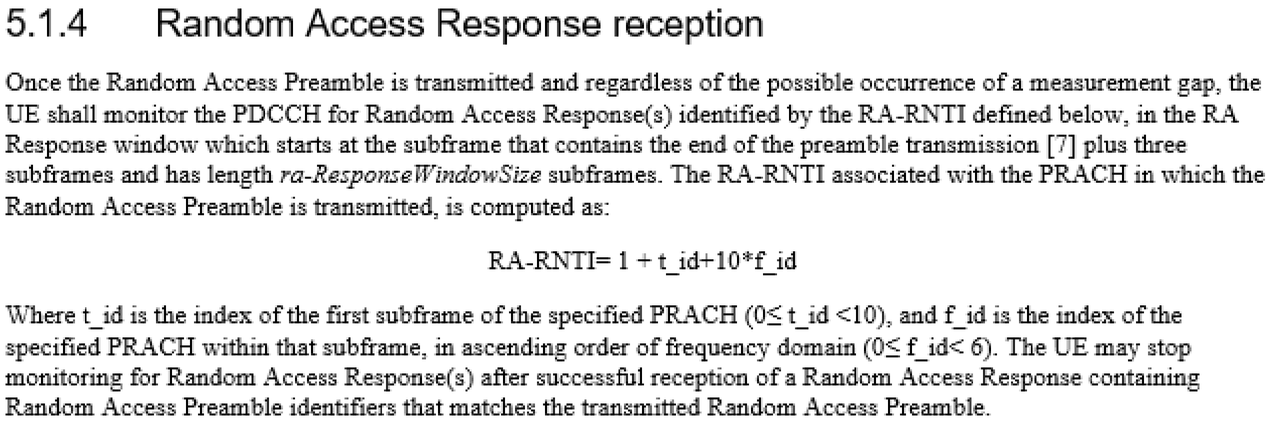
US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

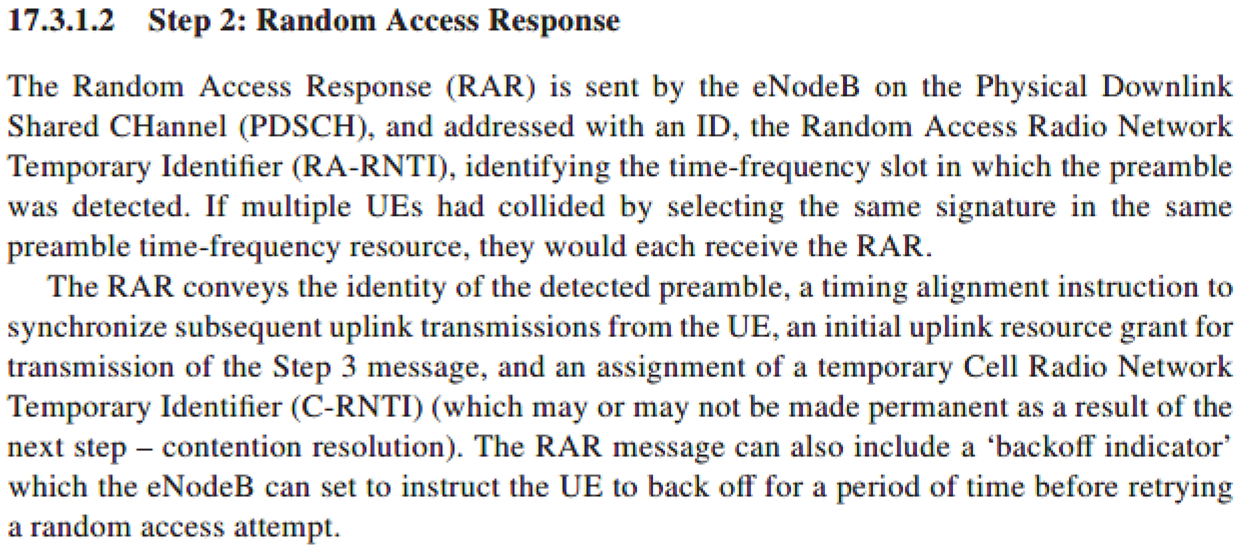
US Patent No. 10,833,908: Claim 12(a)
"The method claim 11, further comprising:"

12. The method claim 11, further comprising:	*See* Claim 11.

US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

determining if the response message identifies the sequence associated with the base station in the random access signal; and	Ford’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $RA\text{-}RNTI= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\le t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\le f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(b)
"determining if the response message identifies the sequence associated with the base station in the random access signal; and"



17.3.1.2 Step 2: Random Access Response

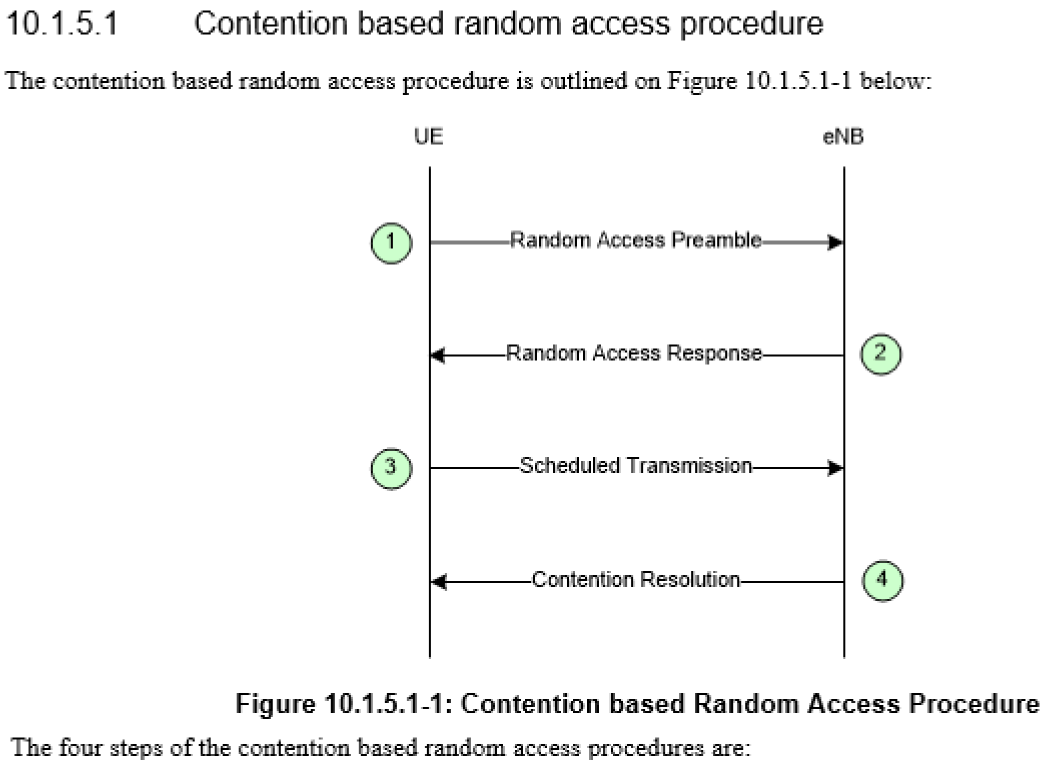
The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

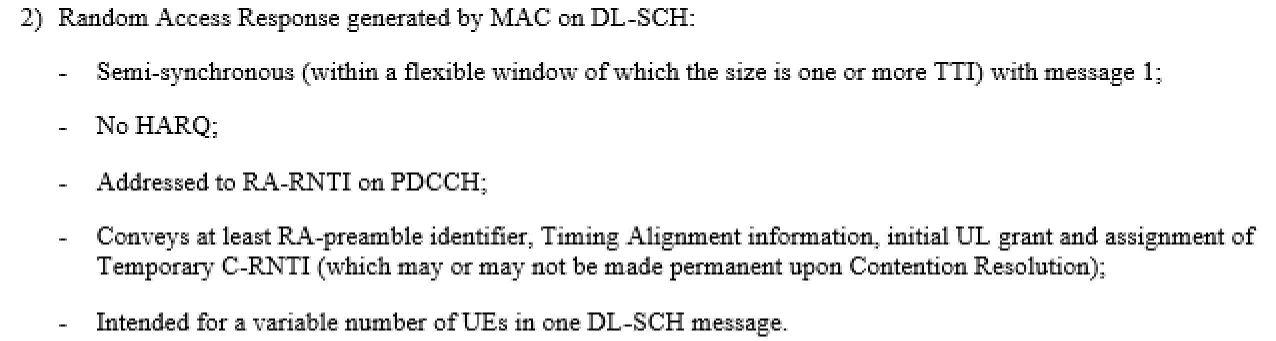
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

See also Claim 2.

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Ford’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

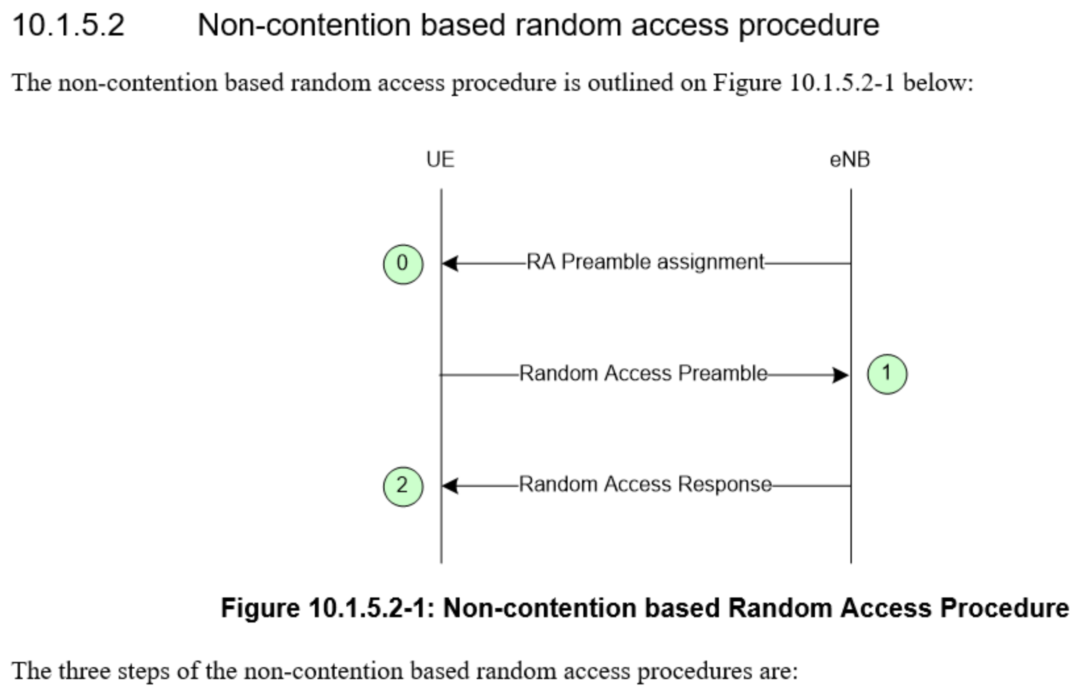
US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

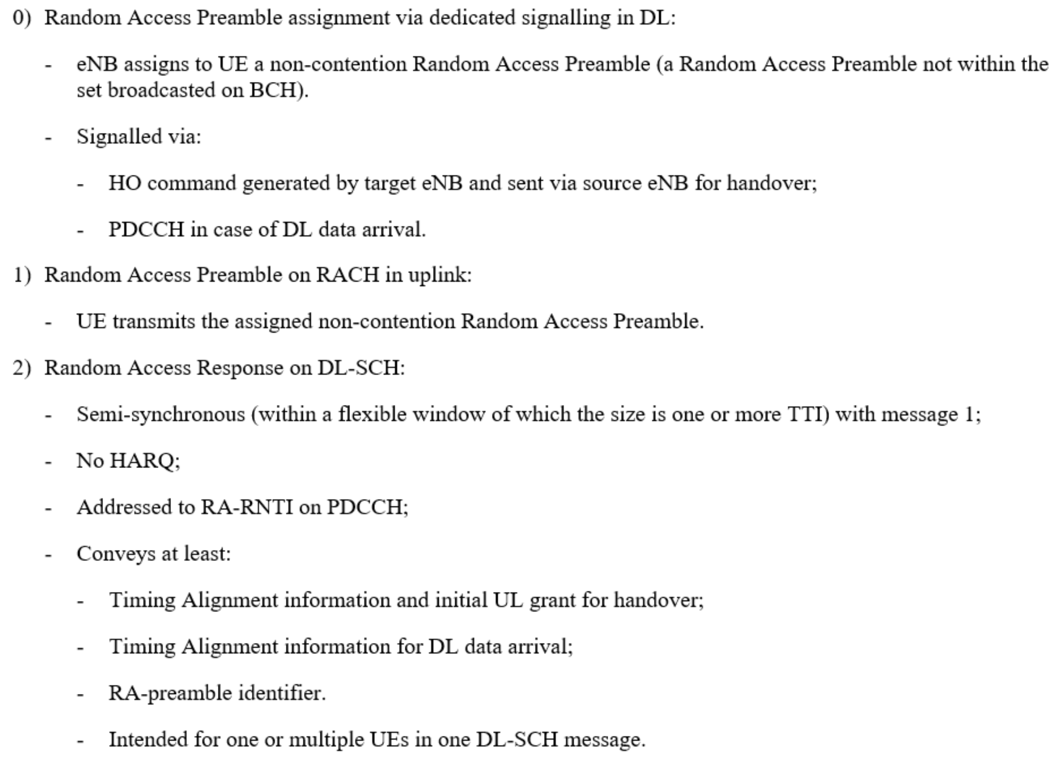


10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

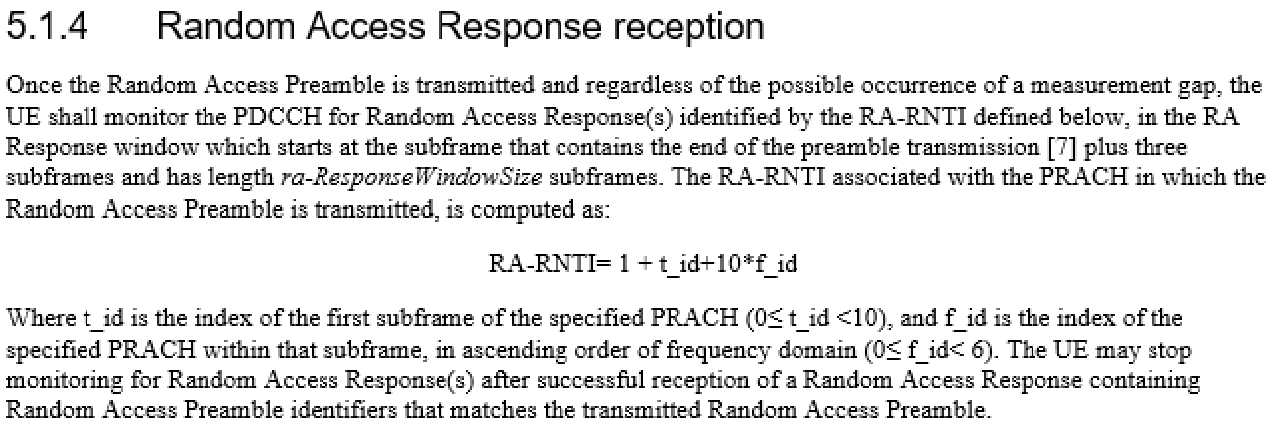


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

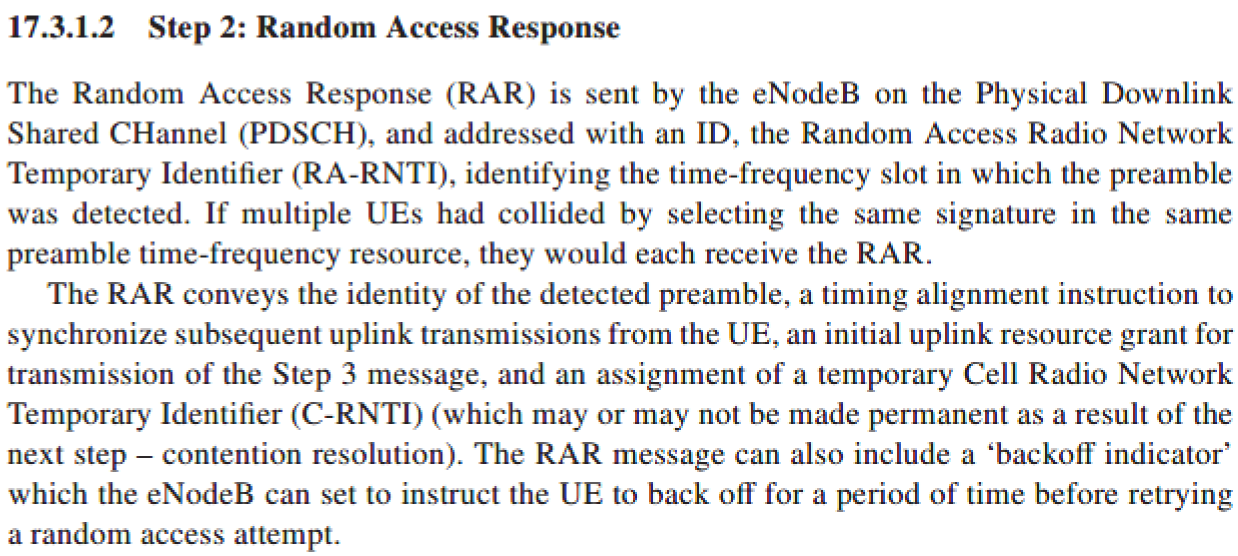
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + \text{t\_id}+10*\text{f\_id}$$

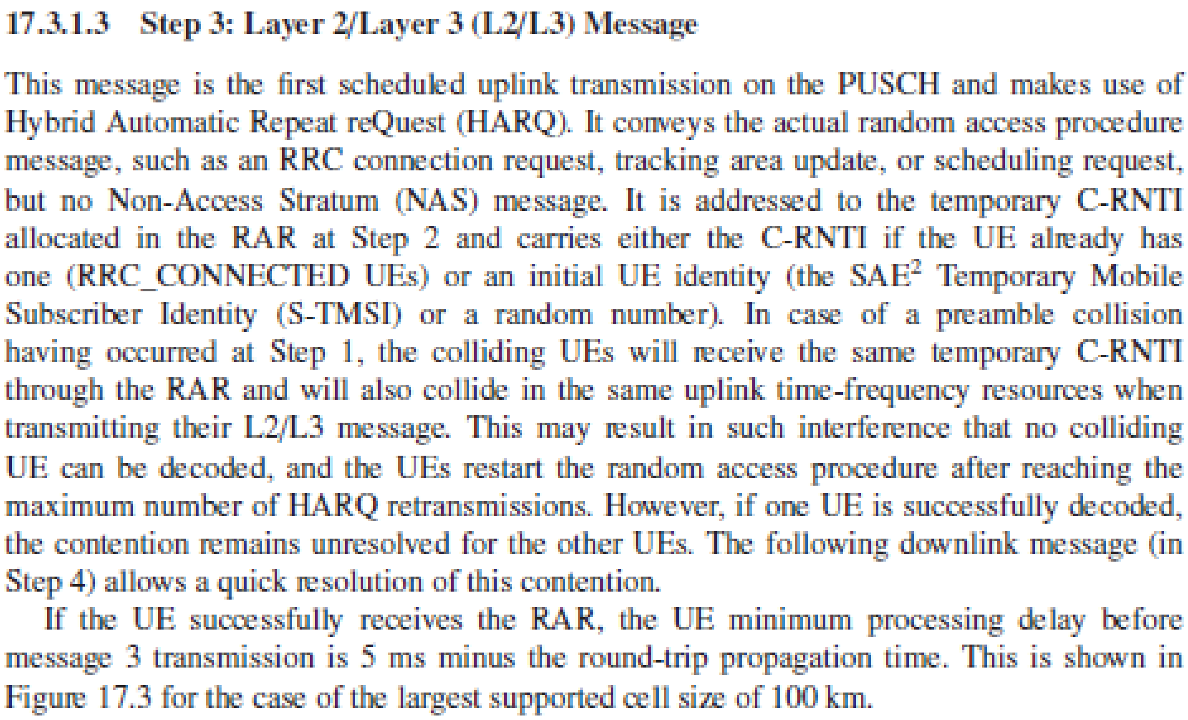
Where t_id is the index of the first subframe of the specified PRACH ($0\leq \text{t\_id} <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq \text{f\_id}< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

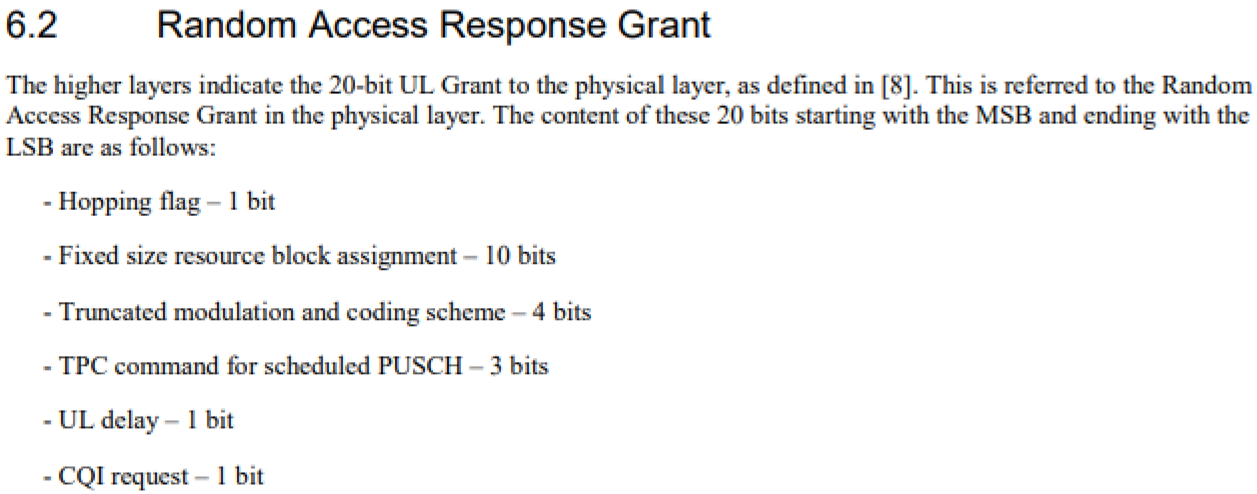
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

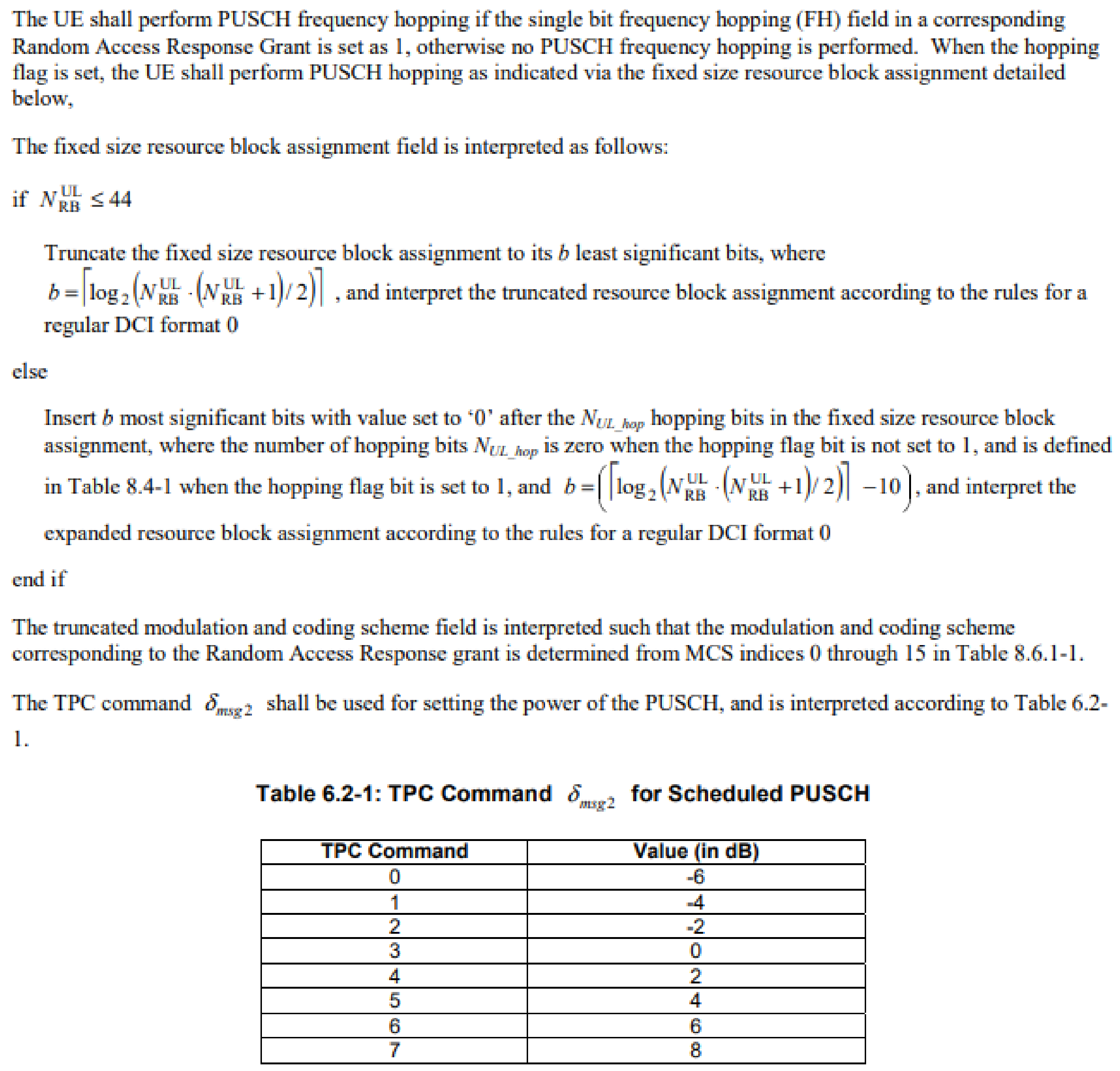
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 13(a)
"The method of claim 12, wherein the response message includes power adjustment information and"

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by Ford's Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)
“The method of claim 12, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

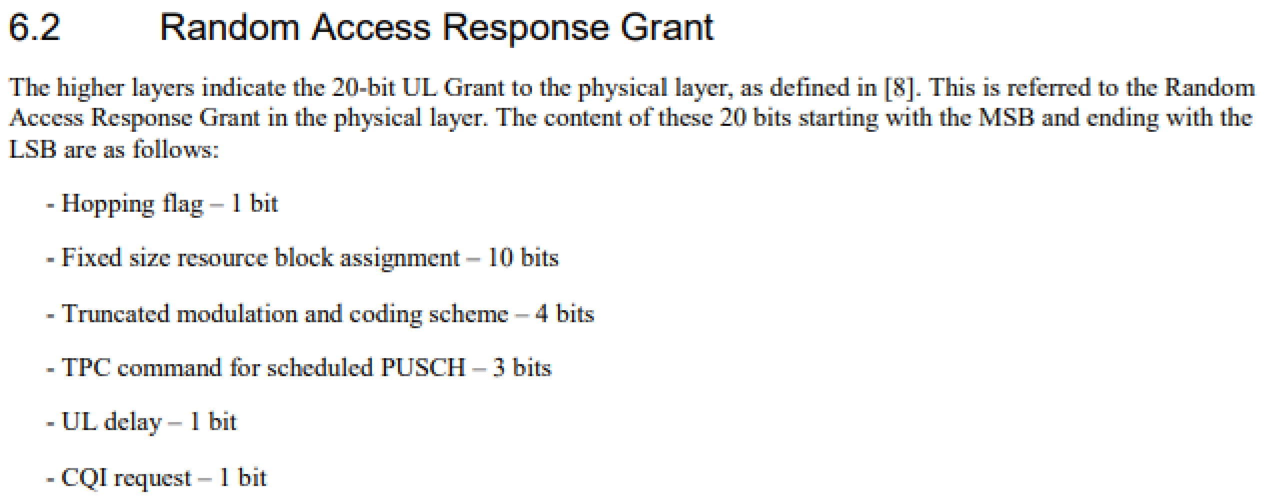
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

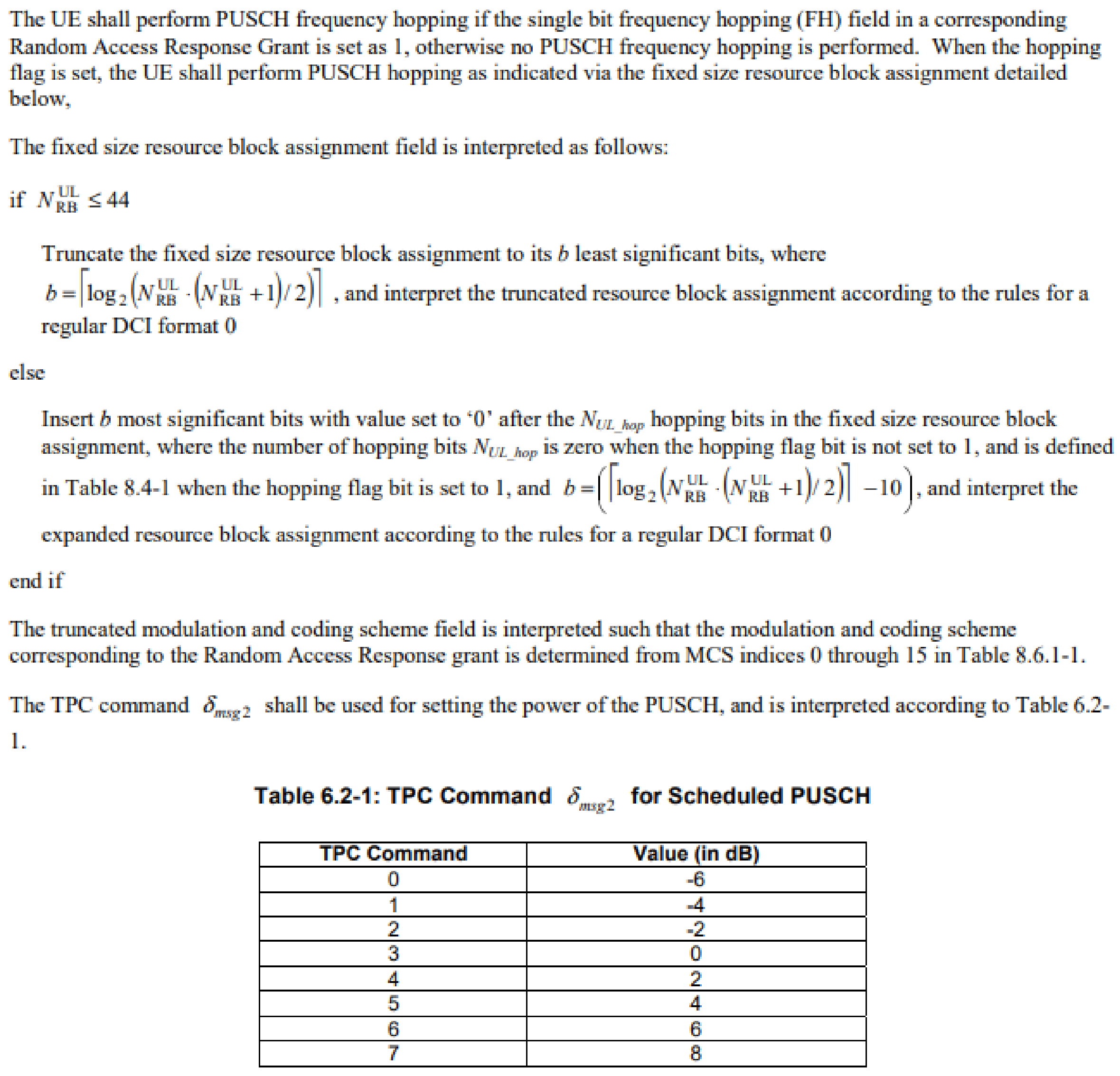
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 13(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”

wherein the second uplink signal is transmitted according to the power adjustment information.	Ford’s Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

> Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

> Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
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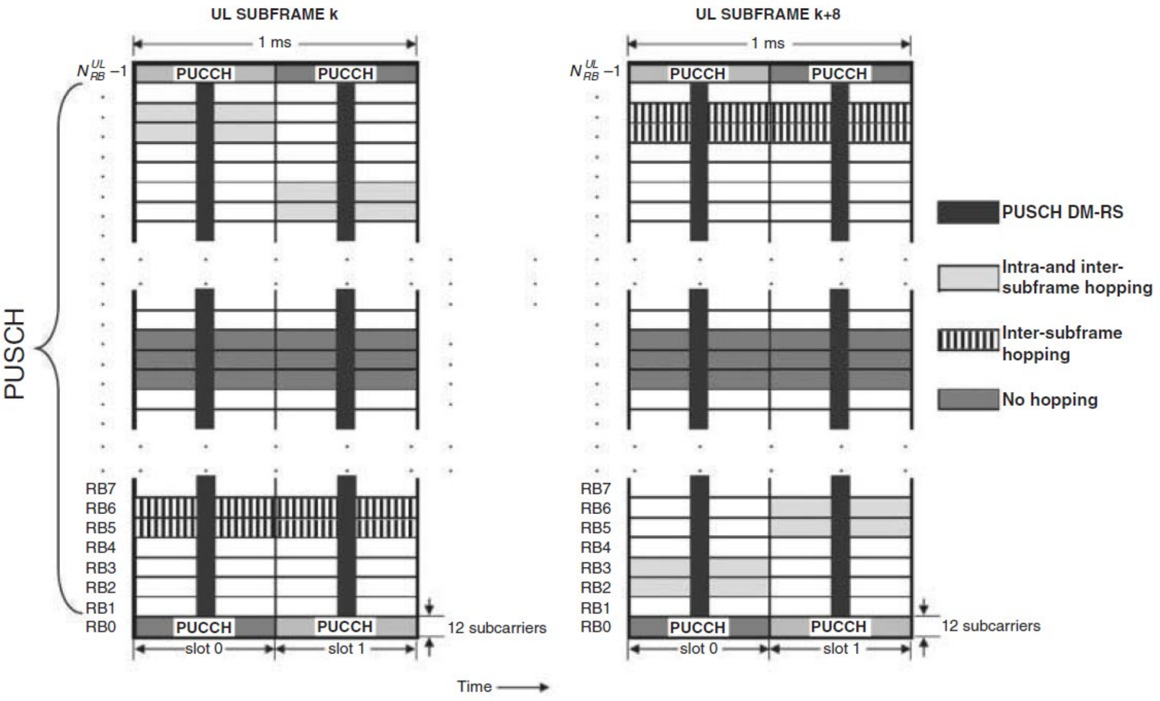
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 14

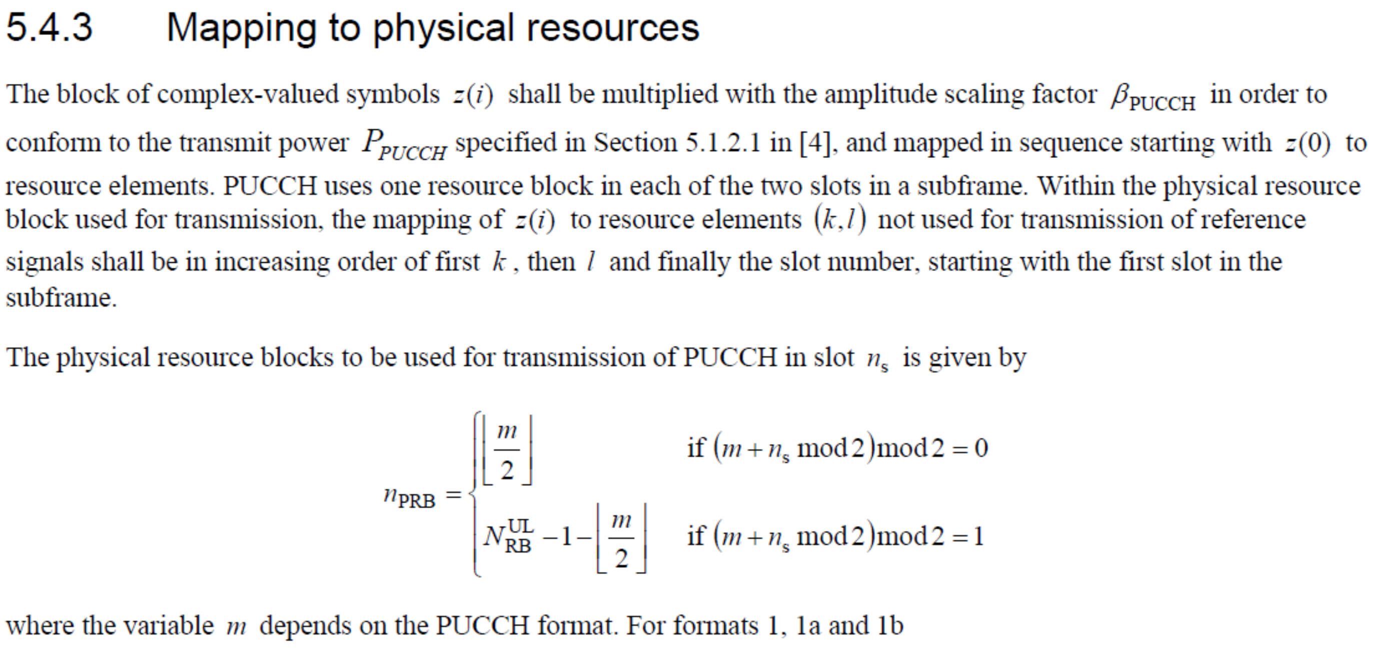
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Ford's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 11. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

$$m = \begin{cases} N_{\text{RB}}^{(2)} & \text{if } n_{\text{PUCCH}}^{(1)} < c\cdot N_{\text{cs}}^{(1)}/\Delta_{\text{shift}}^{\text{PUCCH}} \\ \left\lfloor \dfrac{n_{\text{PUCCH}}^{(1)} - c\cdot N_{\text{cs}}^{(1)}/\Delta_{\text{shift}}^{\text{PUCCH}}}{c\cdot N_{\text{sc}}^{\text{RB}}/\Delta_{\text{shift}}^{\text{PUCCH}}} \right\rfloor + N_{\text{RB}}^{(2)} + \left\lceil \dfrac{N_{\text{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\text{PUCCH}}^{(2)} / \mathrm{N}_{\text{sc}}^{\text{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

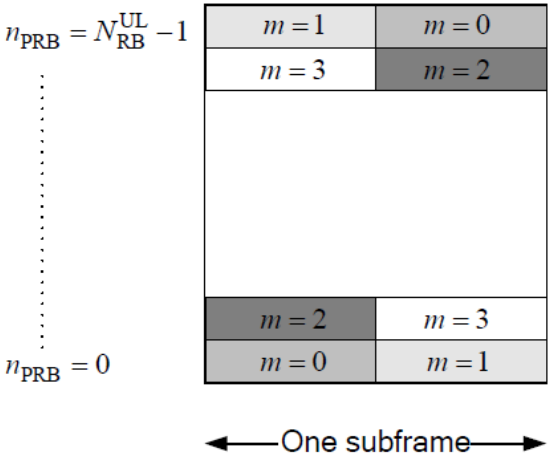


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

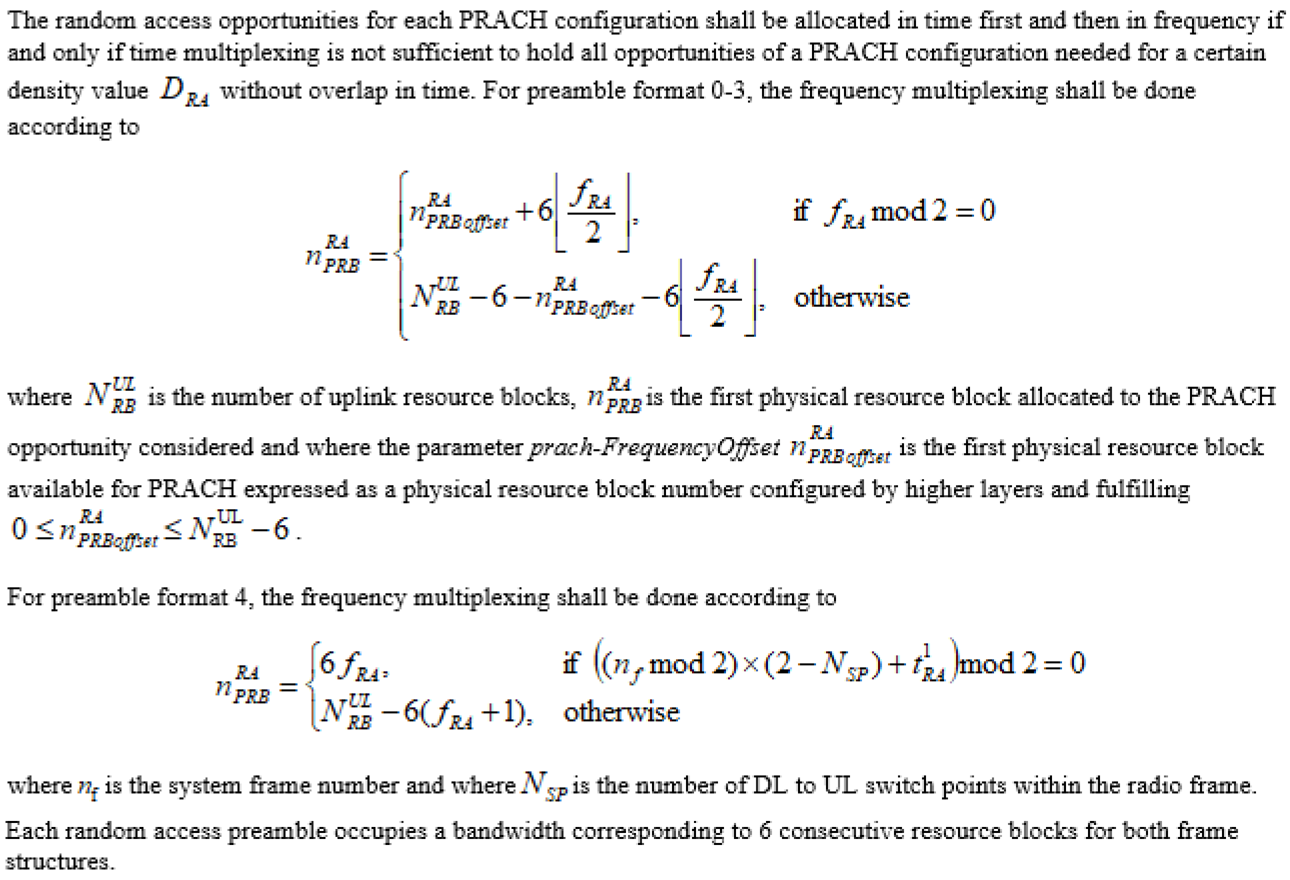
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\text{RA}}_{\text{PRBoffset}}$. For FDD, the parameter directly determines

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH. 5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. …

US Patent No. 10,833,908: Claim 14
“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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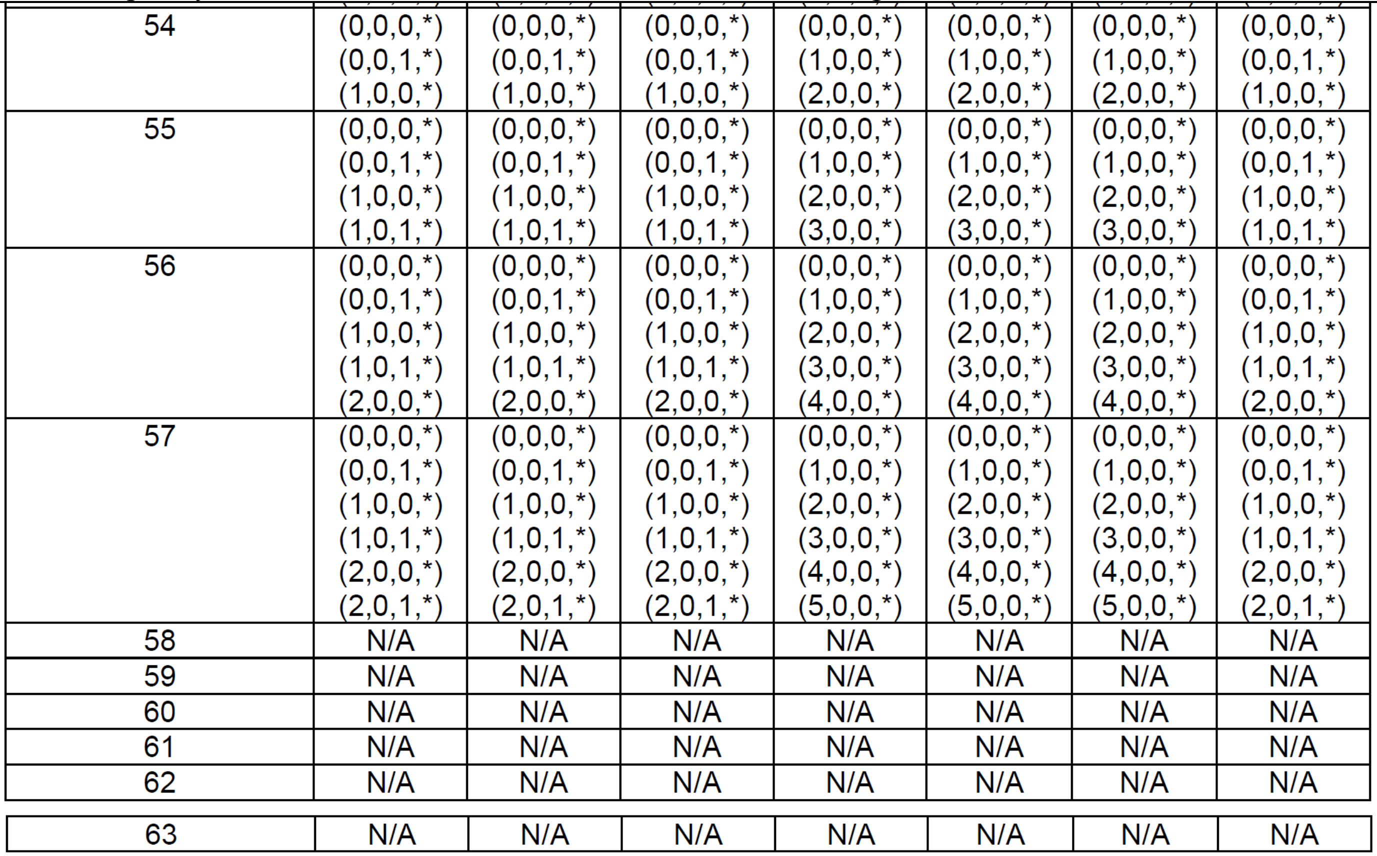
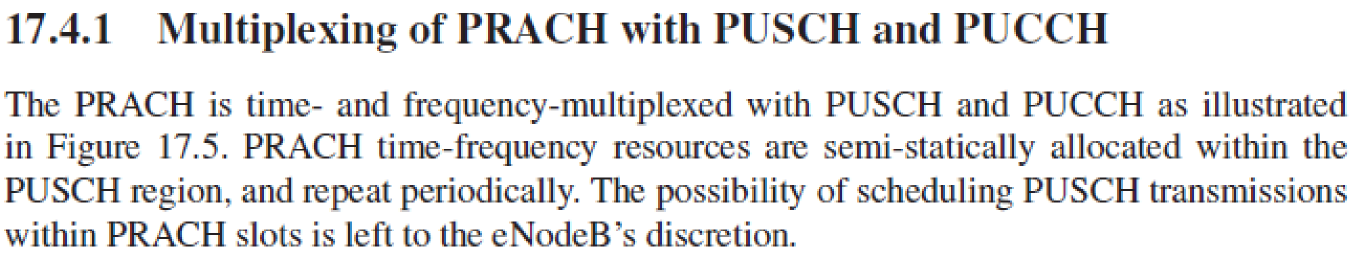
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

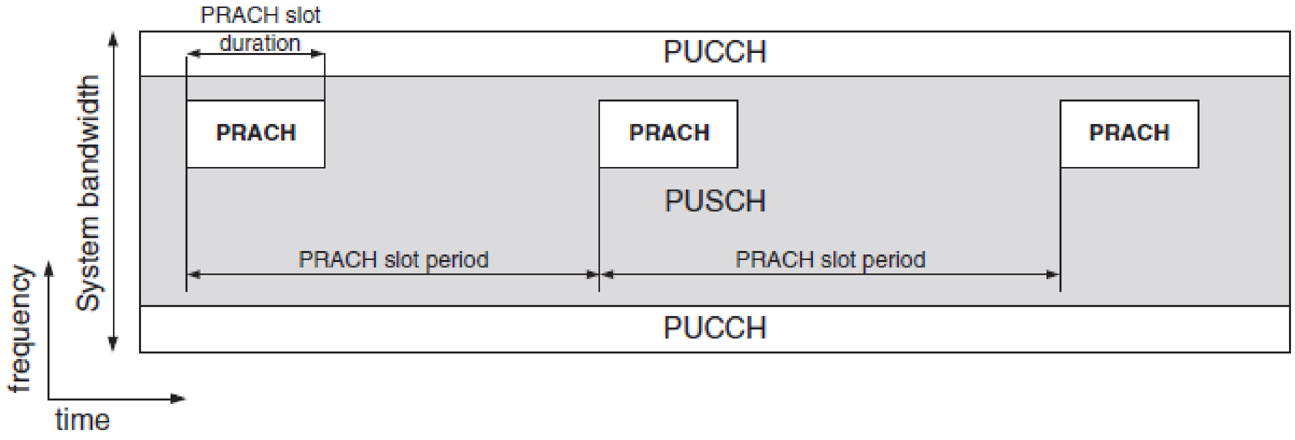


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

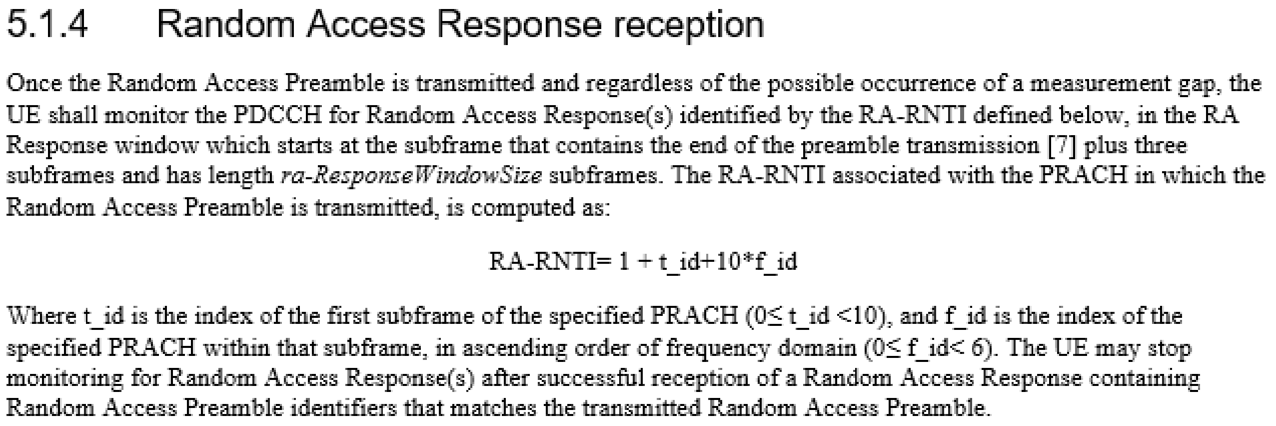
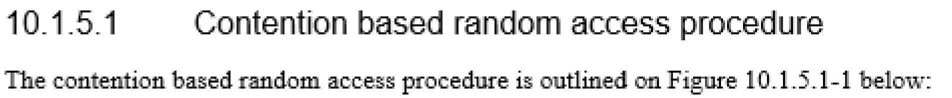
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

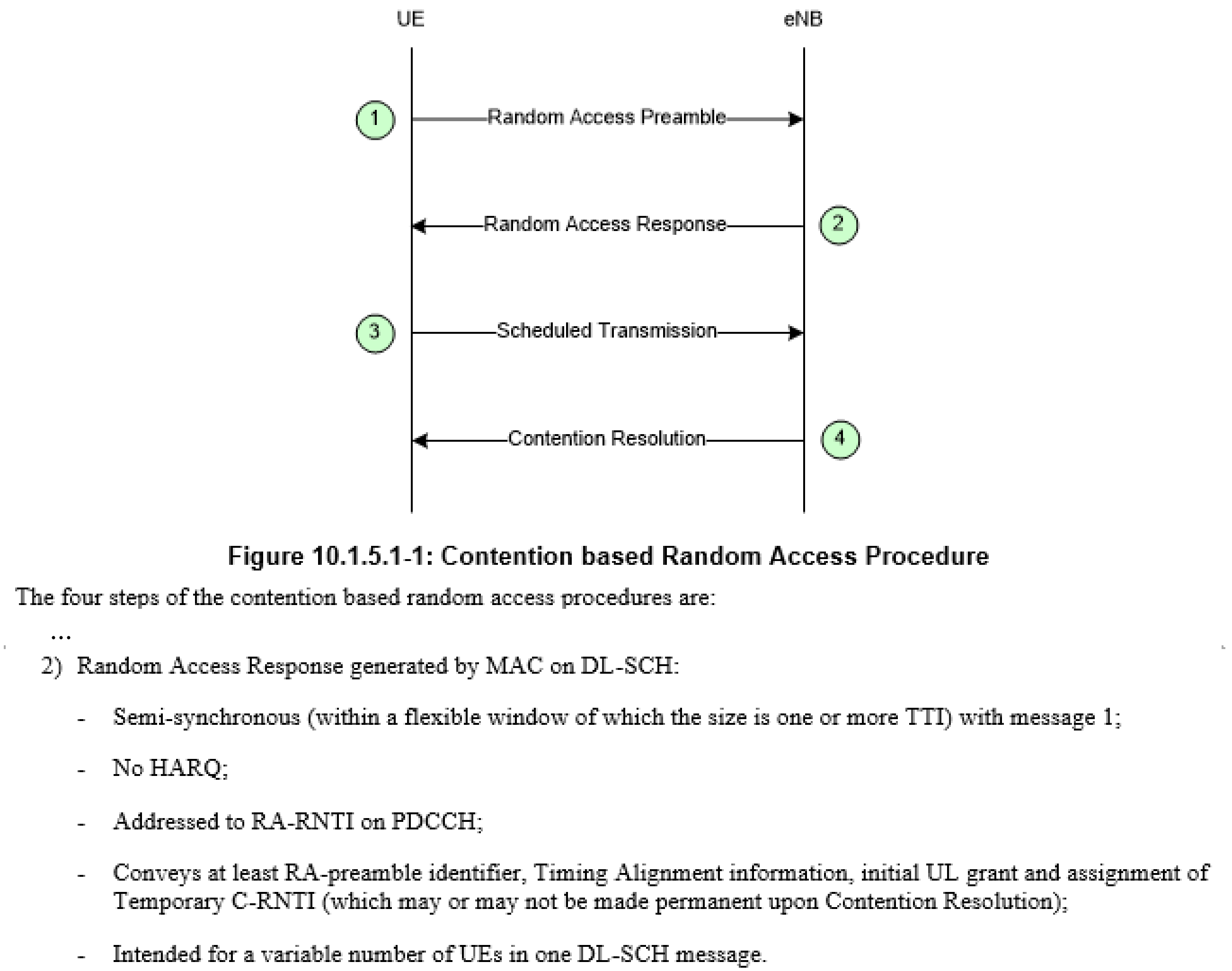
US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

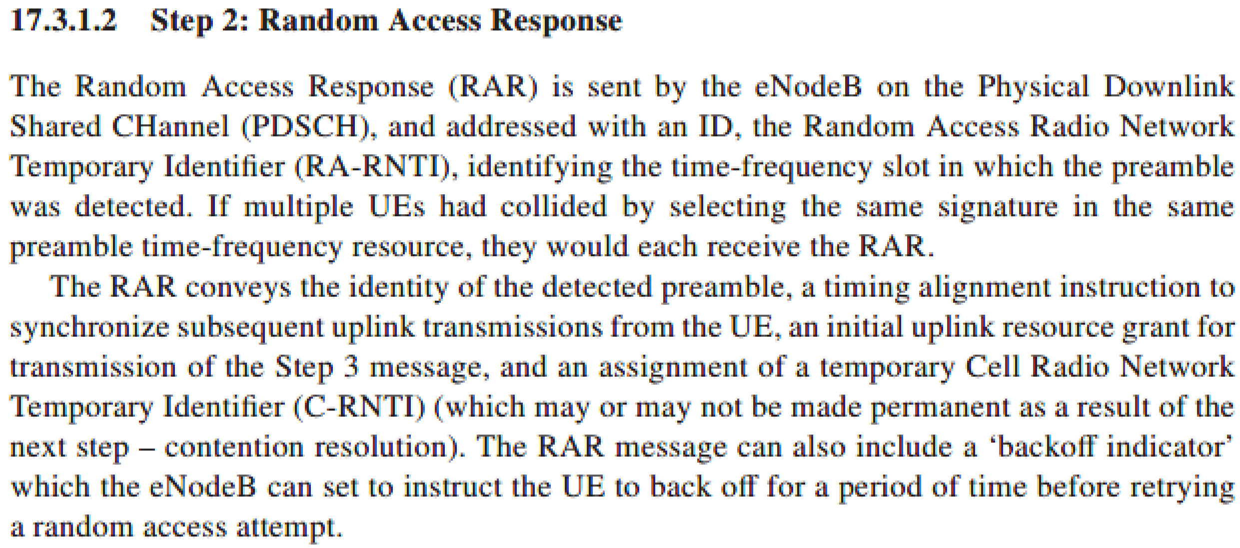
15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Ford's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: ... 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15
“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

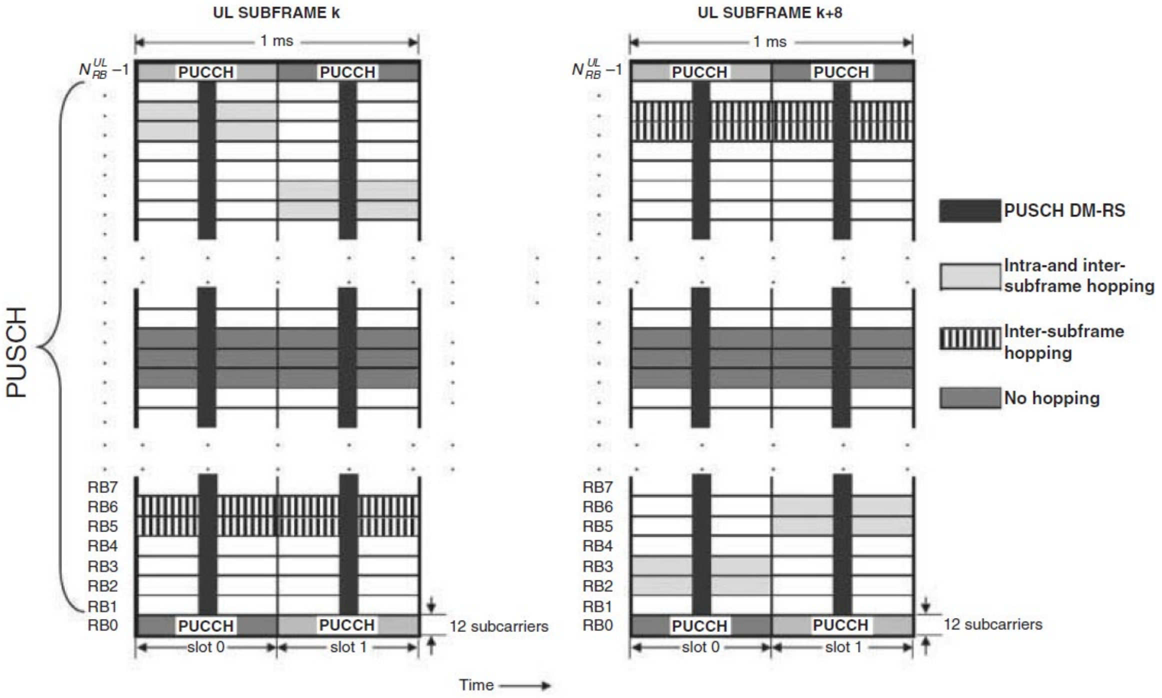
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 16
"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Ford's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 17

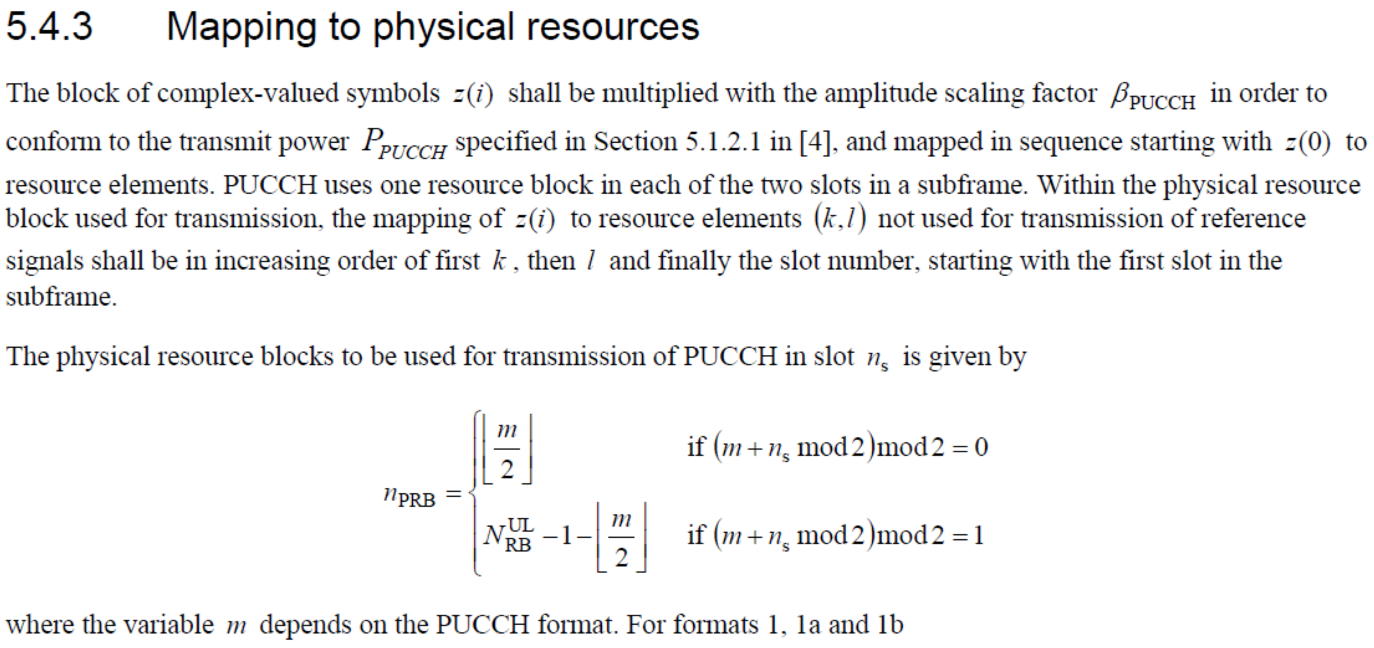
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Ford's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_\mathrm{s} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_\mathrm{s} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\text{RB}}^{(2)} & \text{if } n_{\text{PUCCH}}^{(1)} < c \cdot N_{\text{cs}}^{(1)} / \Delta_{\text{shift}}^{\text{PUCCH}} \\ \left\lfloor \dfrac{n_{\text{PUCCH}}^{(1)} - c \cdot N_{\text{cs}}^{(1)} / \Delta_{\text{shift}}^{\text{PUCCH}}}{c \cdot N_{\text{sc}}^{\text{RB}} / \Delta_{\text{shift}}^{\text{PUCCH}}} \right\rfloor + N_{\text{RB}}^{(2)} + \left\lceil \dfrac{N_{\text{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\text{PUCCH}}^{(2)} / \text{N}_{\text{sc}}^{\text{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

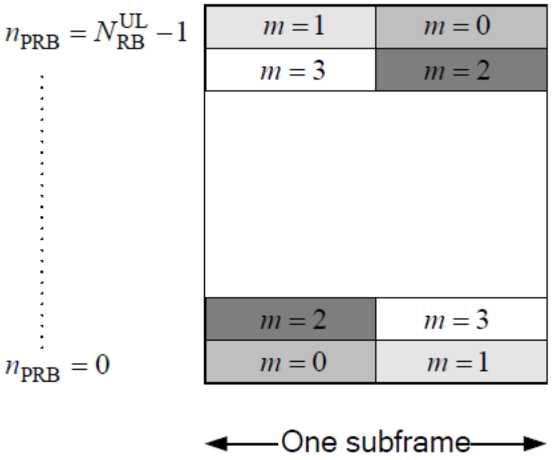


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

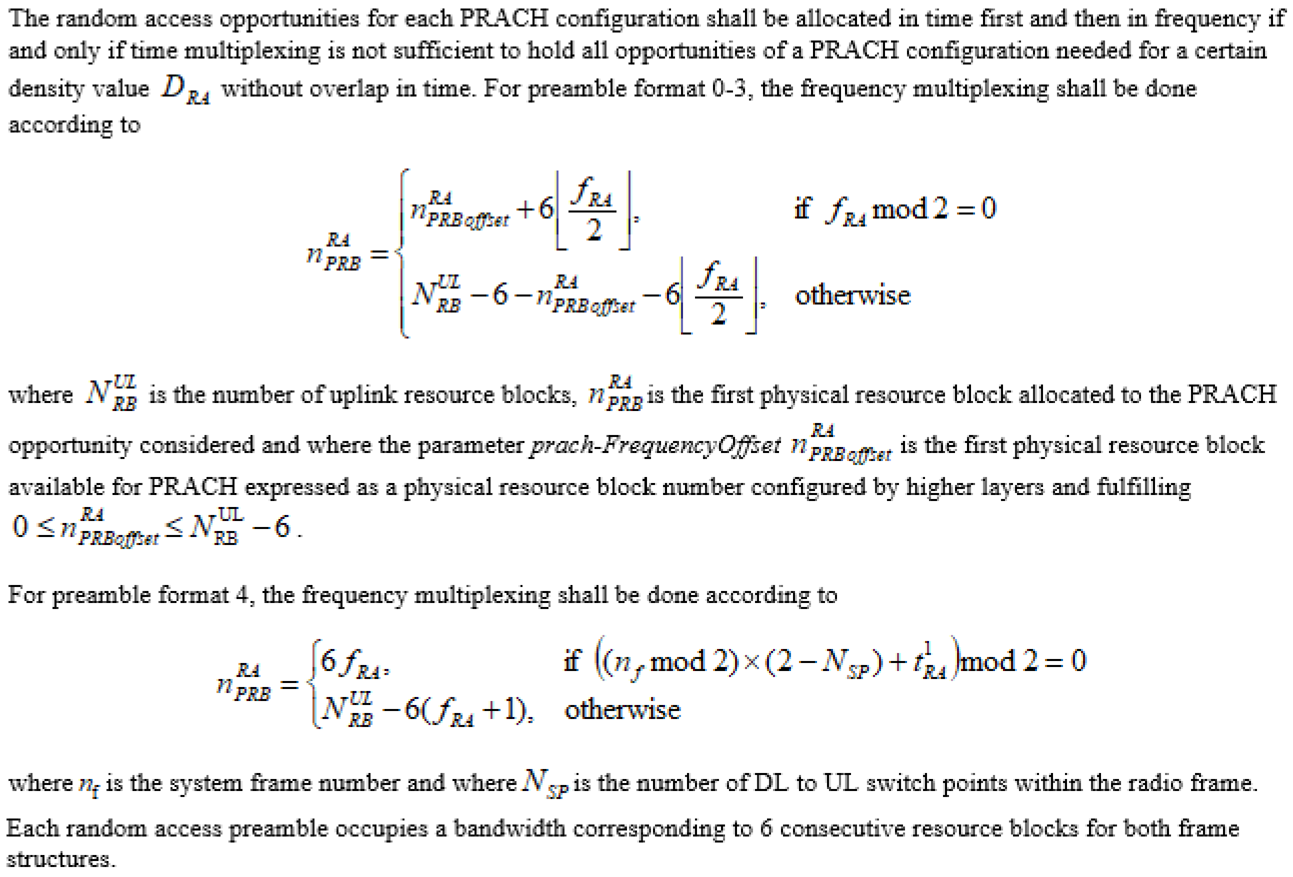
…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

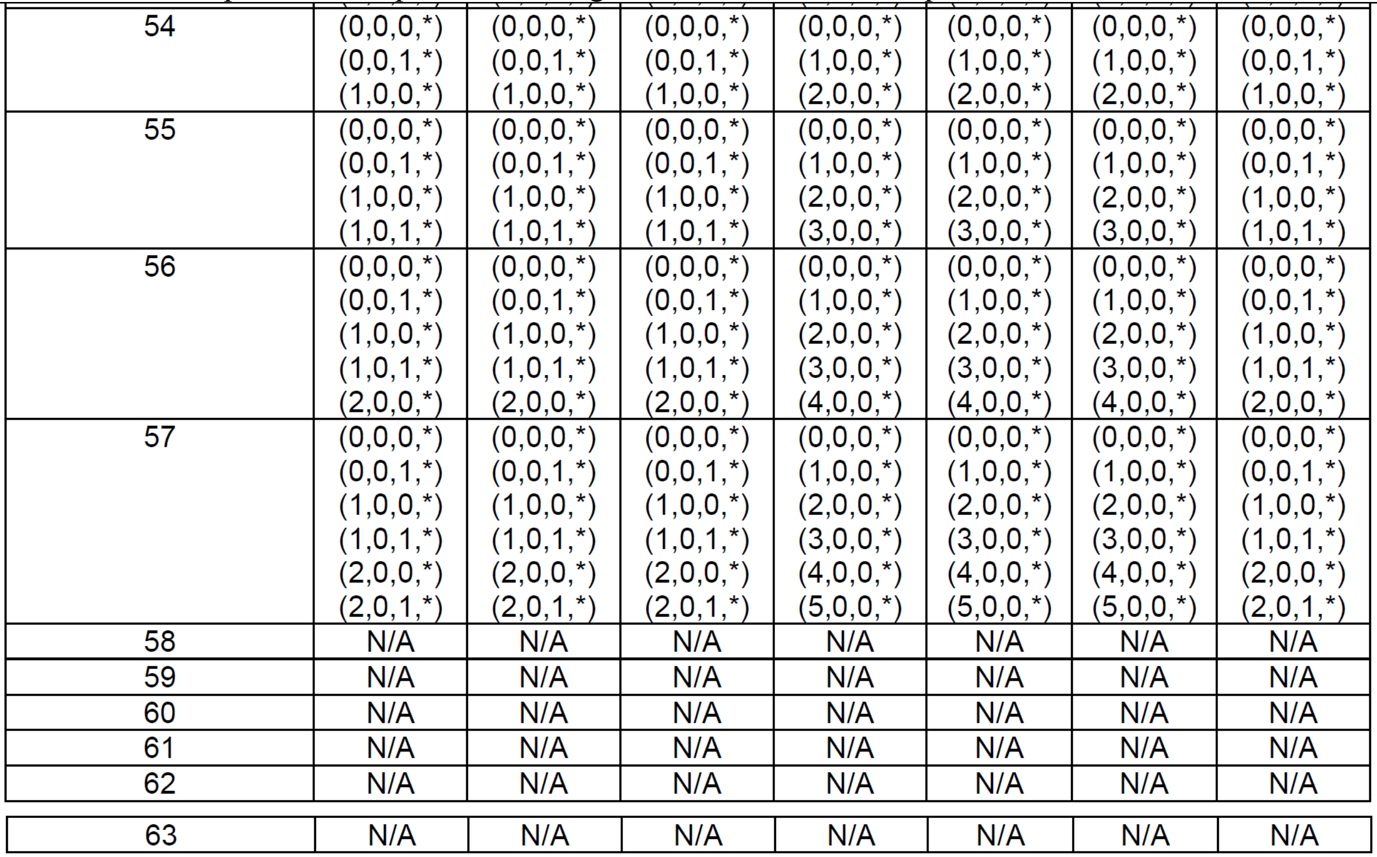
PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.

.

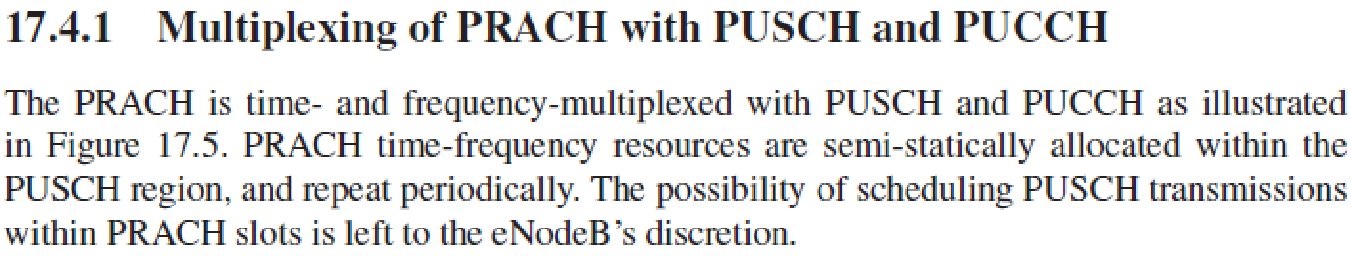
.

US Patent No. 10,833,908: Claim 17
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

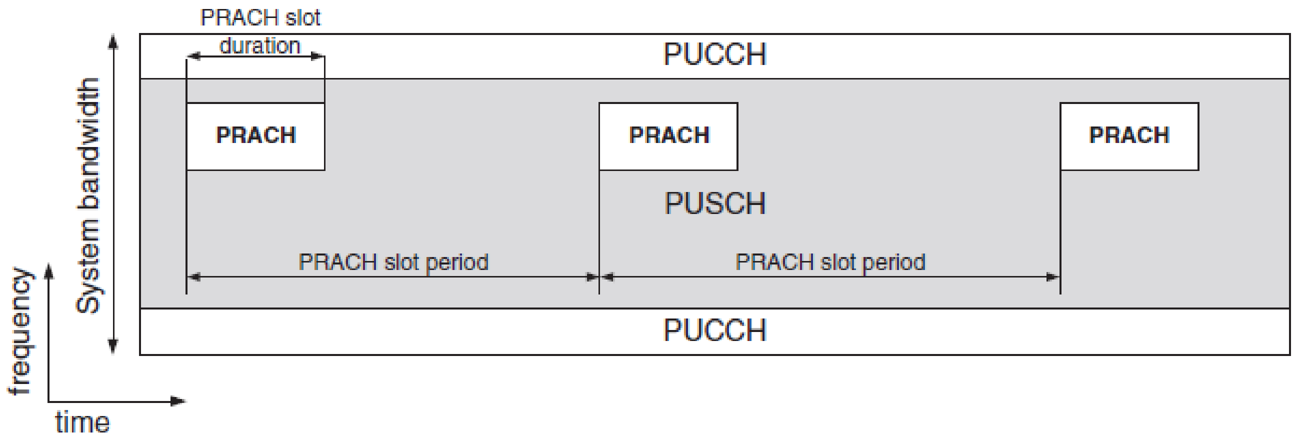


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

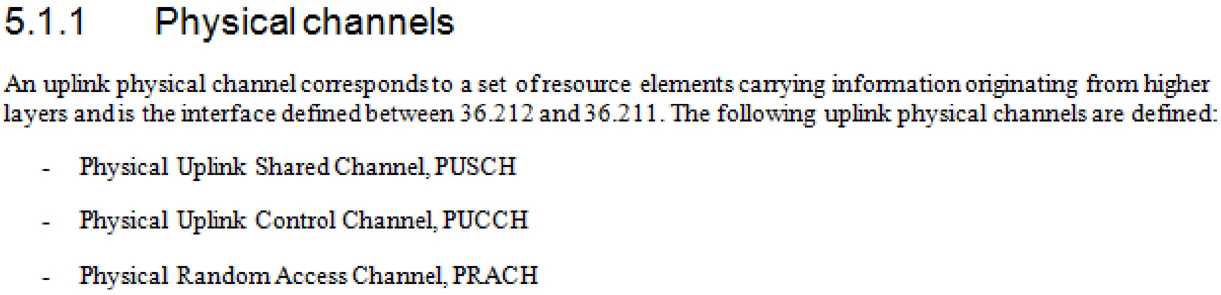
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 17

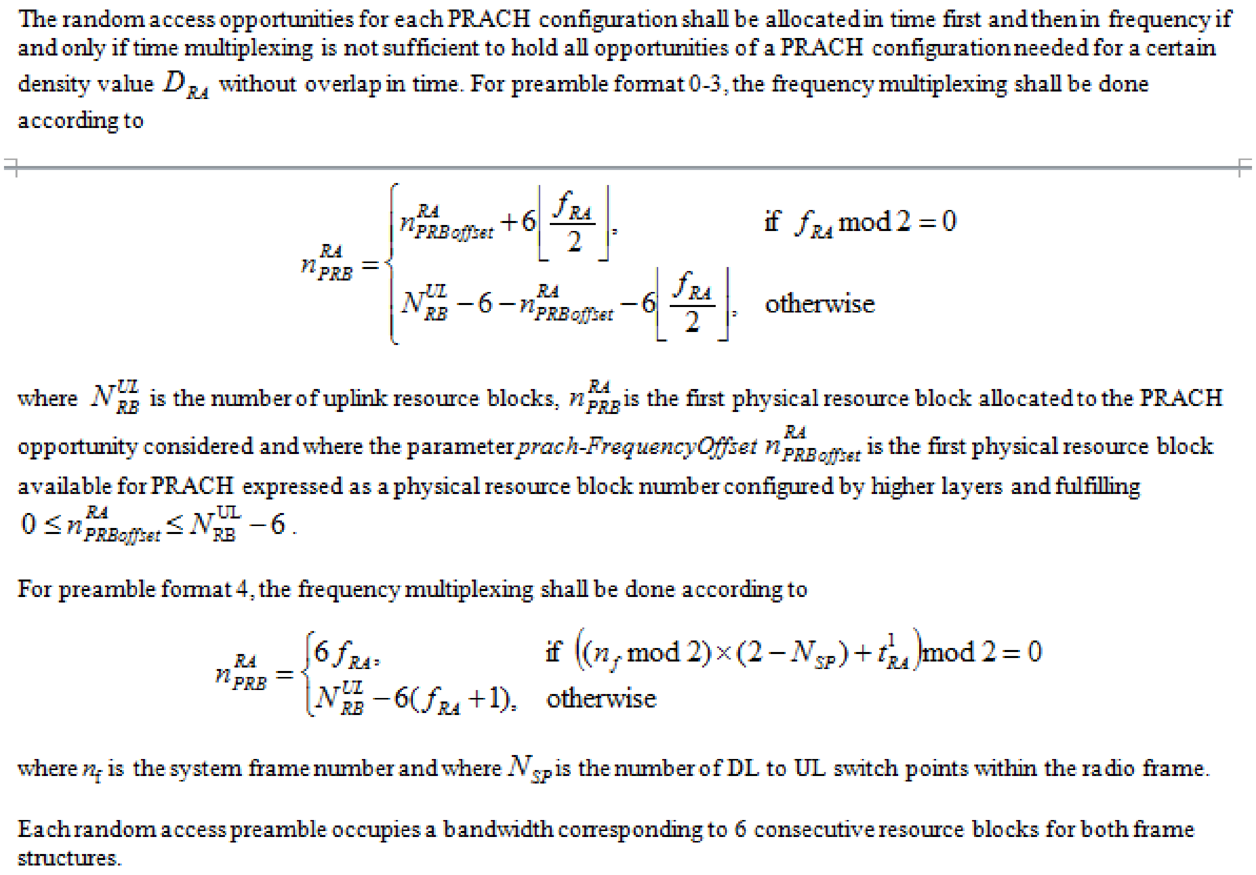
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Ford's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

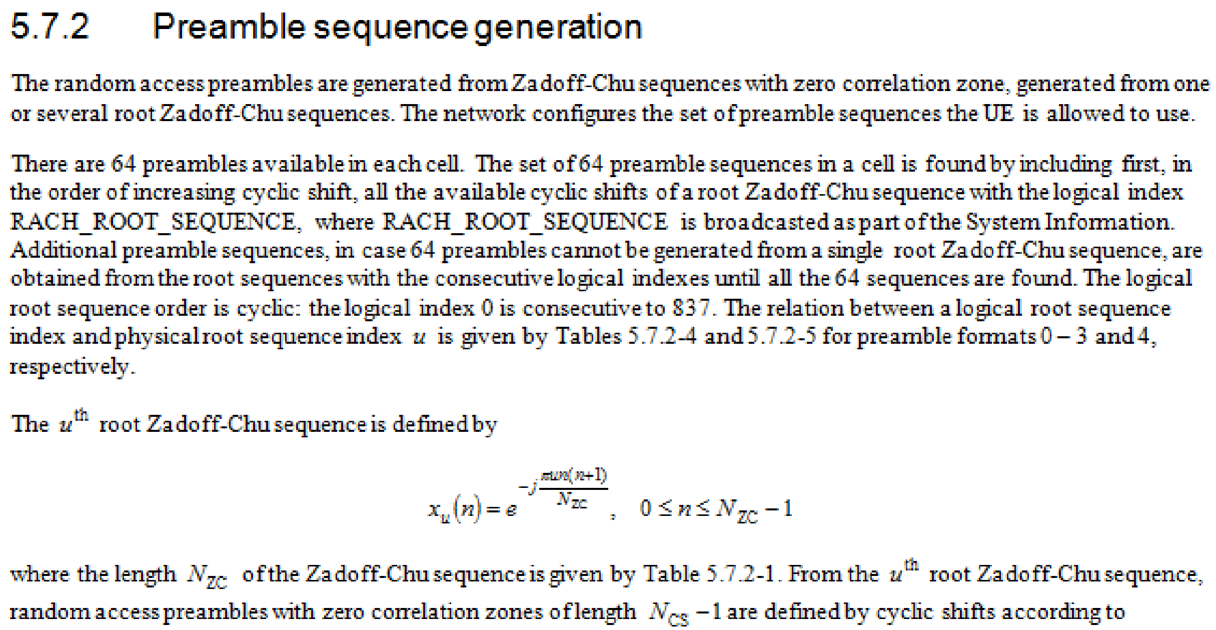
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

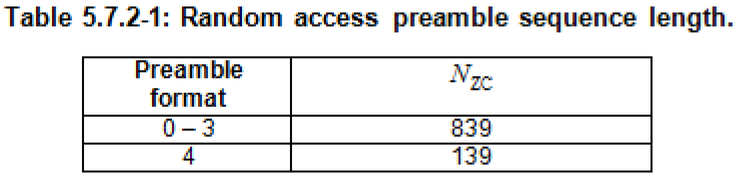
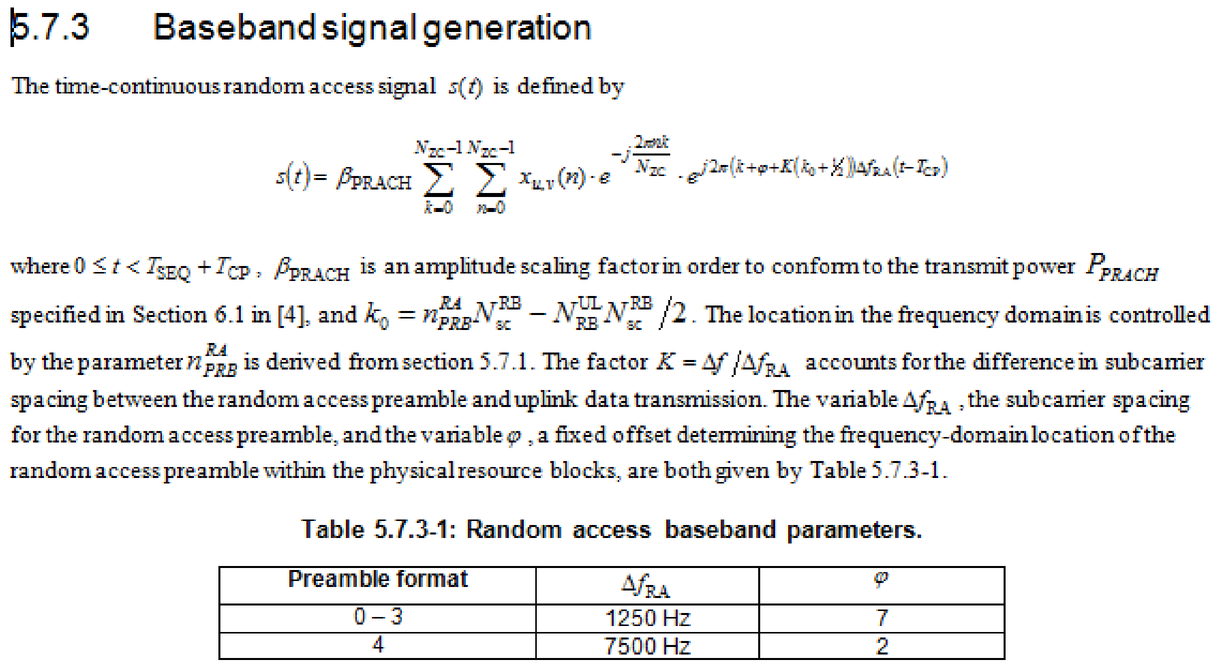


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

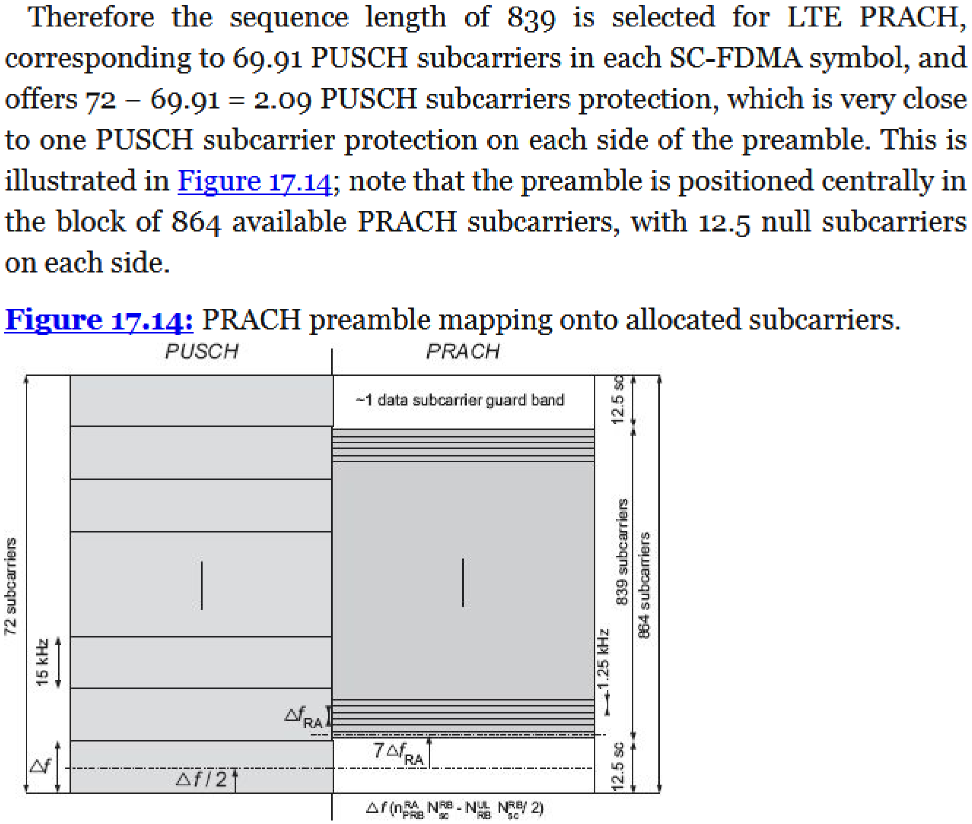
where $0\leq t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

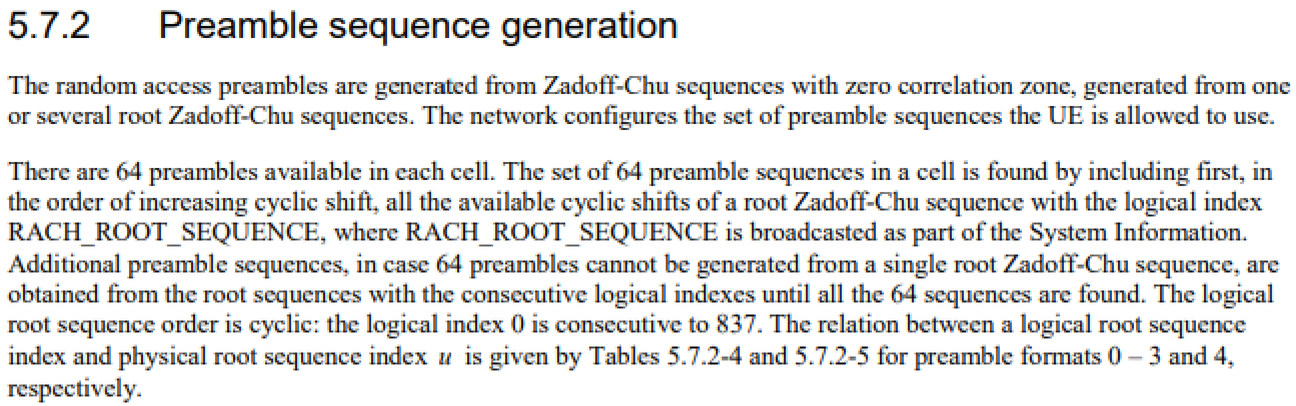
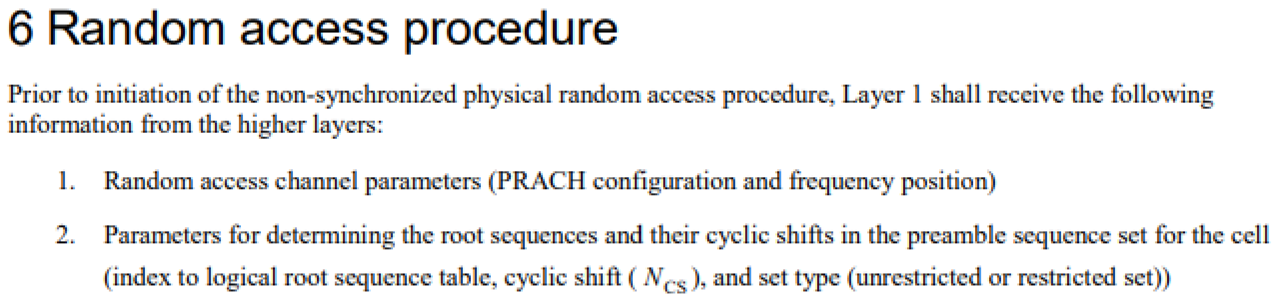
See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”

	 Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Ford's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

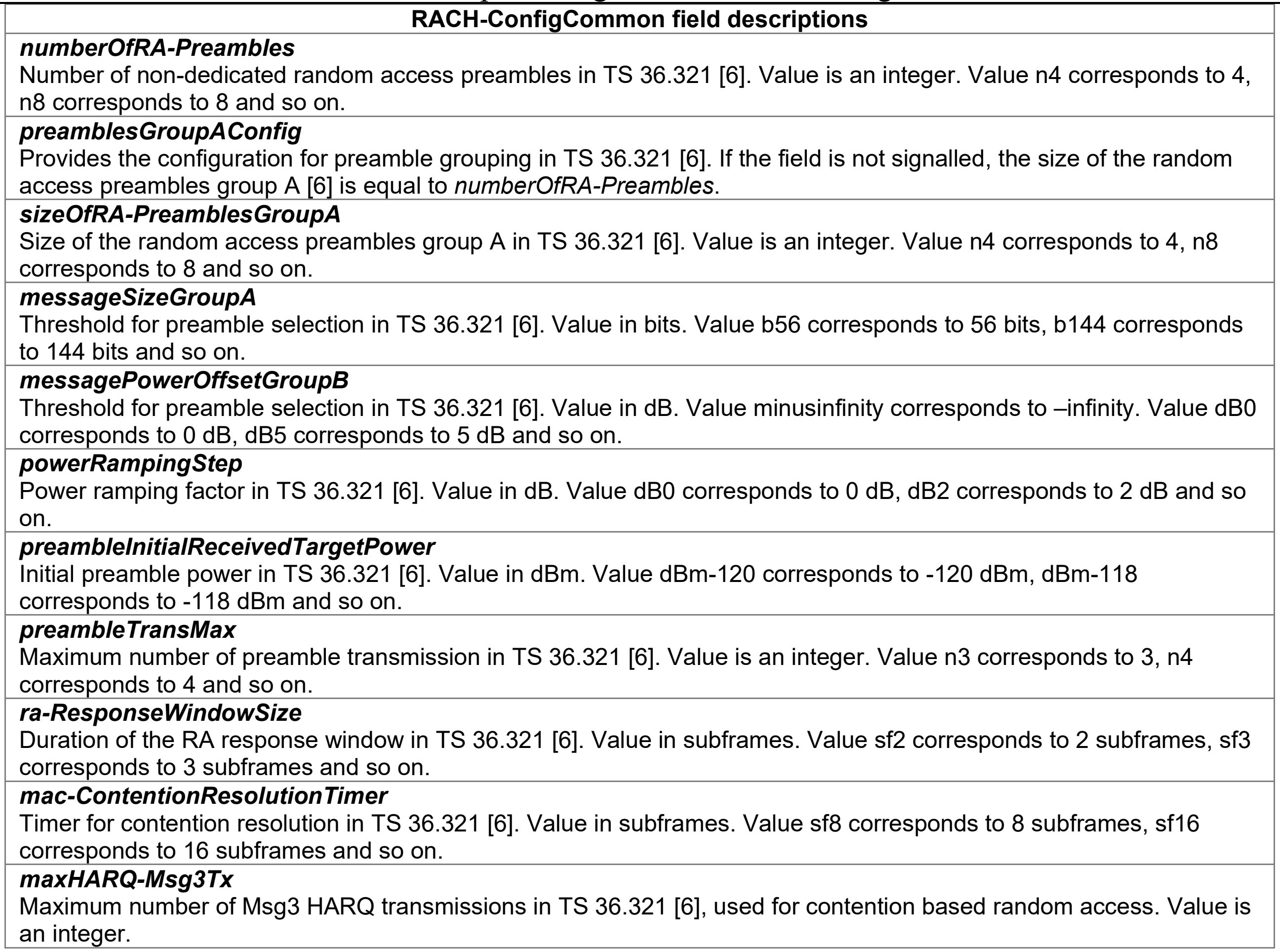
```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

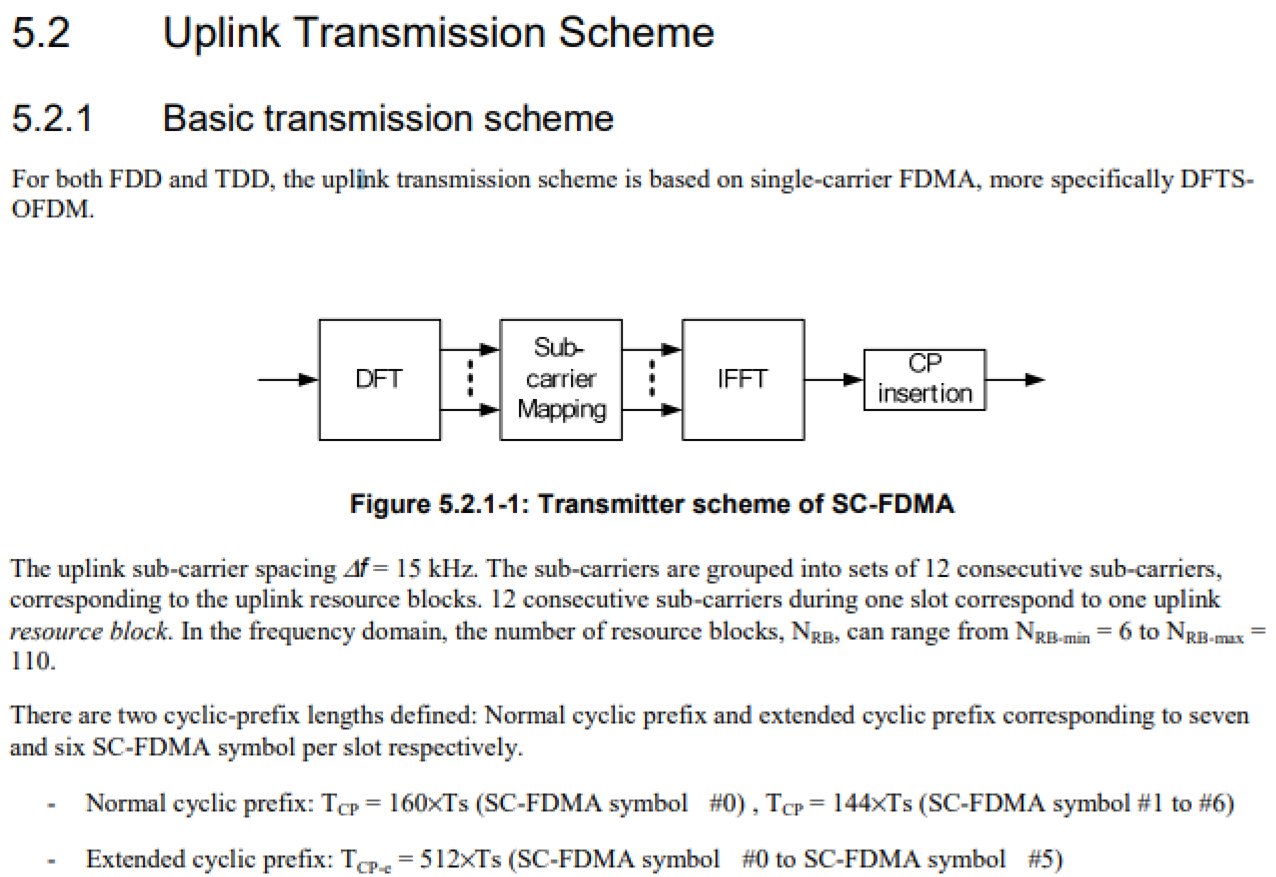


RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. Ford's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,* Ford's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

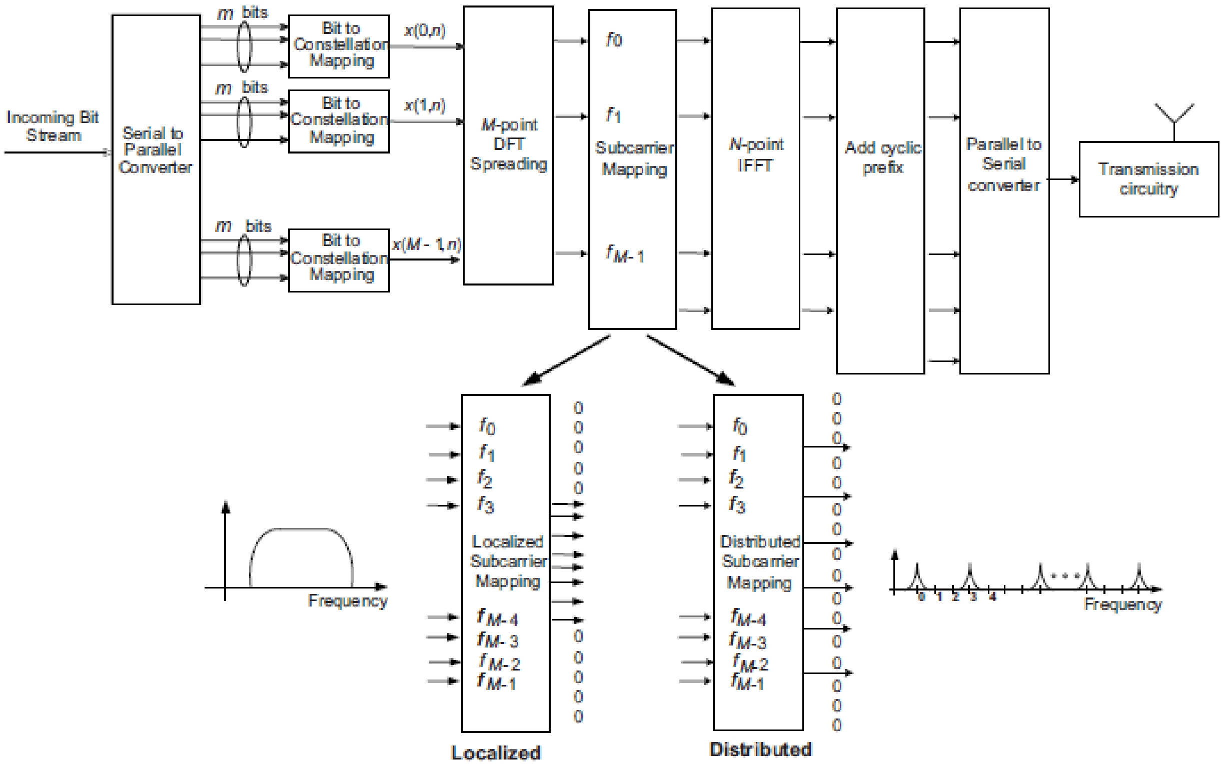
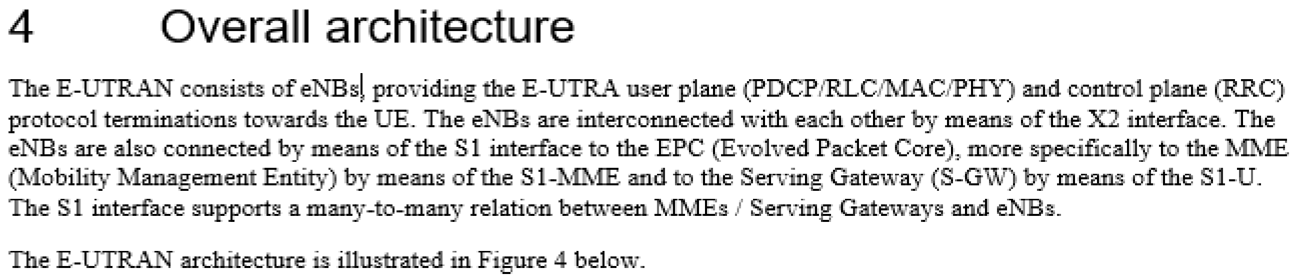


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

21. A mobile station comprising:	To the extent the preamble is considered a limitation, Ford's Accused Instrumentalities meet the preamble of claim 21 of the '908 patent. *E.g.,* Ford's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Ford offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

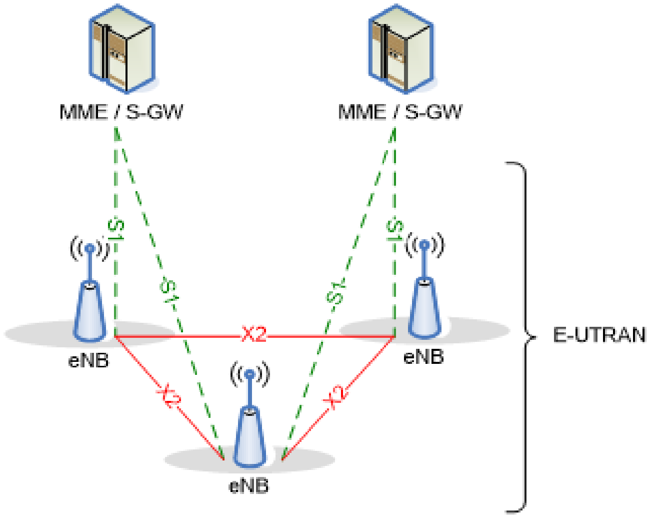


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

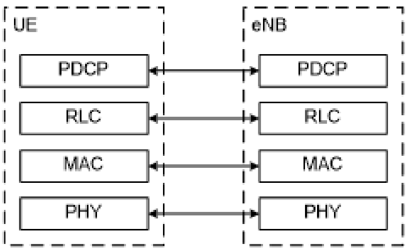


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

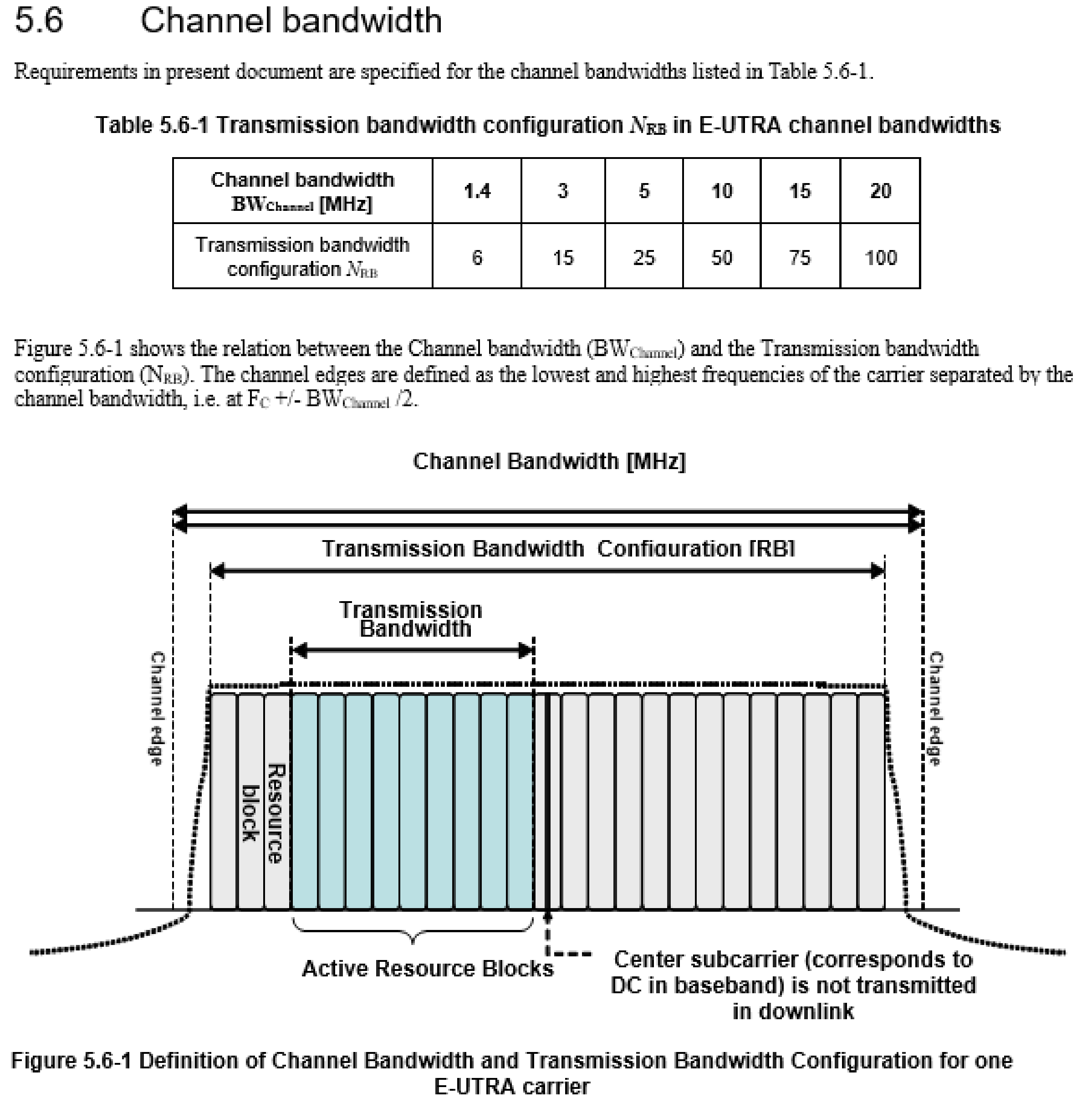
US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	Ford's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The Ford Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

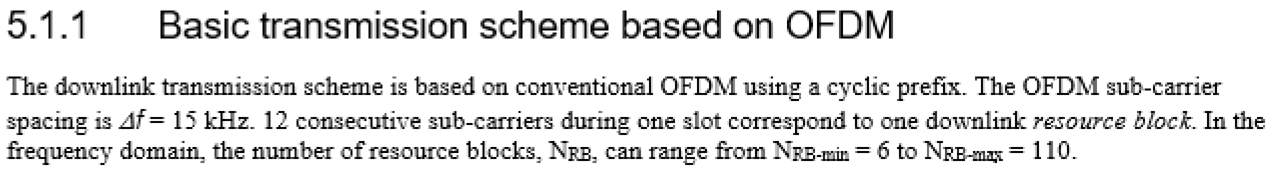
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

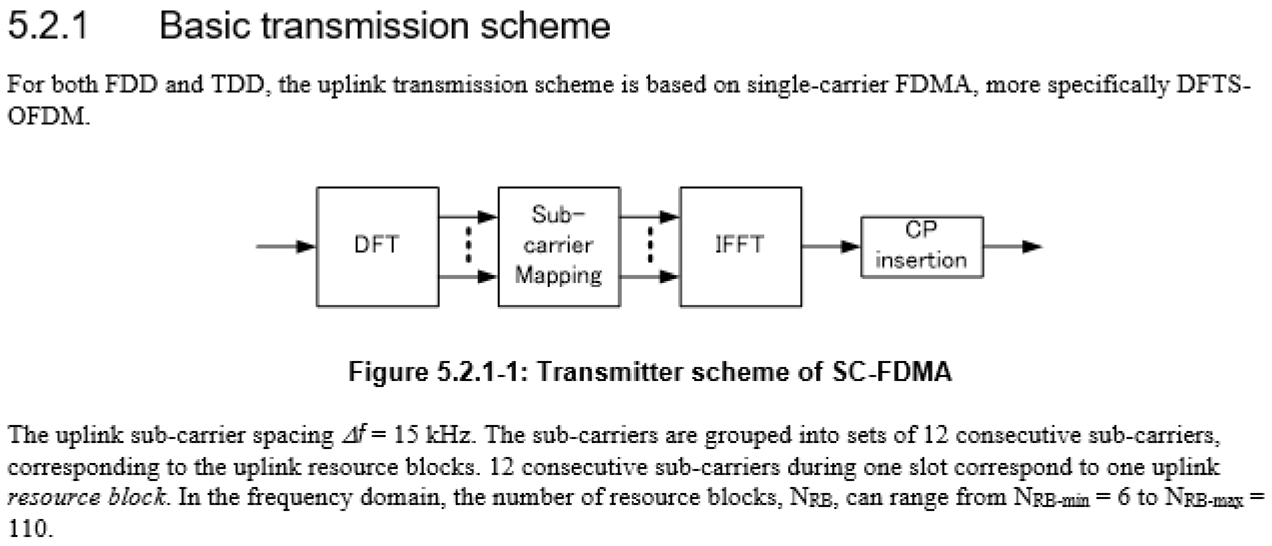
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

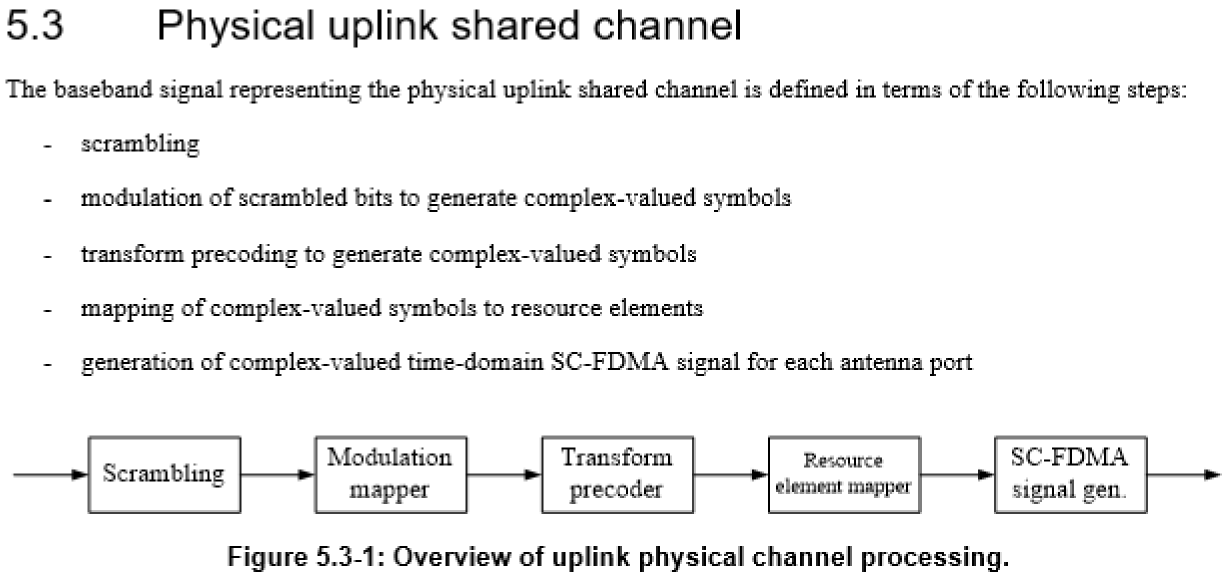
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

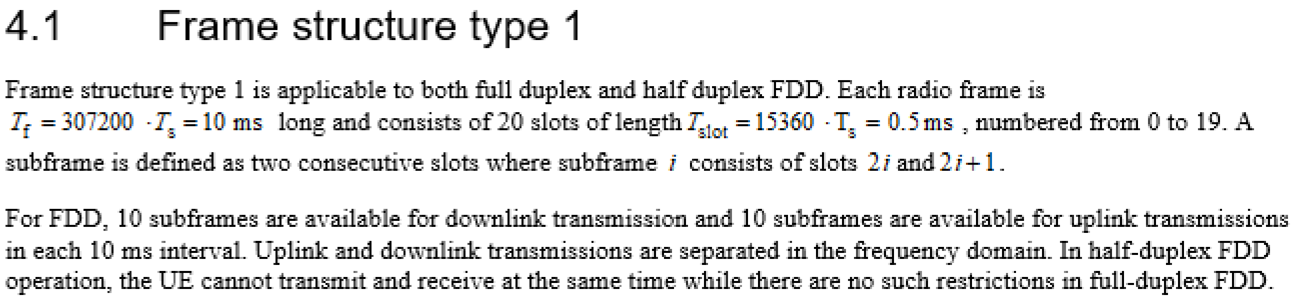
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_\mathrm{f} = 307200 \cdot T_\mathrm{s} = 10\ \mathrm{ms}$ long and consists of 20 slots of length $T_\mathrm{slot} = 15360 \cdot T_\mathrm{s} = 0.5\ \mathrm{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)

“a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

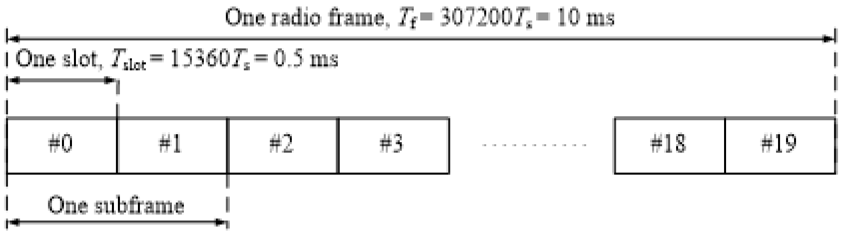
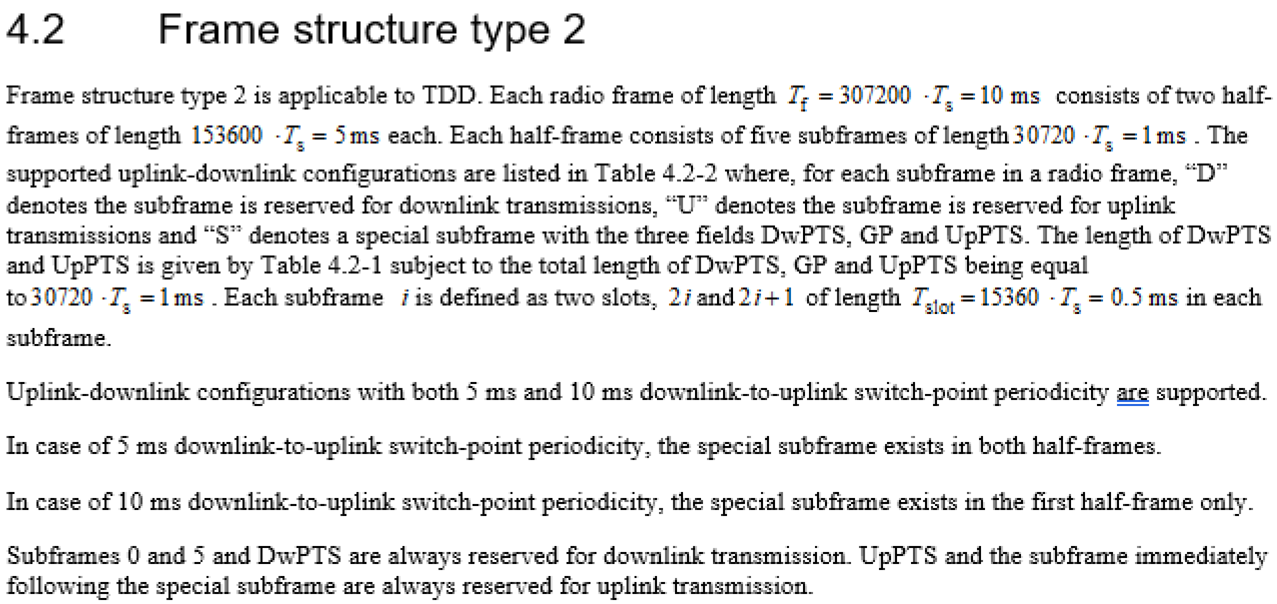


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

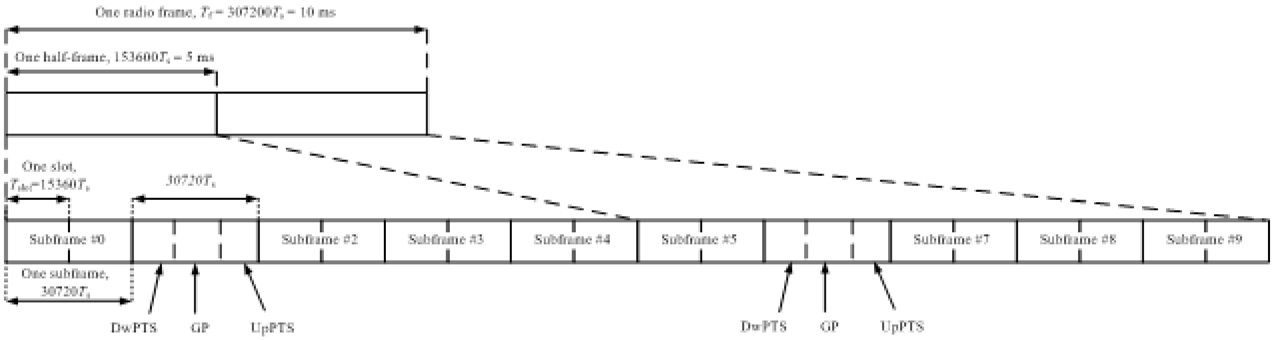
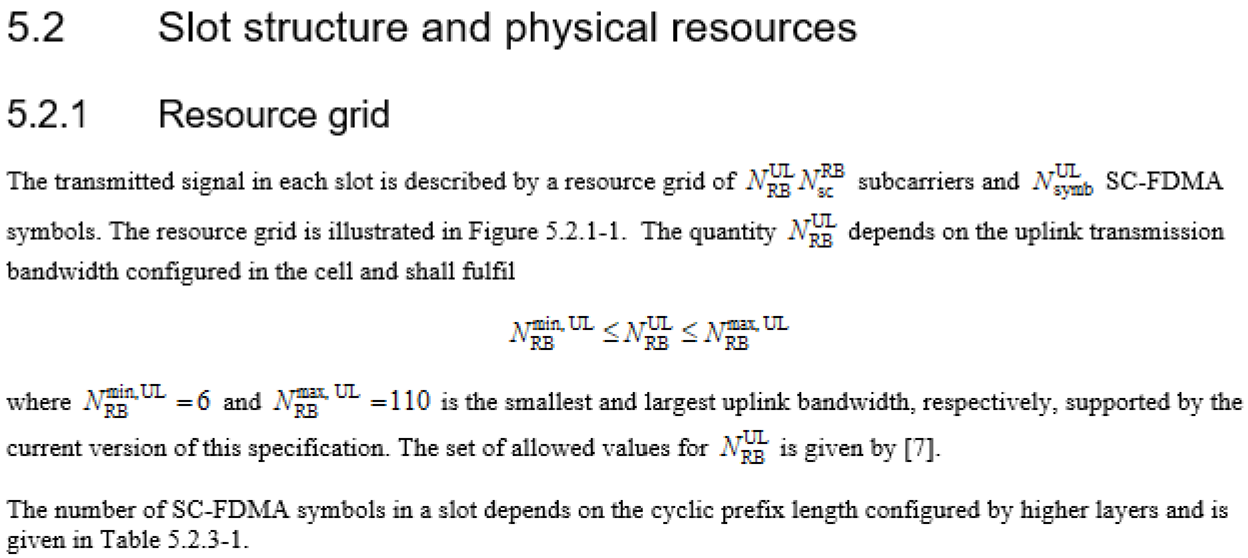


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

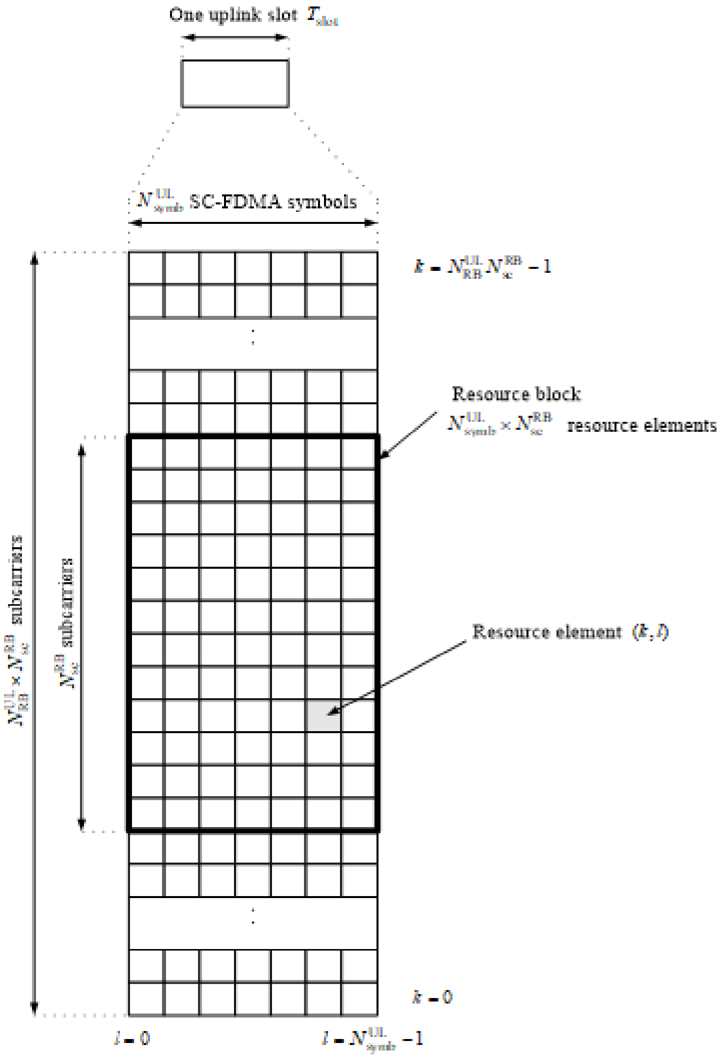
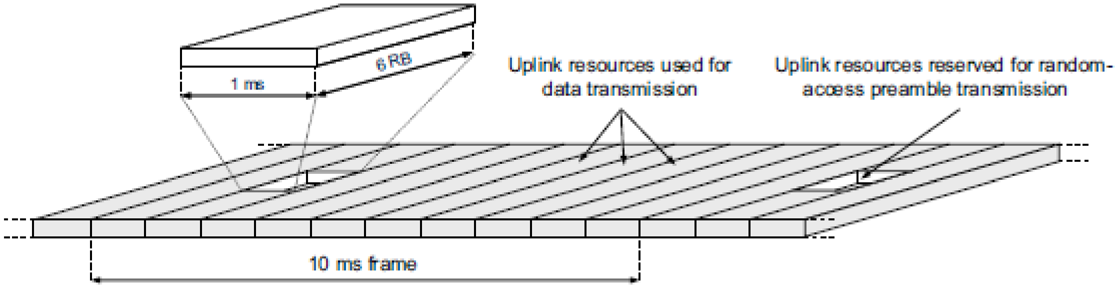


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

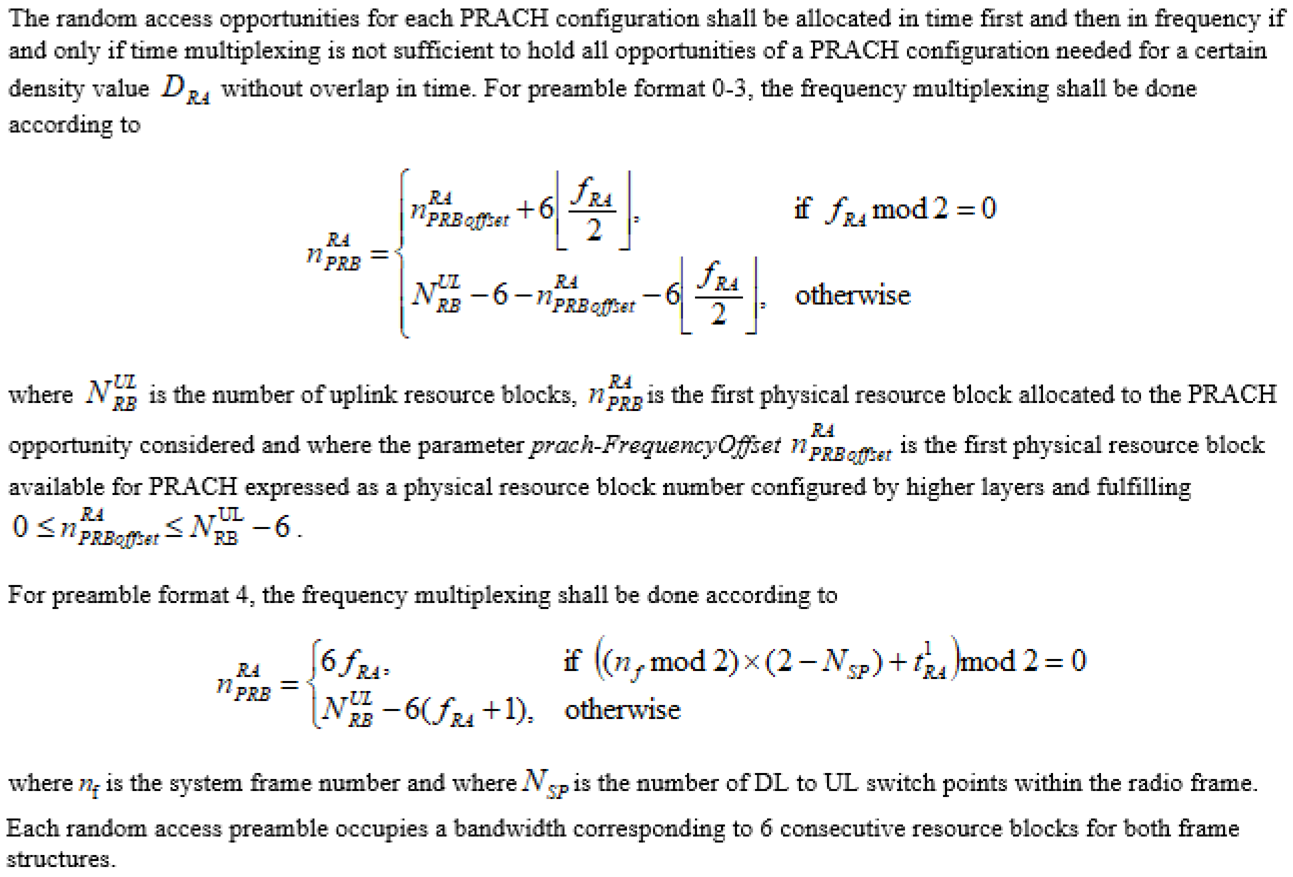
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 21(c)

“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	Ford’s Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

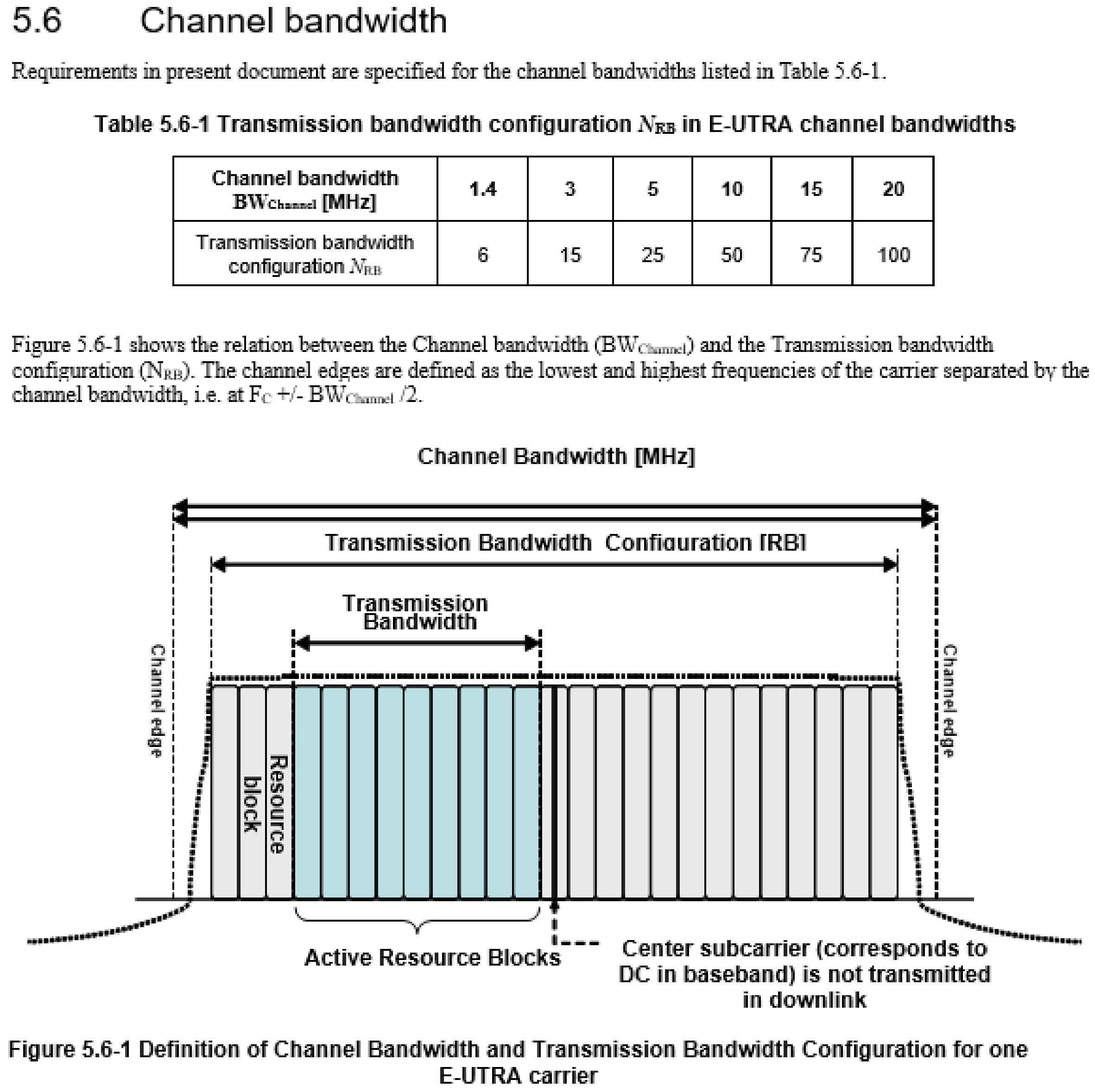
$$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

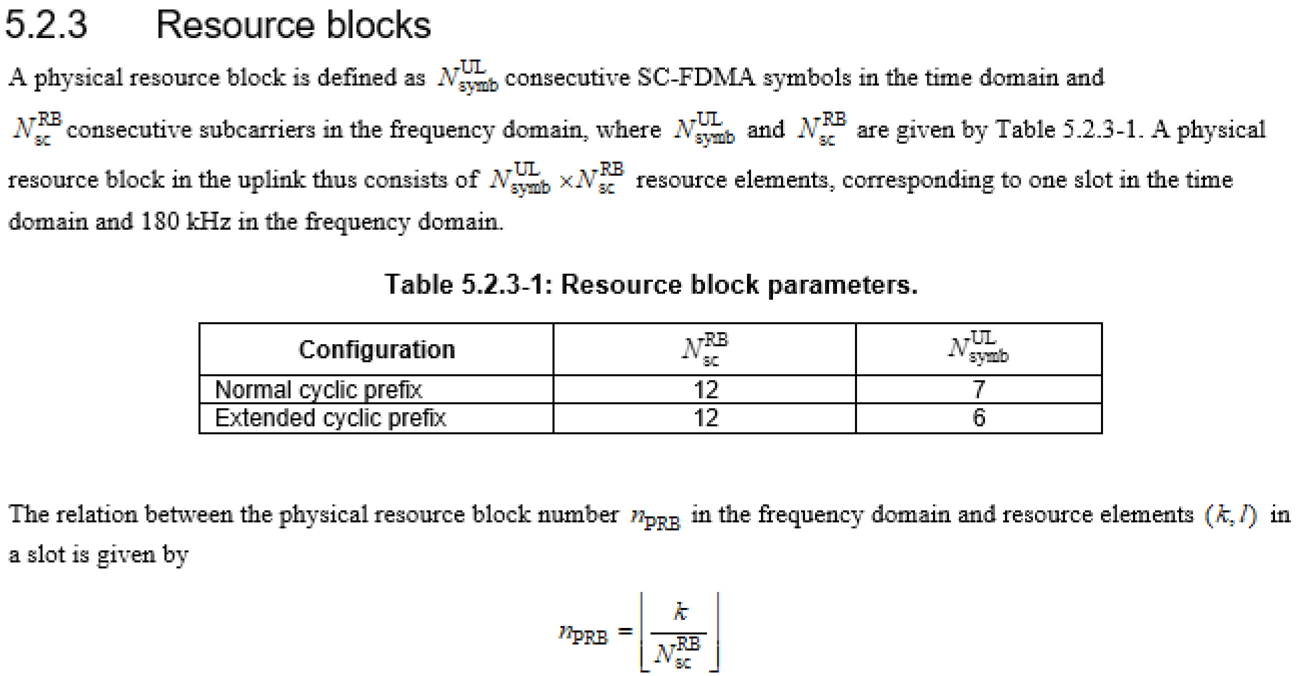
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

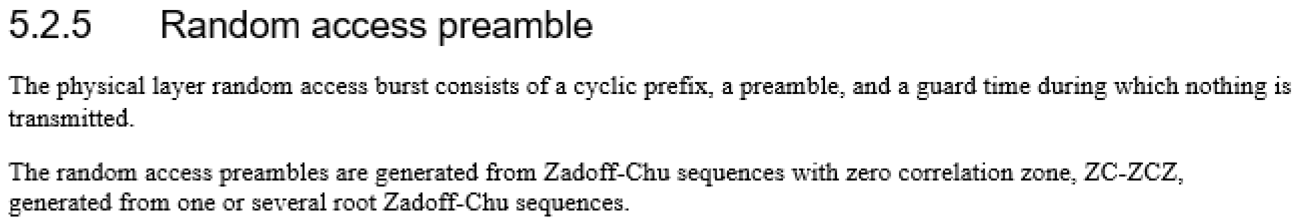
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

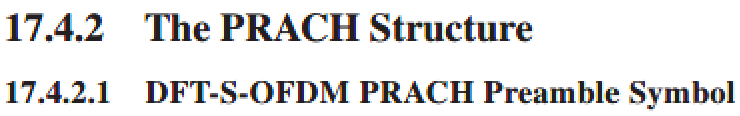


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

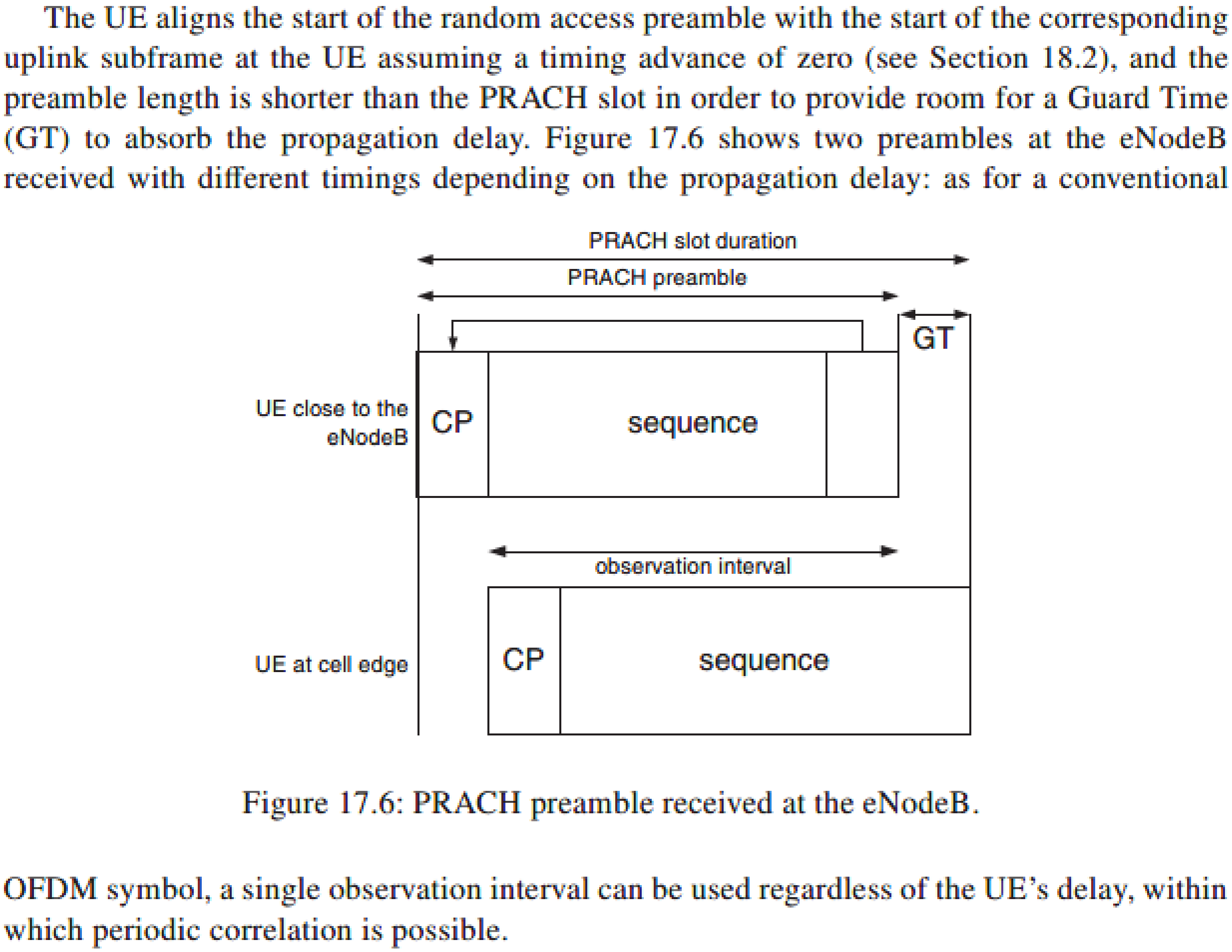


17.4.2 The PRACH Structure

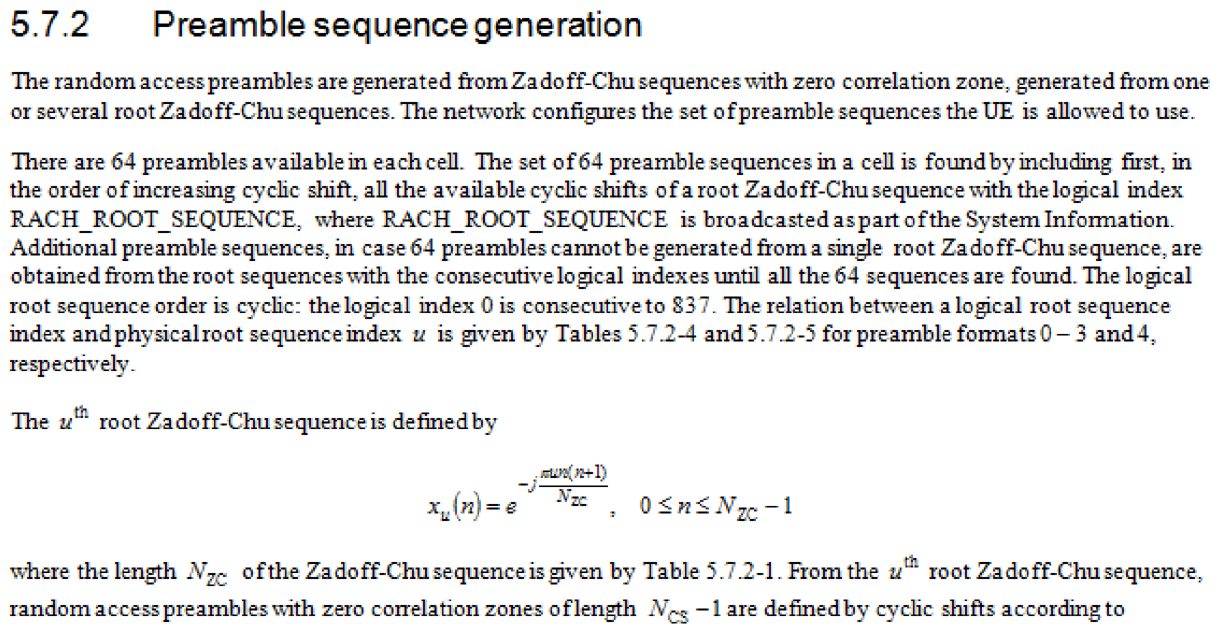
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

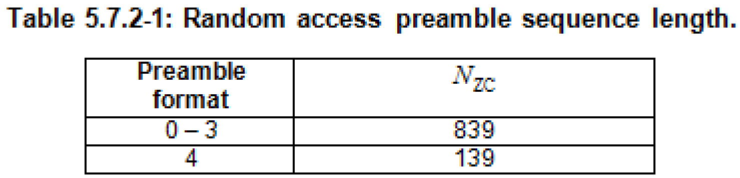
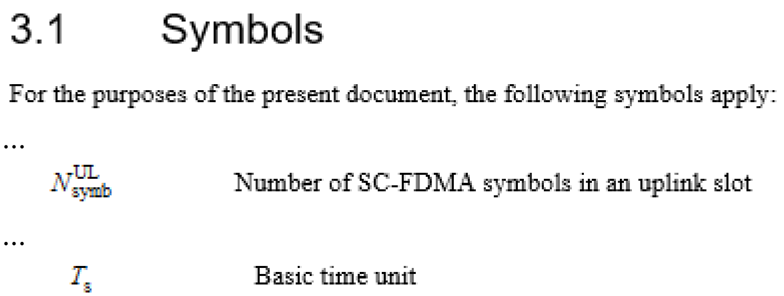
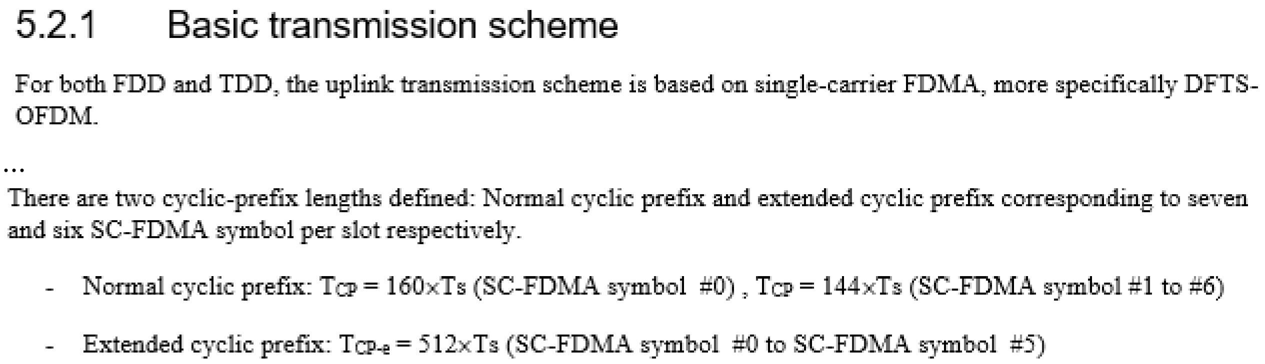


Table 5.7.2-1: Random access preamble sequence length.

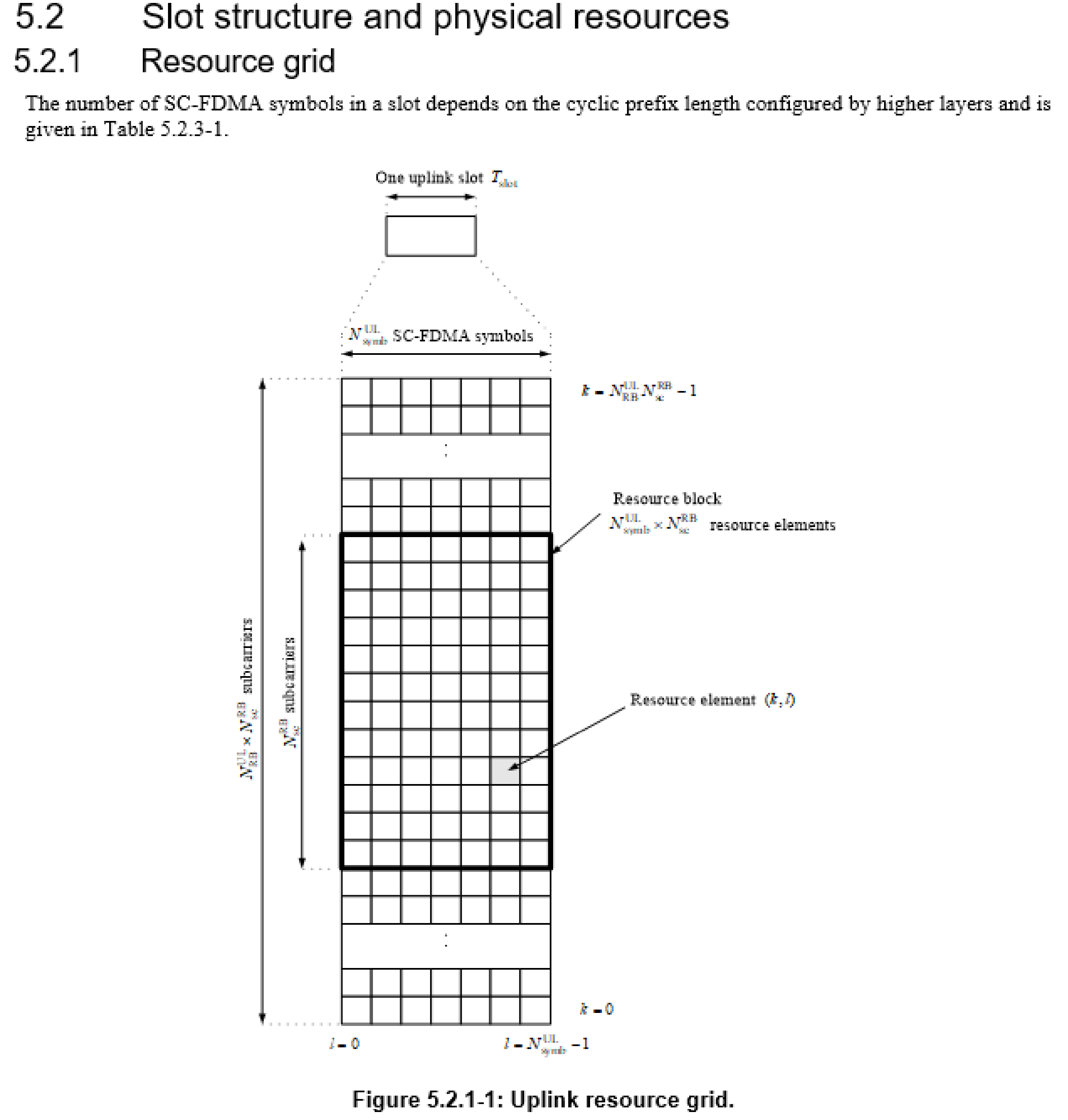
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Ford's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: T_{CP-e} = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



5.2 Slot structure and physical resources

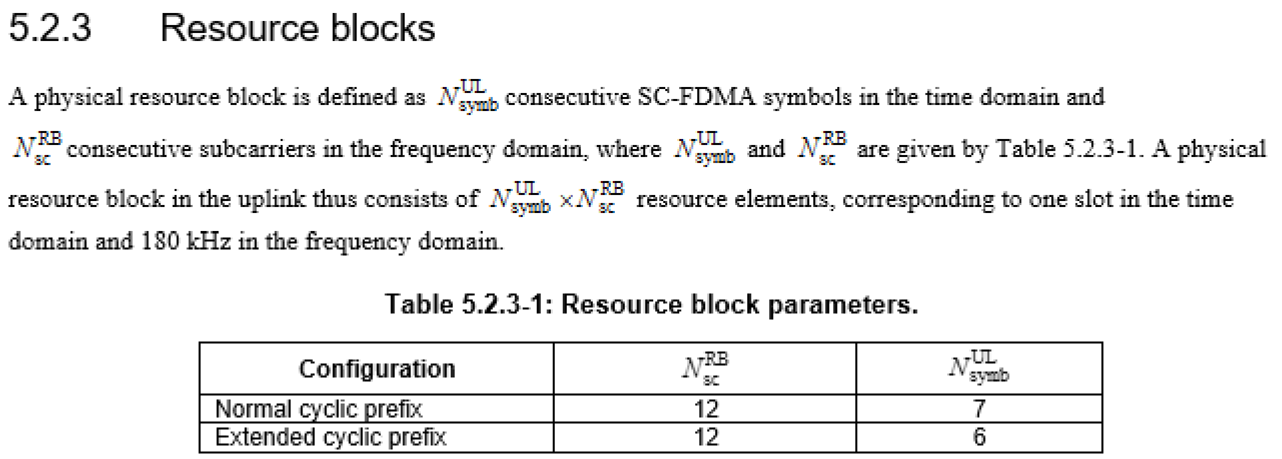
5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

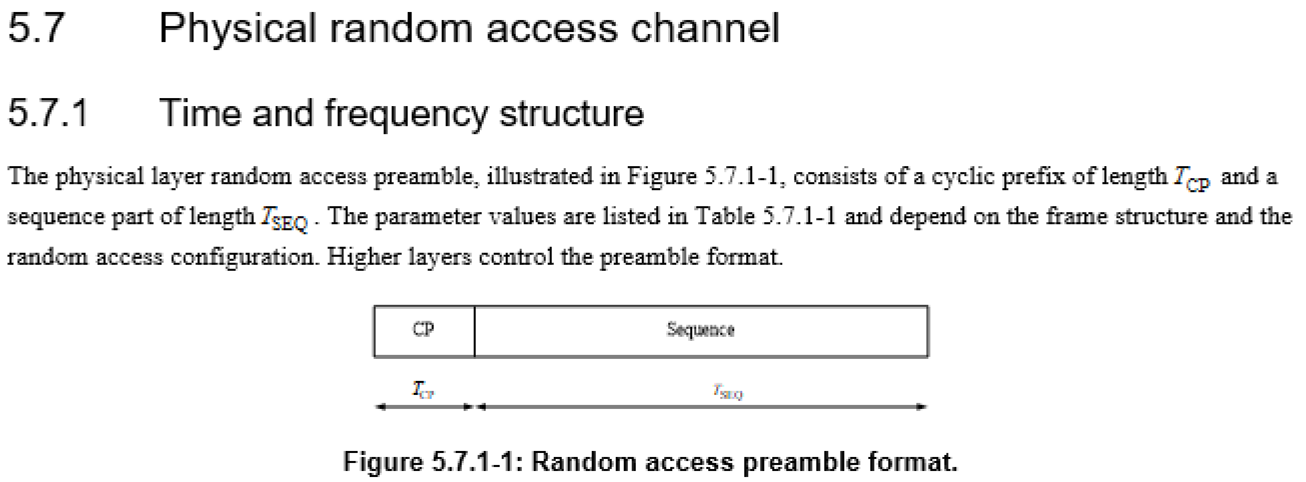
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

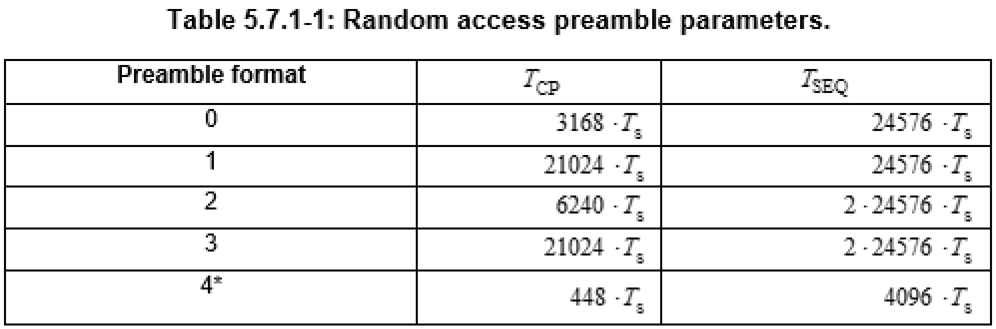
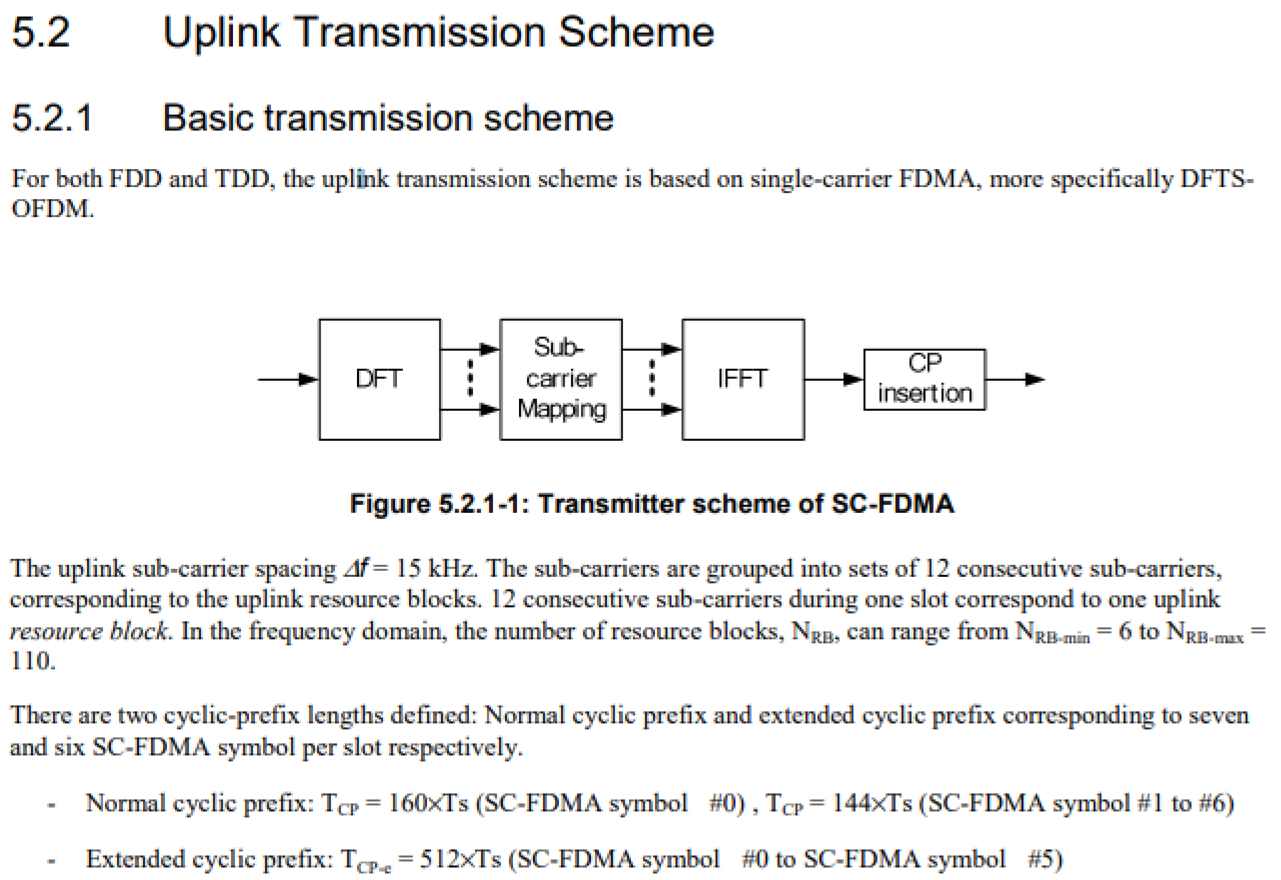


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)
"a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;"

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	Ford's Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, Ford's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)

"a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;"

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

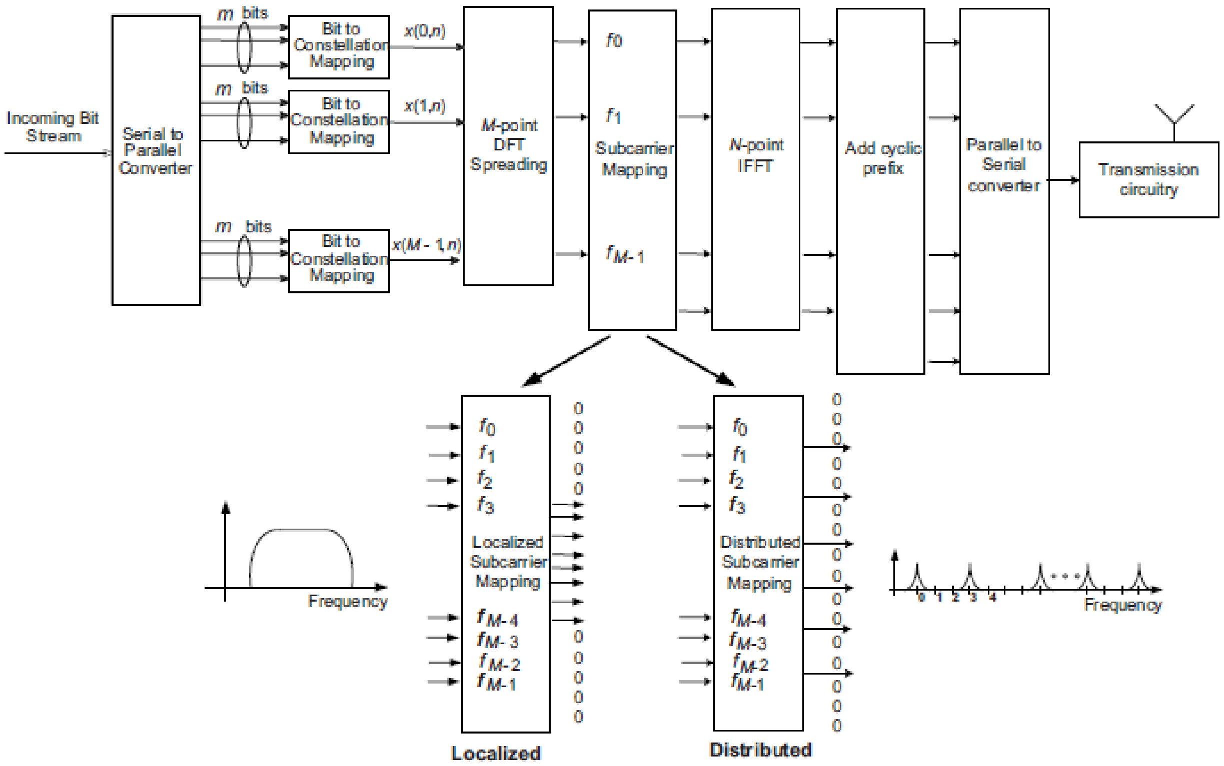


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

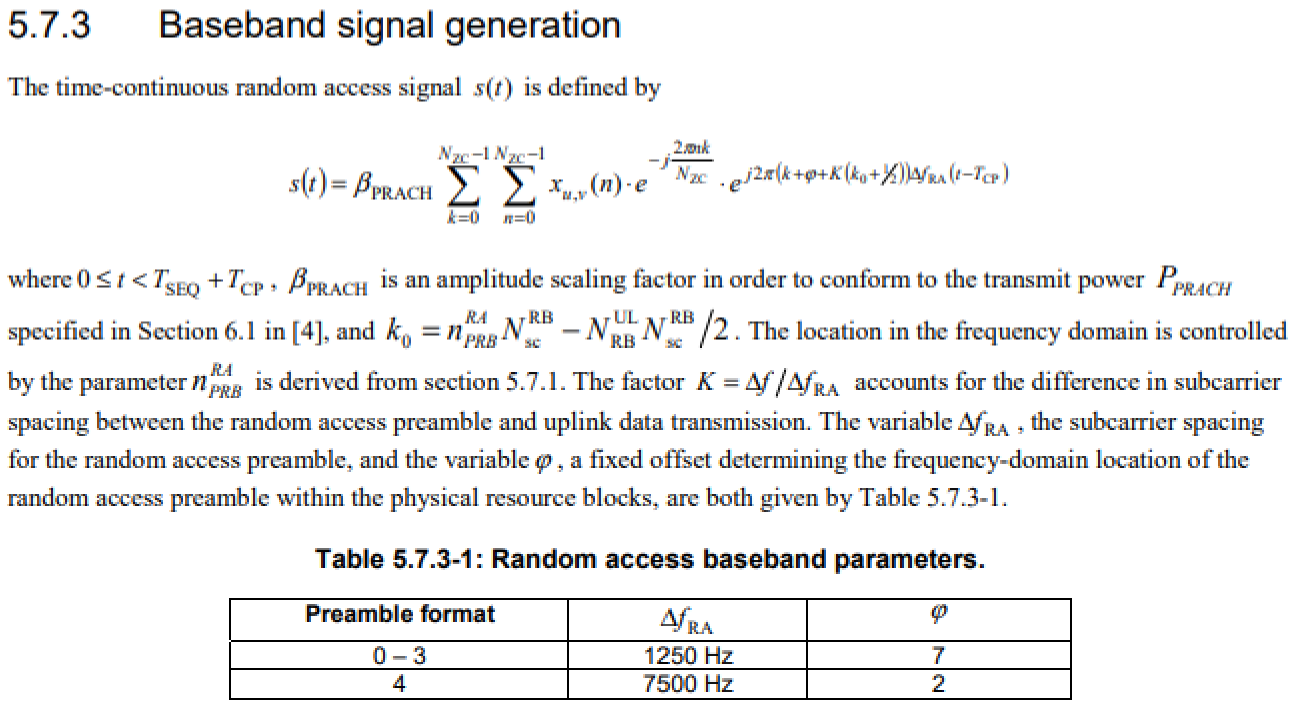
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 21(f)

"wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band"

<table>
<tr>
<td>wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;</td>
<td>
Ford's Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. <i>E.g.</i>,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.


<h3>5.7.3 Baseband signal generation</h3>
The time-continuous random access signal $s(t)$ is defined by

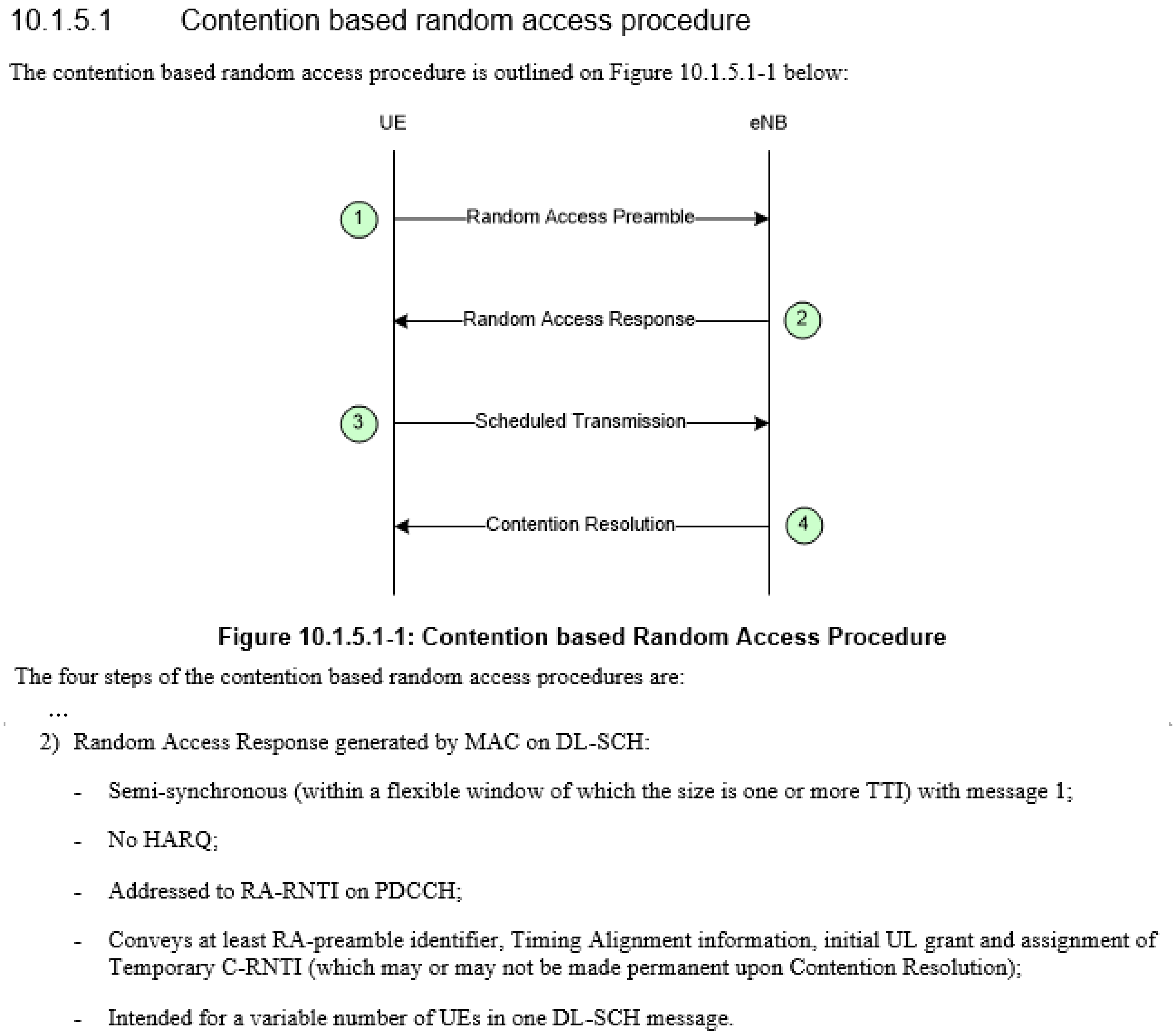
$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi(k+\varphi+K(k_0+\frac{1}{2}))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

where $0\le t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

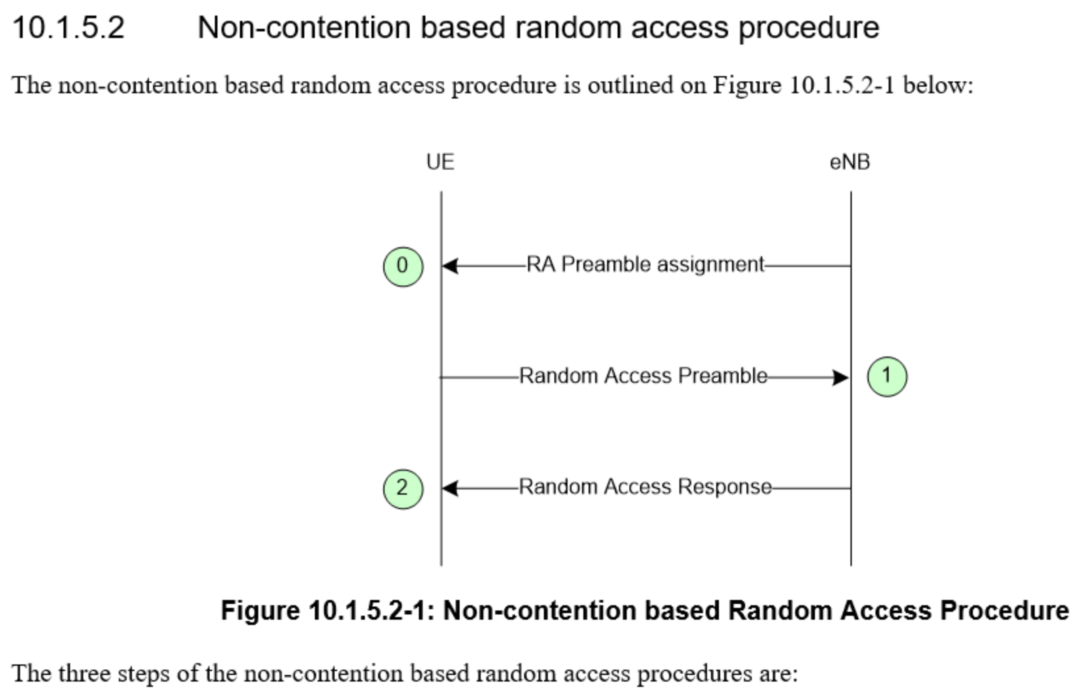
Table 5.7.3-1: Random access baseband parameters.
<table>
<tr><th>Preamble format</th><th>Δf_{RA}</th><th>φ</th></tr>
<tr><td>0 – 3</td><td>1250 Hz</td><td>7</td></tr>
<tr><td>4</td><td>7500 Hz</td><td>2</td></tr>
</table>

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.
</td>
</tr>
</table>

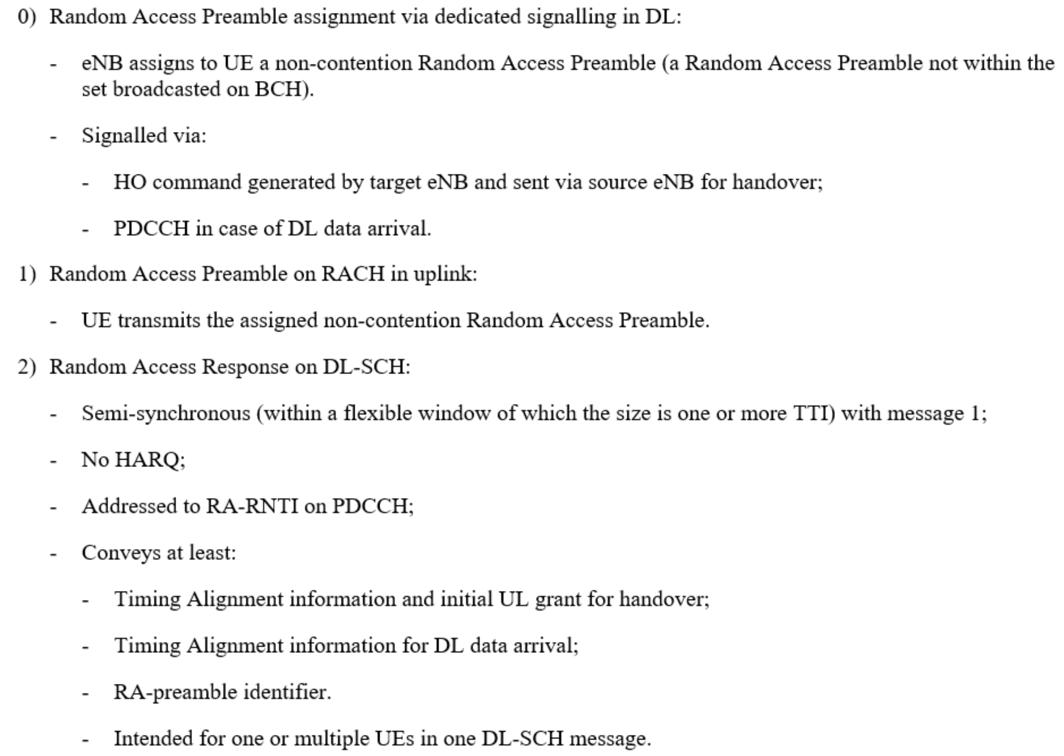
US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

wherein the mobile station is further configured to receive, from the base station, a second analog signal	Ford’s Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

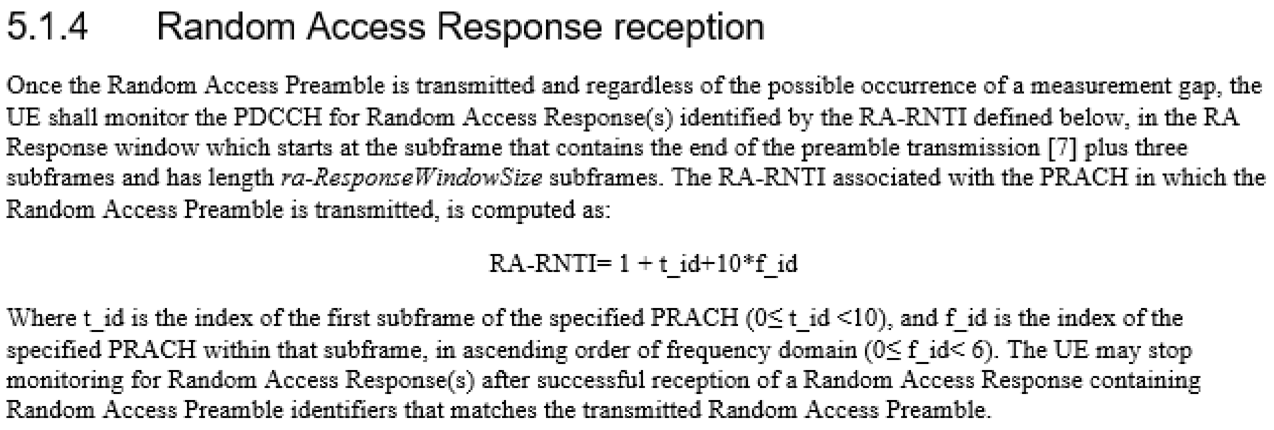
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



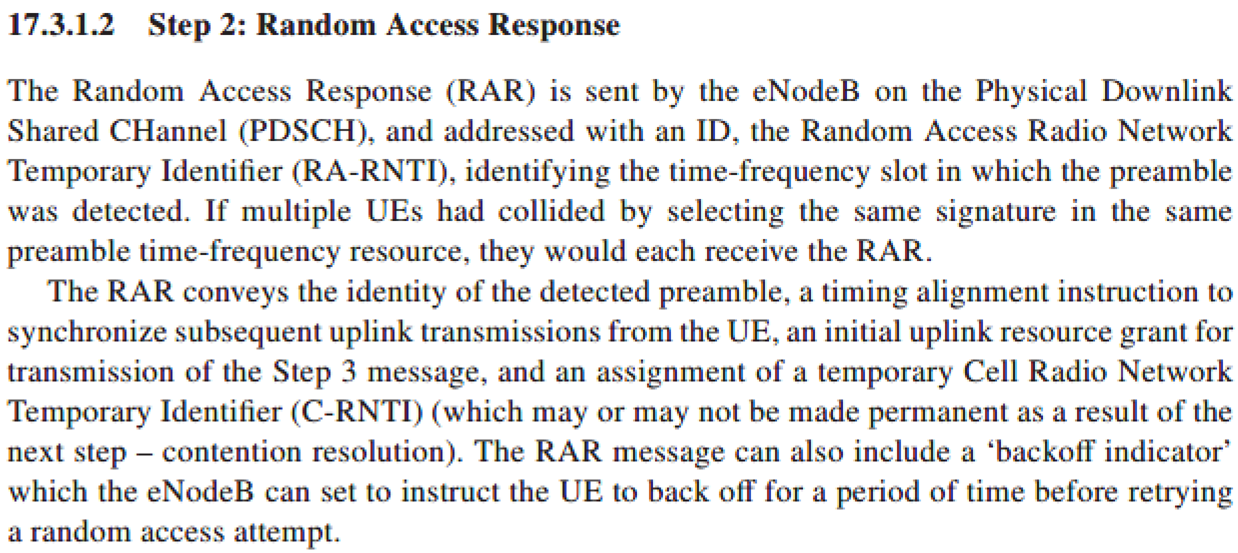
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

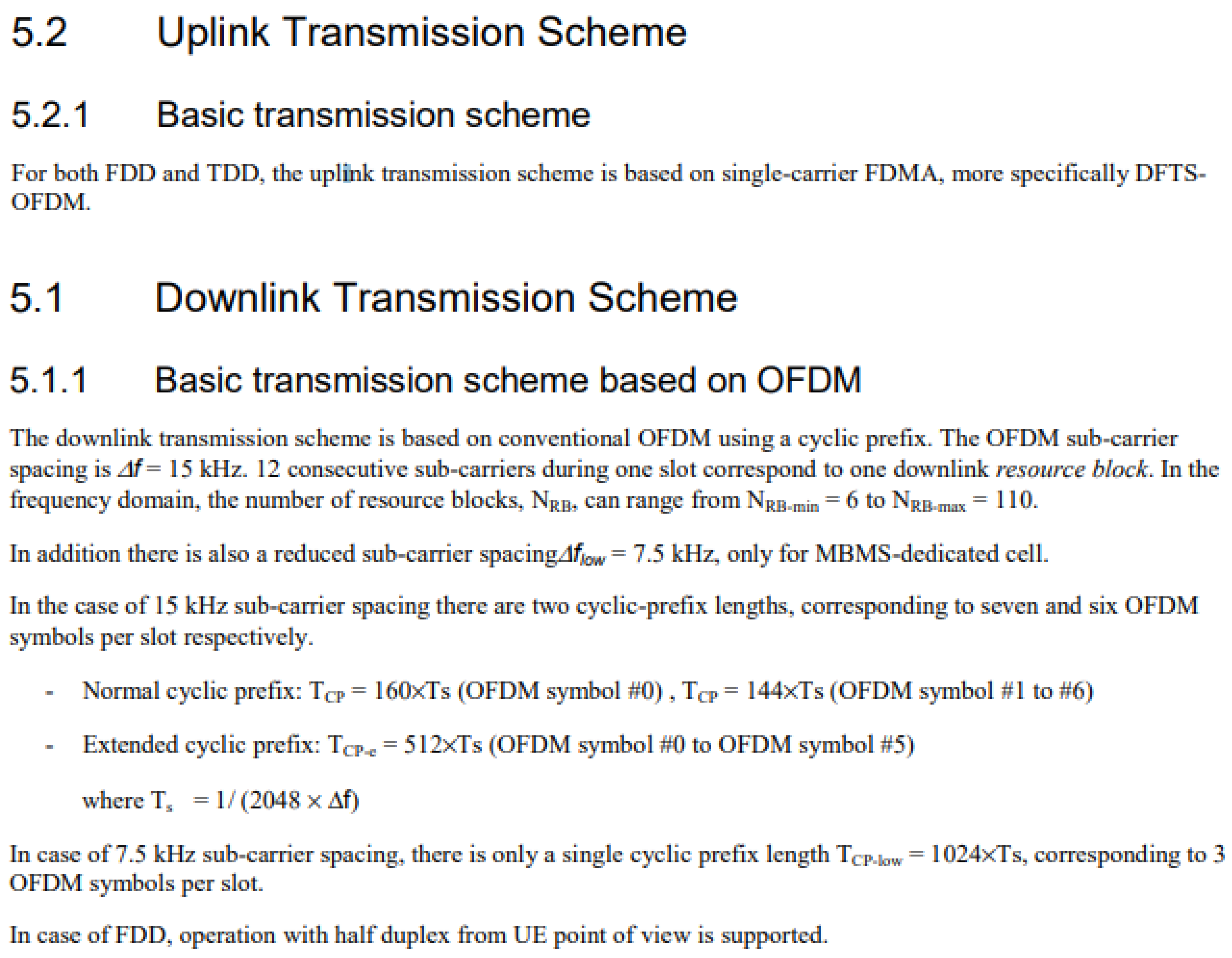
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	Ford's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, Ford's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **5.1 Downlink Transmission Scheme** **5.1.1 Basic transmission scheme based on OFDM** The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (OFDM symbol #0) , T_{CP} = 144×Ts (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low}$ = 1024×Ts, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

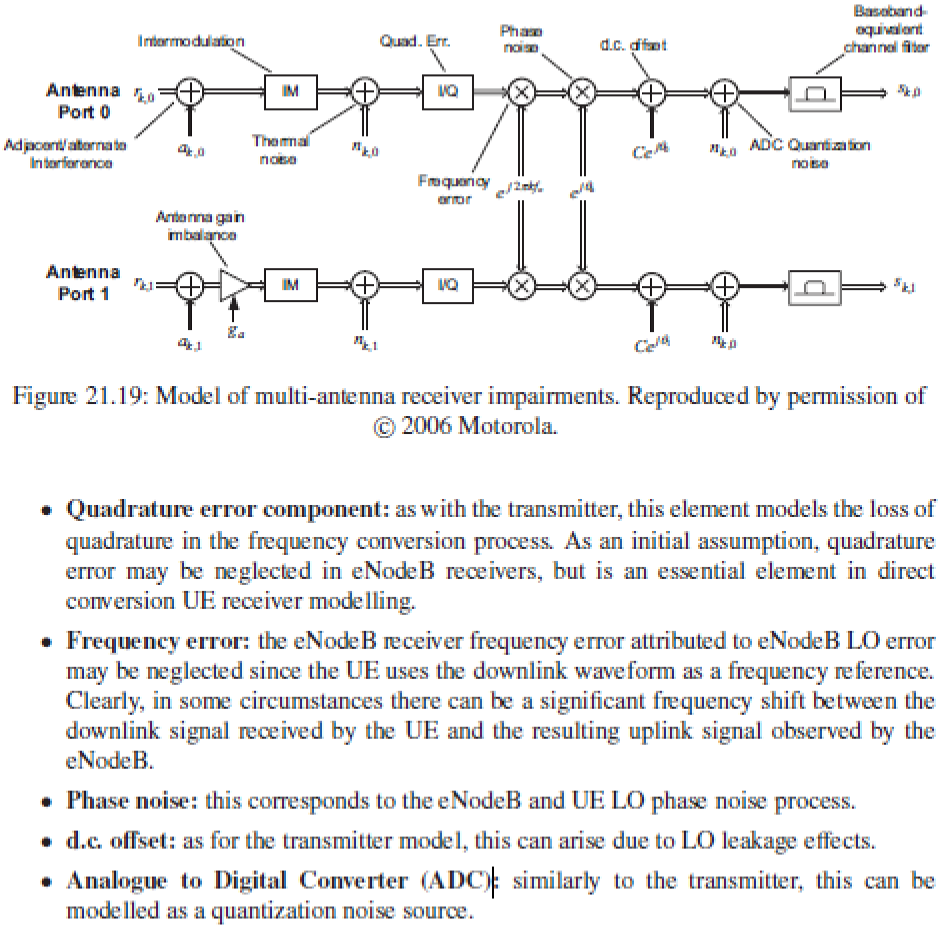


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.

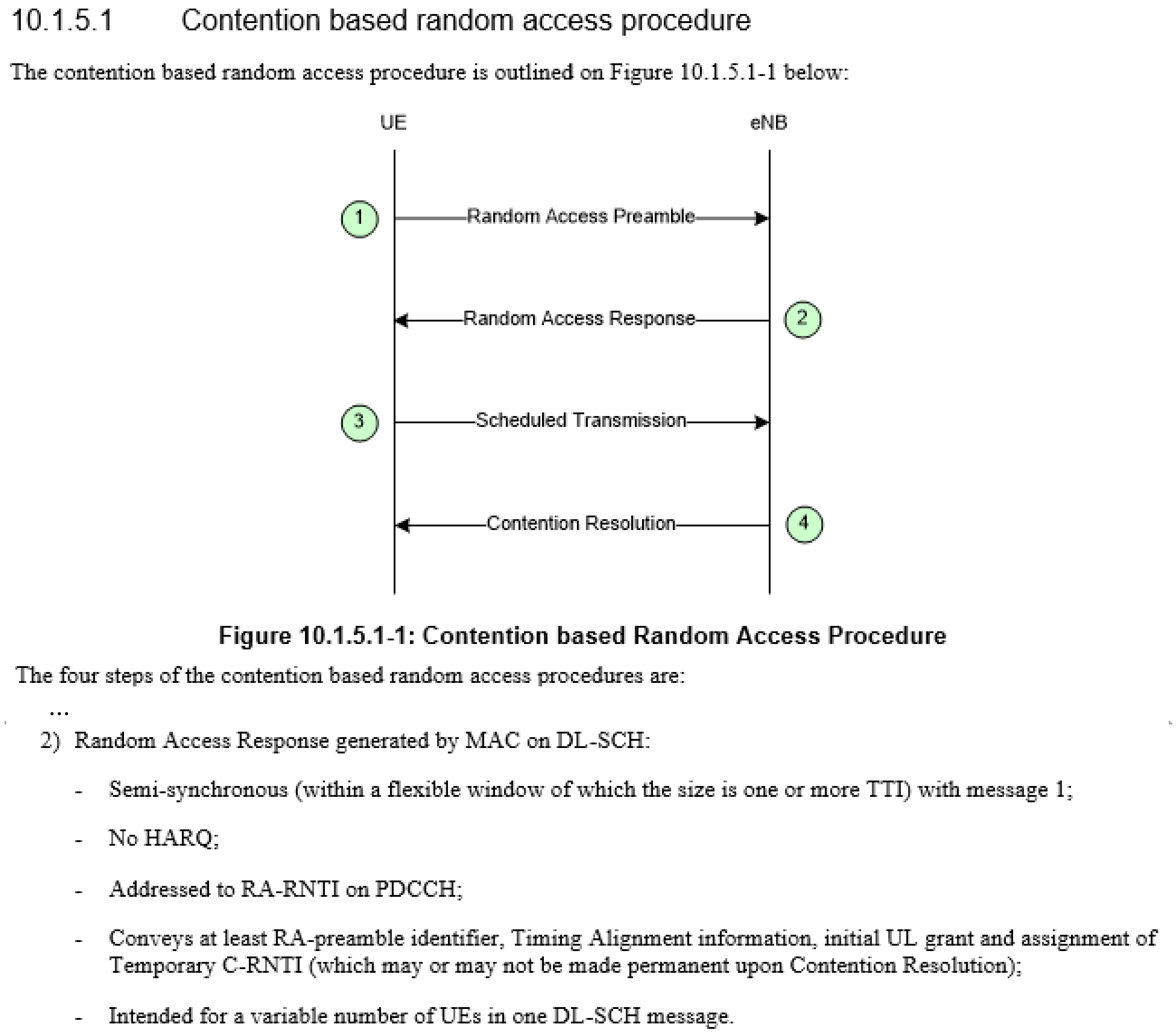
- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

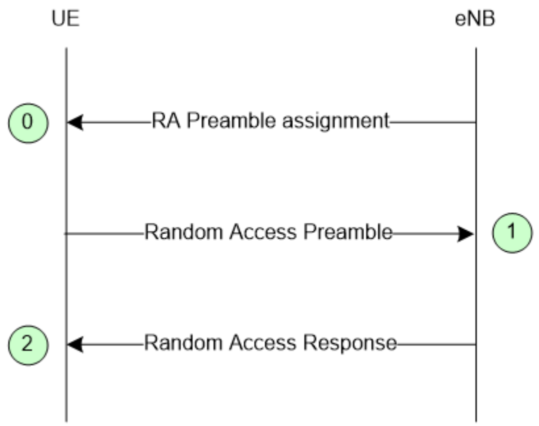
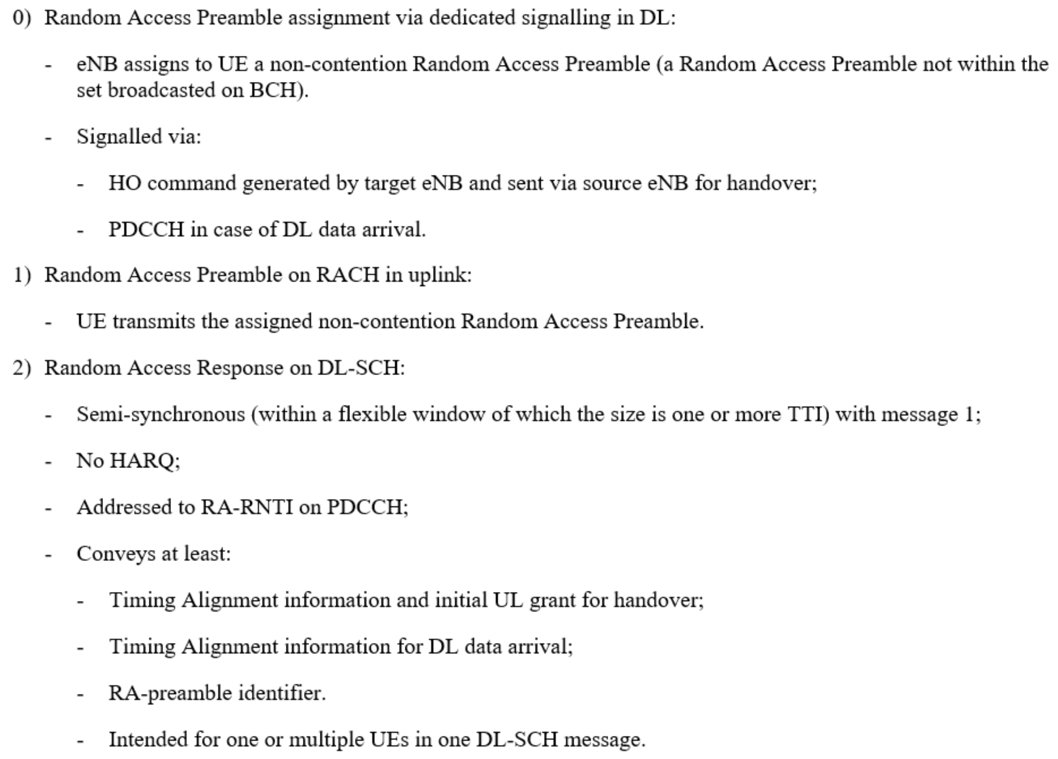


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

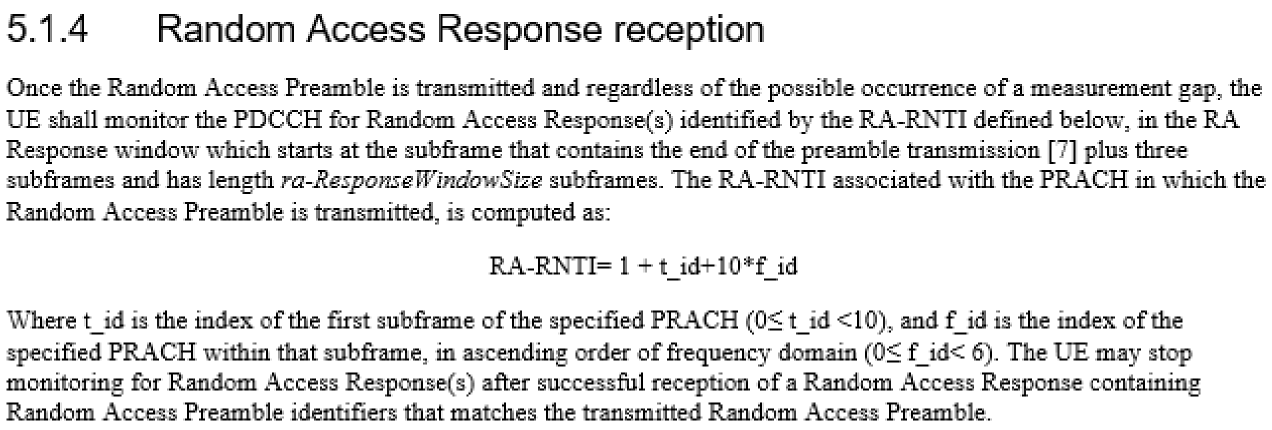


0) Random Access Preamble assignment via dedicated signalling in DL:
    - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
    - Signalled via:
        - HO command generated by target eNB and sent via source eNB for handover;
        - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
    - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
    - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
    - No HARQ;
    - Addressed to RA-RNTI on PDCCH;
    - Conveys at least:
        - Timing Alignment information and initial UL grant for handover;
        - Timing Alignment information for DL data arrival;
        - RA-preamble identifier.
        - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



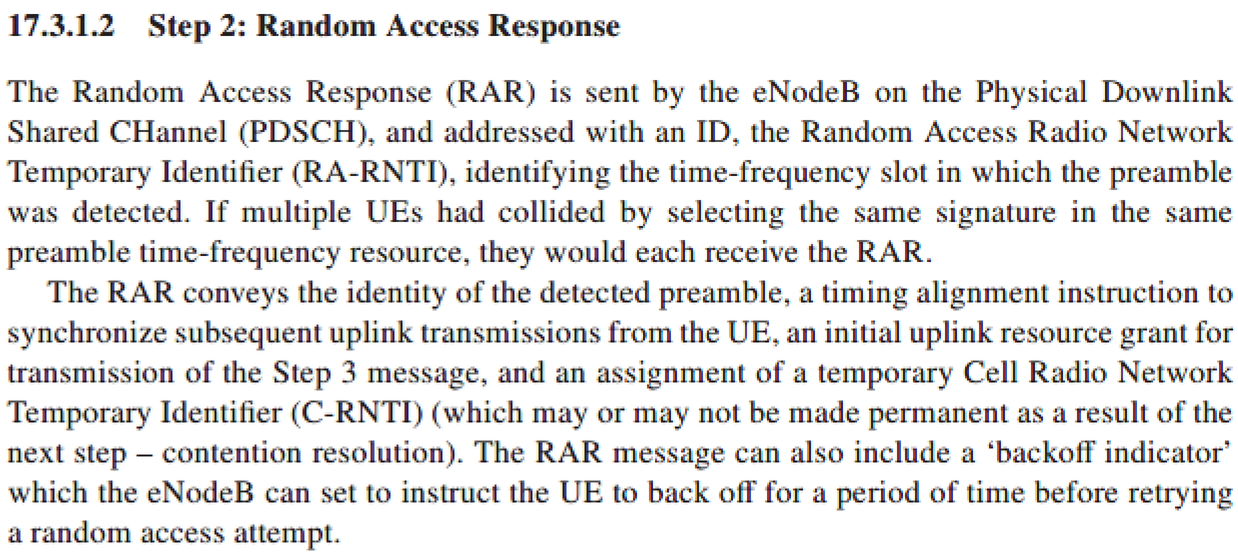
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

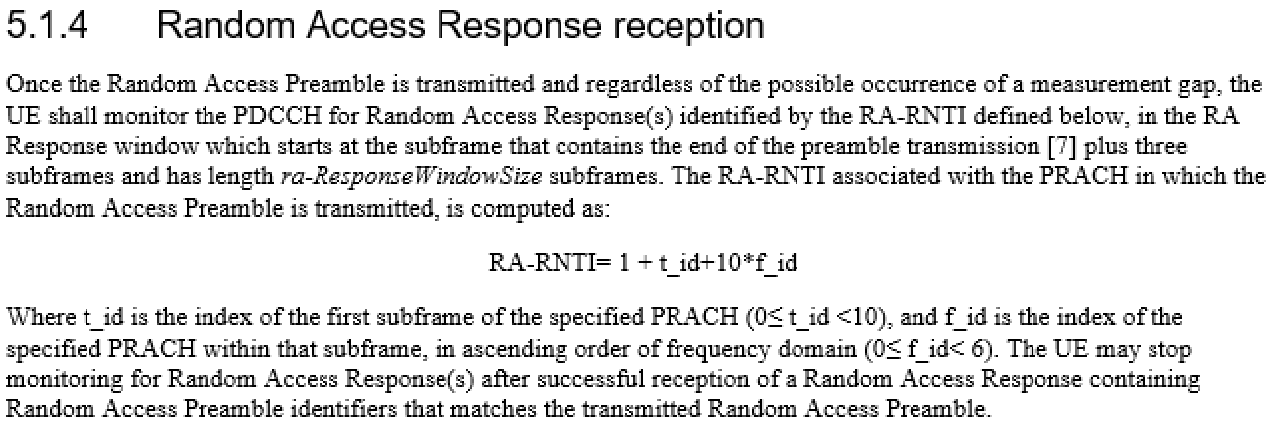
US Patent No. 10,833,908: Claim 21(h)
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

	See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

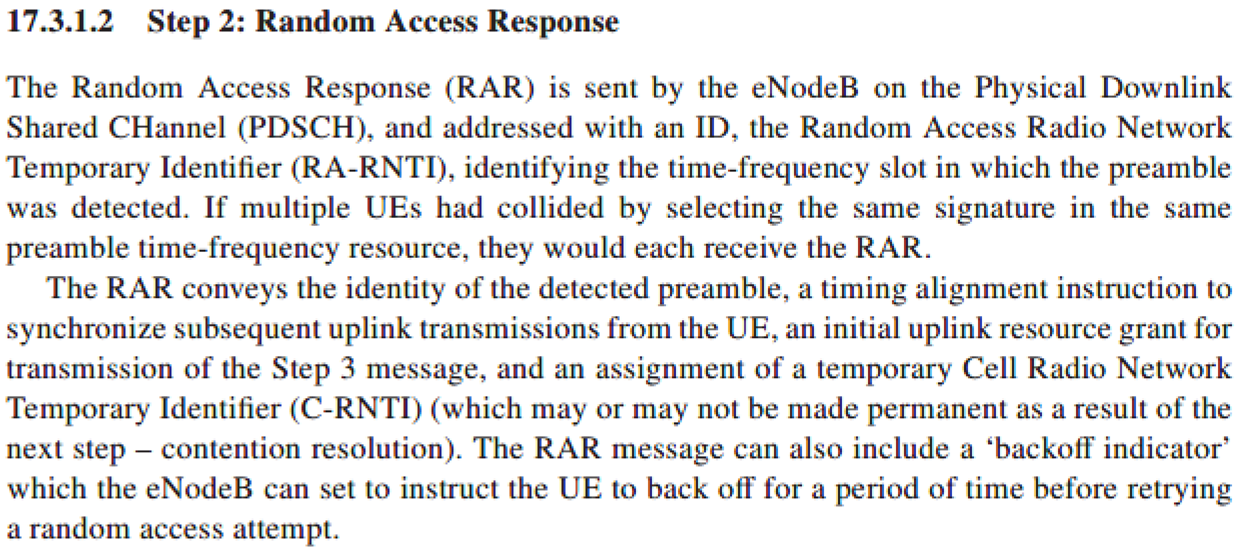
US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

22. The mobile station of claim 21, wherein:	*See* Claim 21.

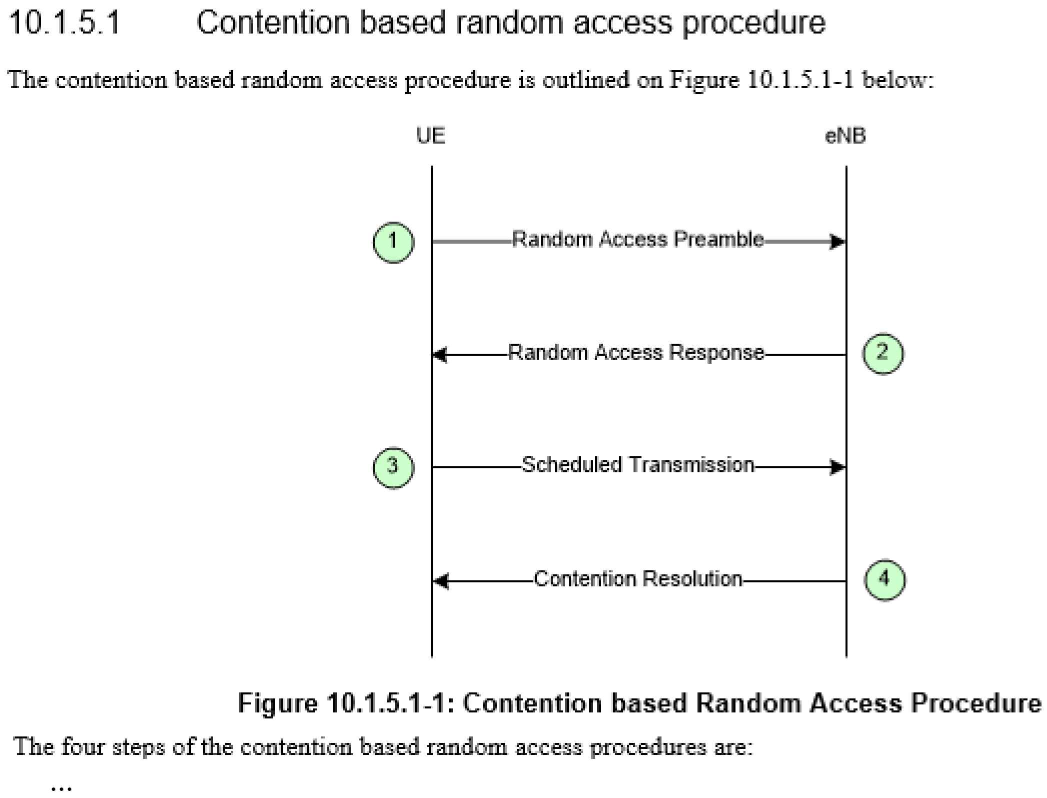
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

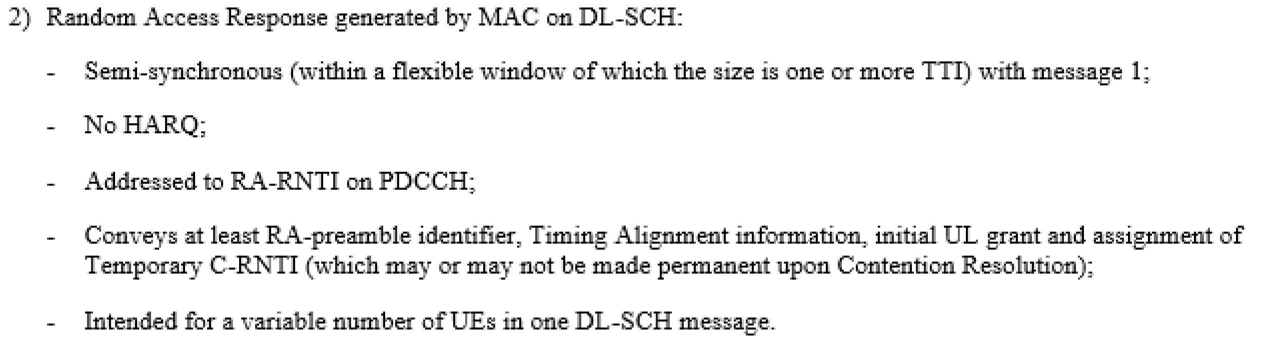
the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	Ford’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 22(b)
"the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

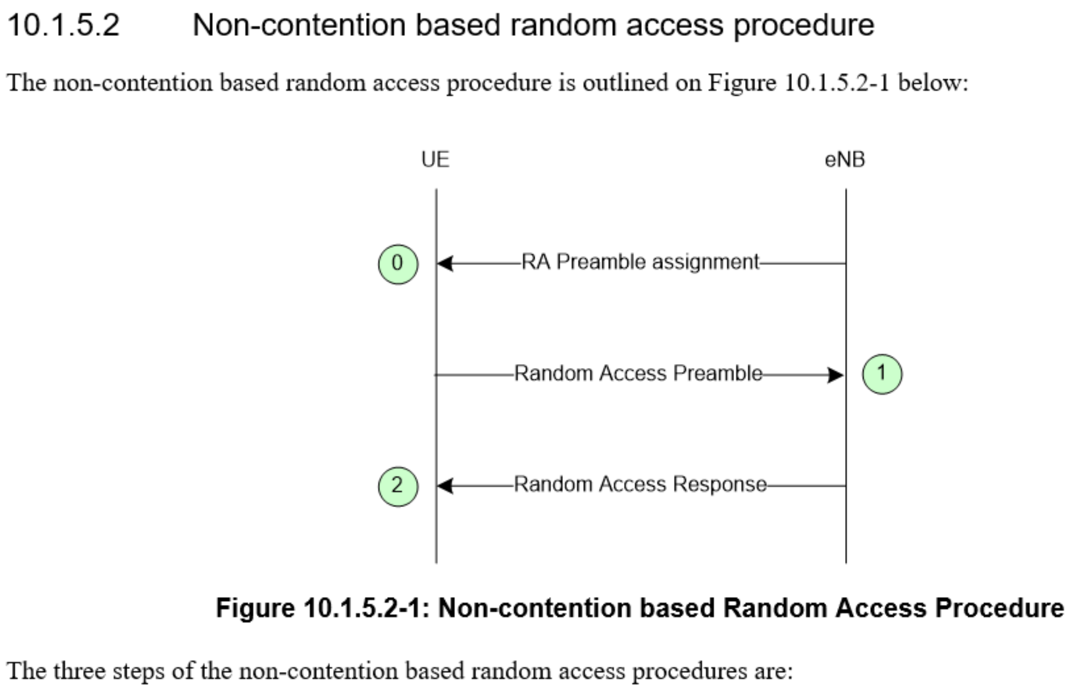
on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Ford's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



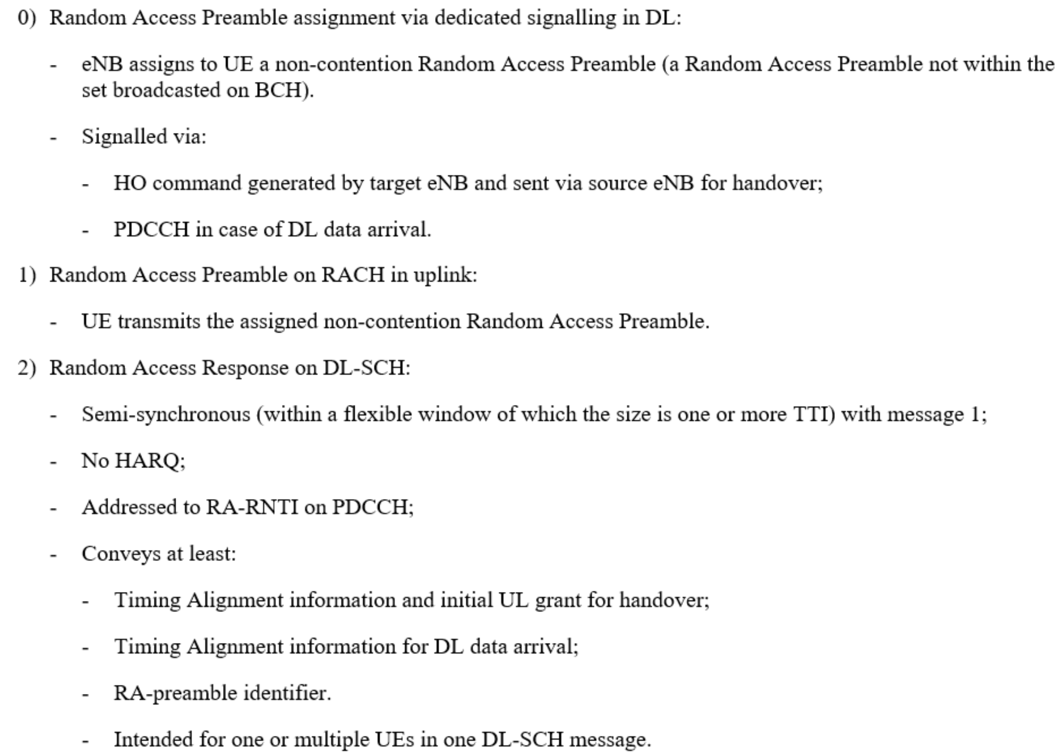
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

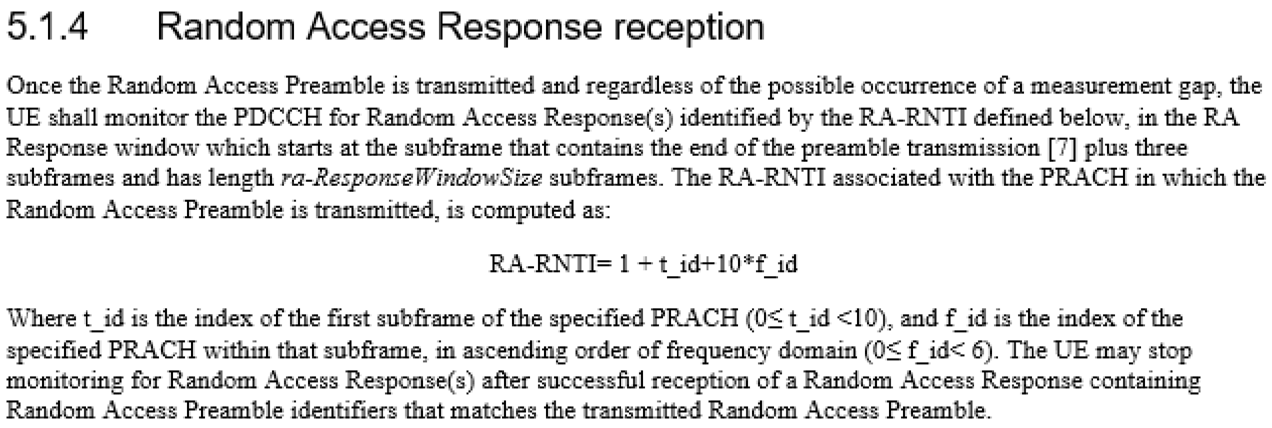
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

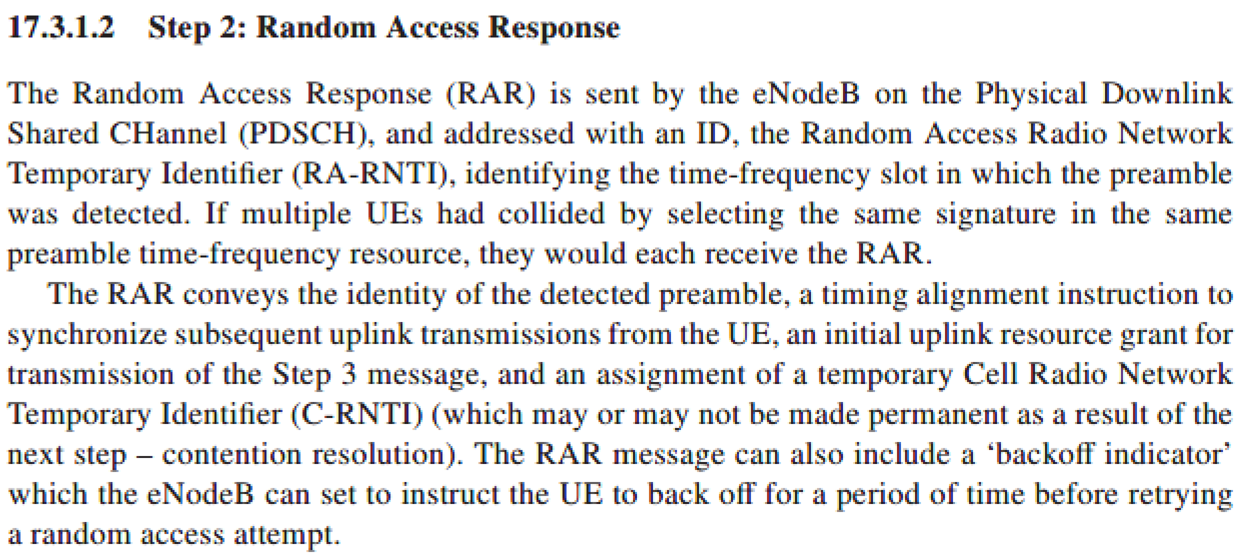
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

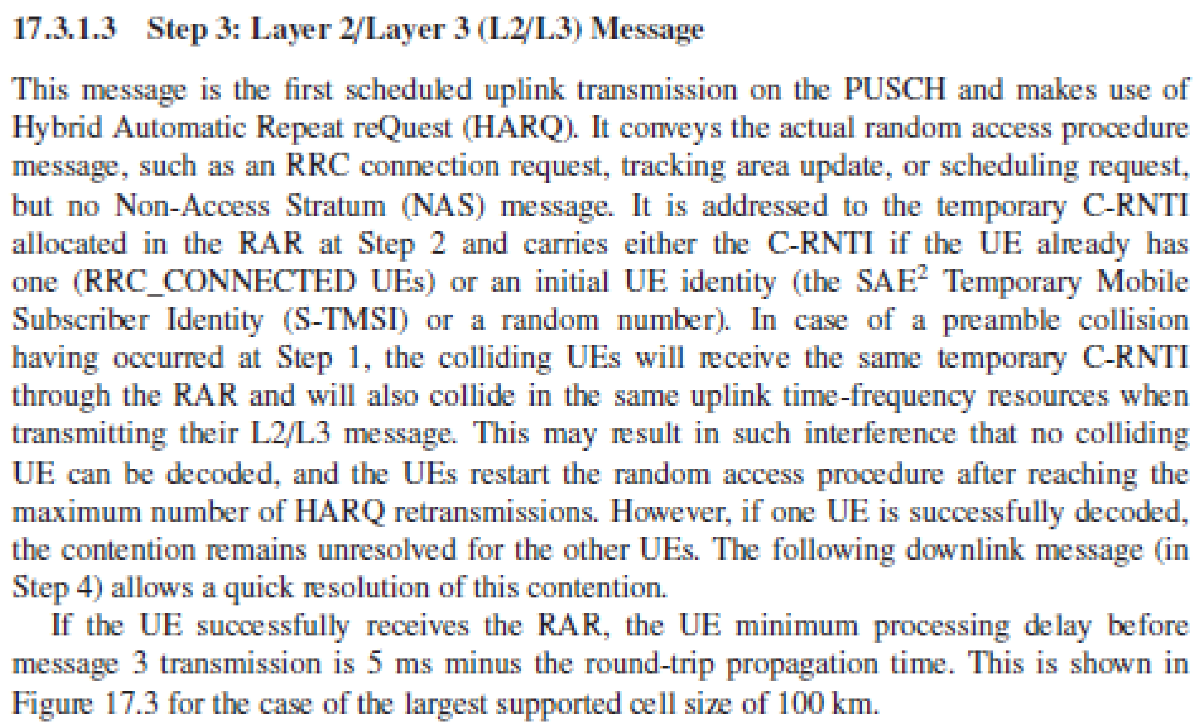
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message

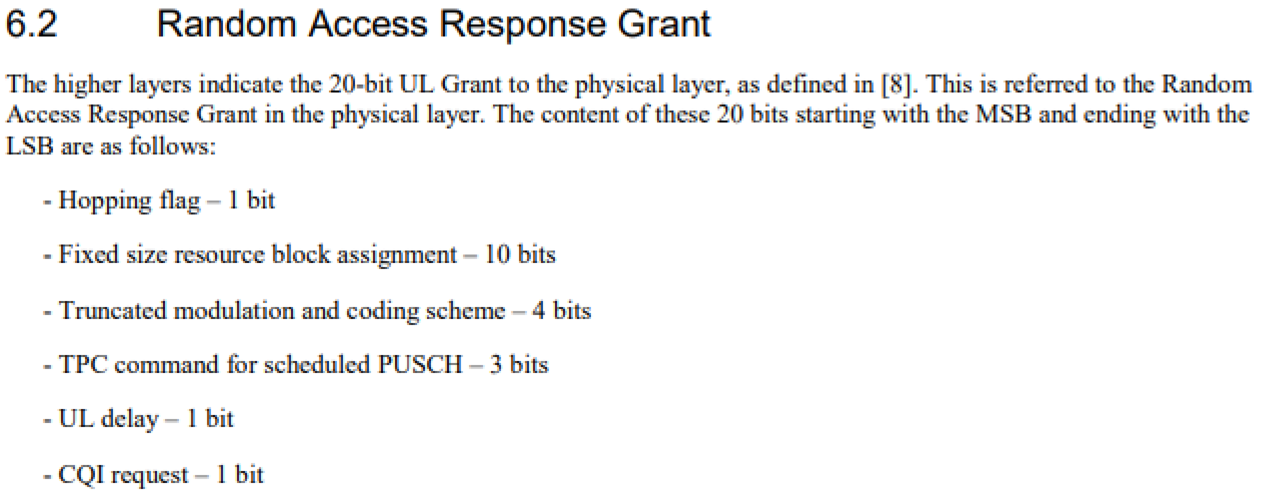
This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention.

If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km.

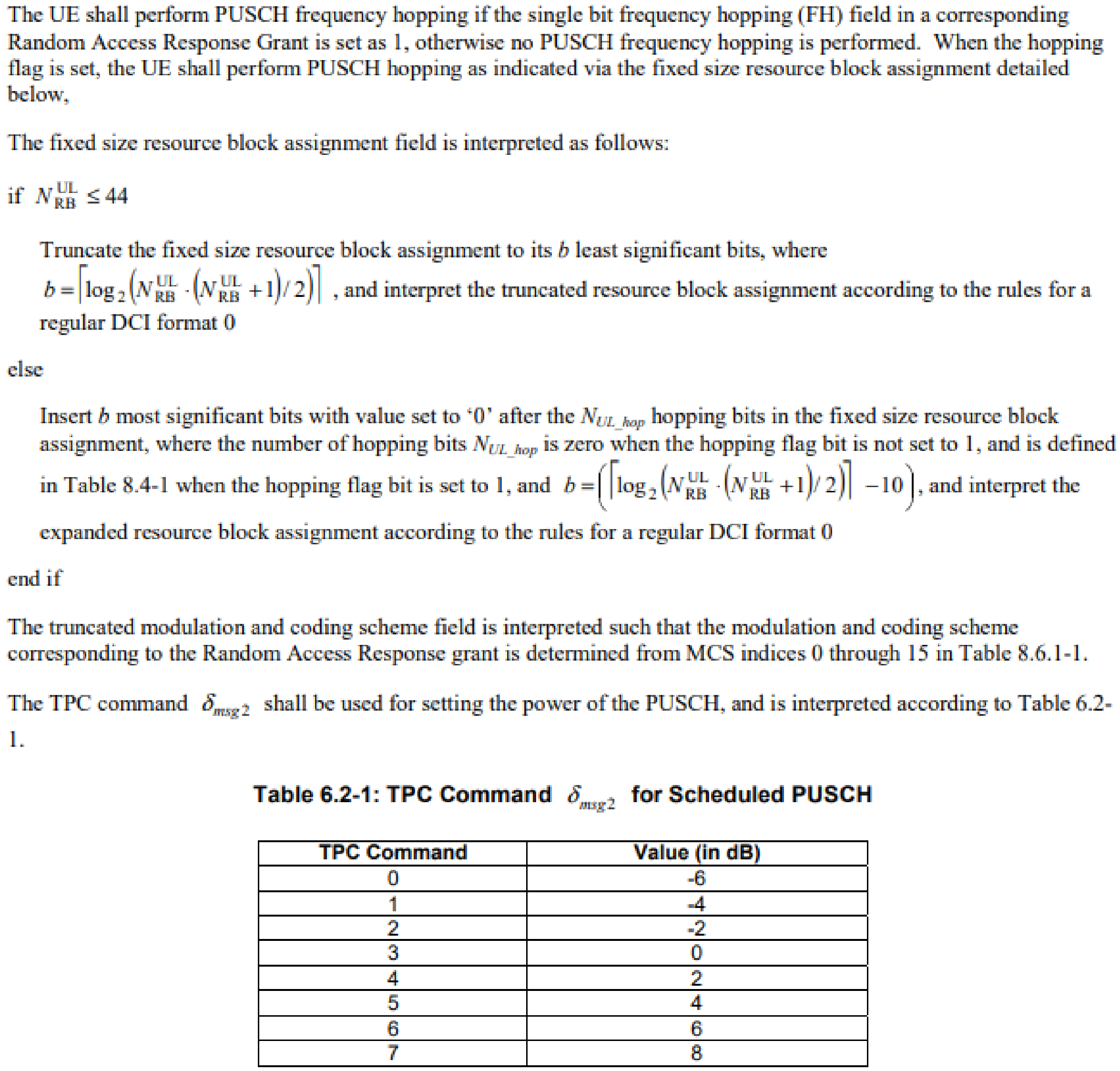
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

See also Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by Ford's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
“The mobile station of claim 22, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{RB}^{UL} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \lceil \log_2 (N_{RB}^{UL} \cdot (N_{RB}^{UL}+1)/2) \rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\lceil \log_2 (N_{RB}^{UL} \cdot (N_{RB}^{UL}+1)/2) \rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

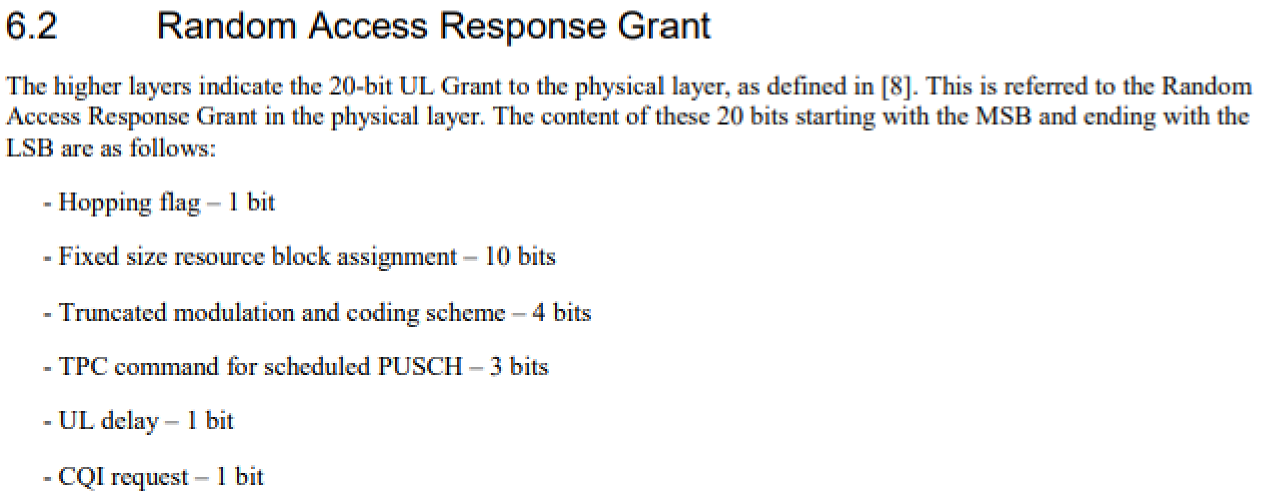
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

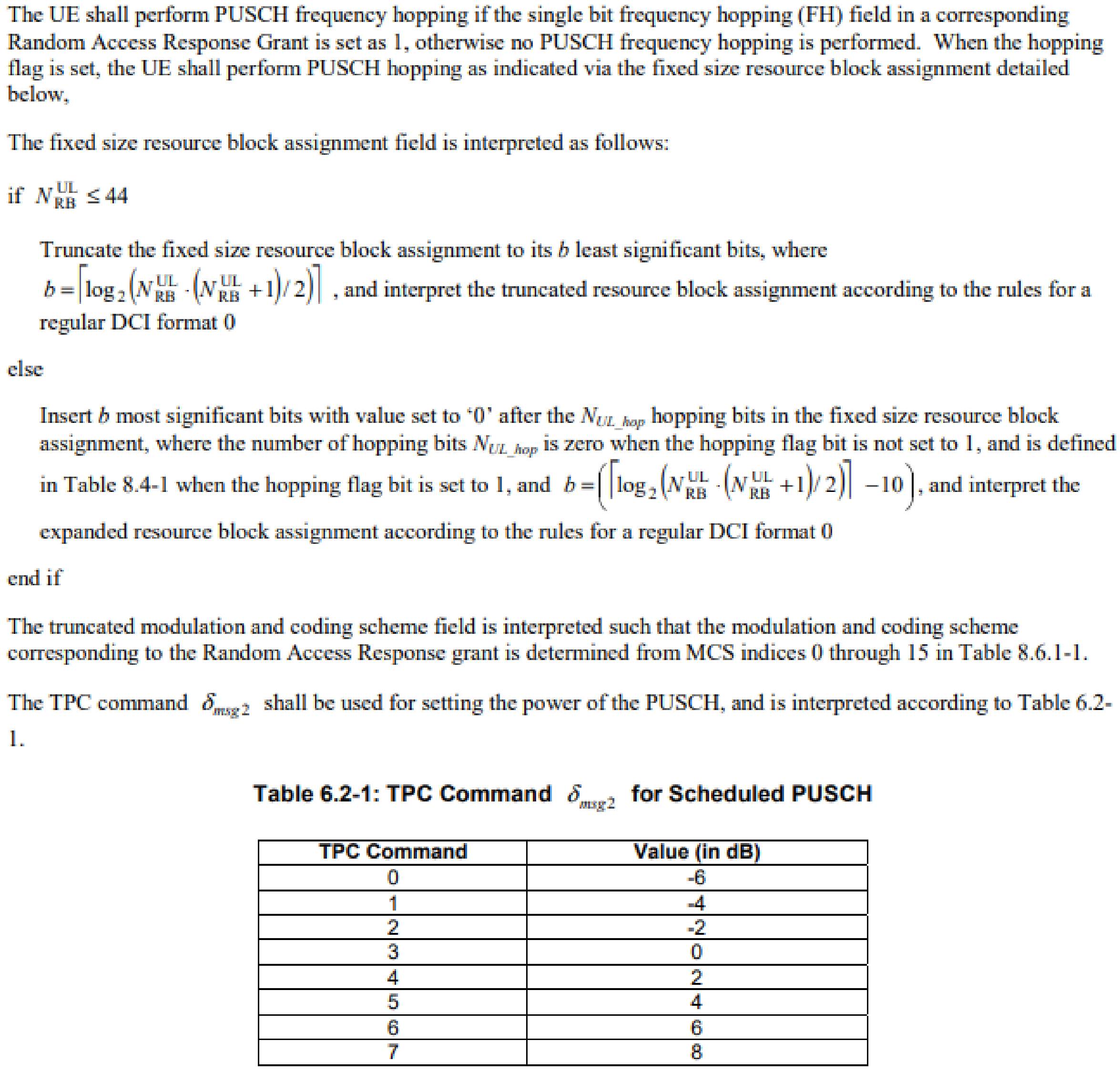
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	Ford's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

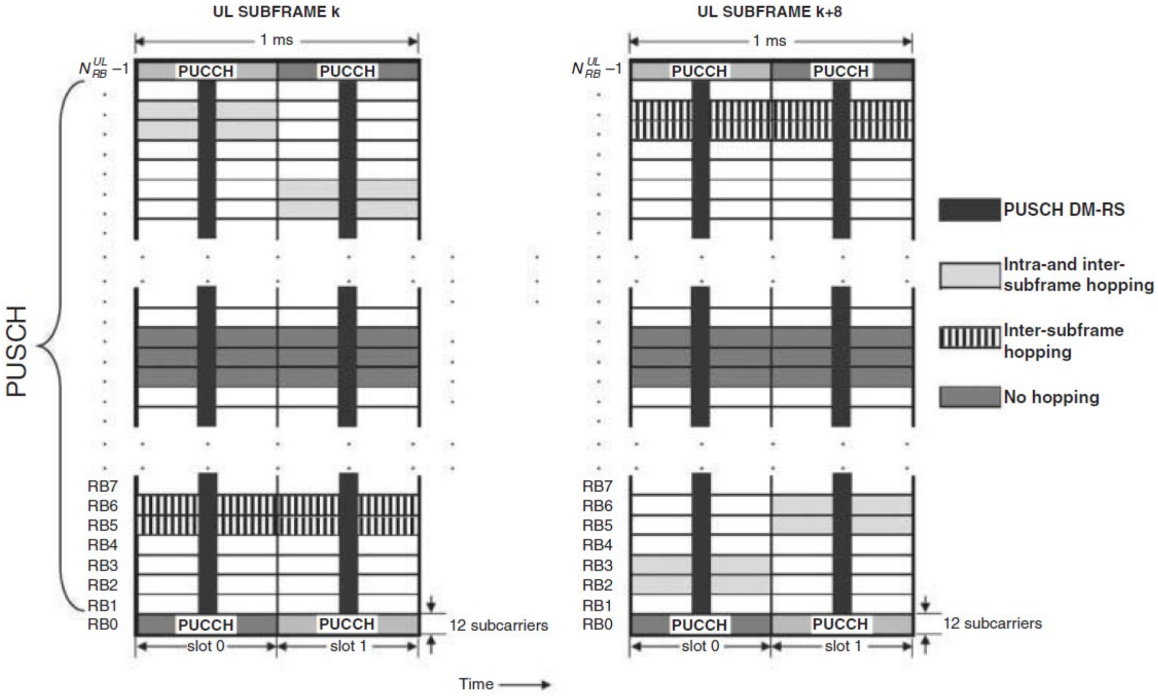
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

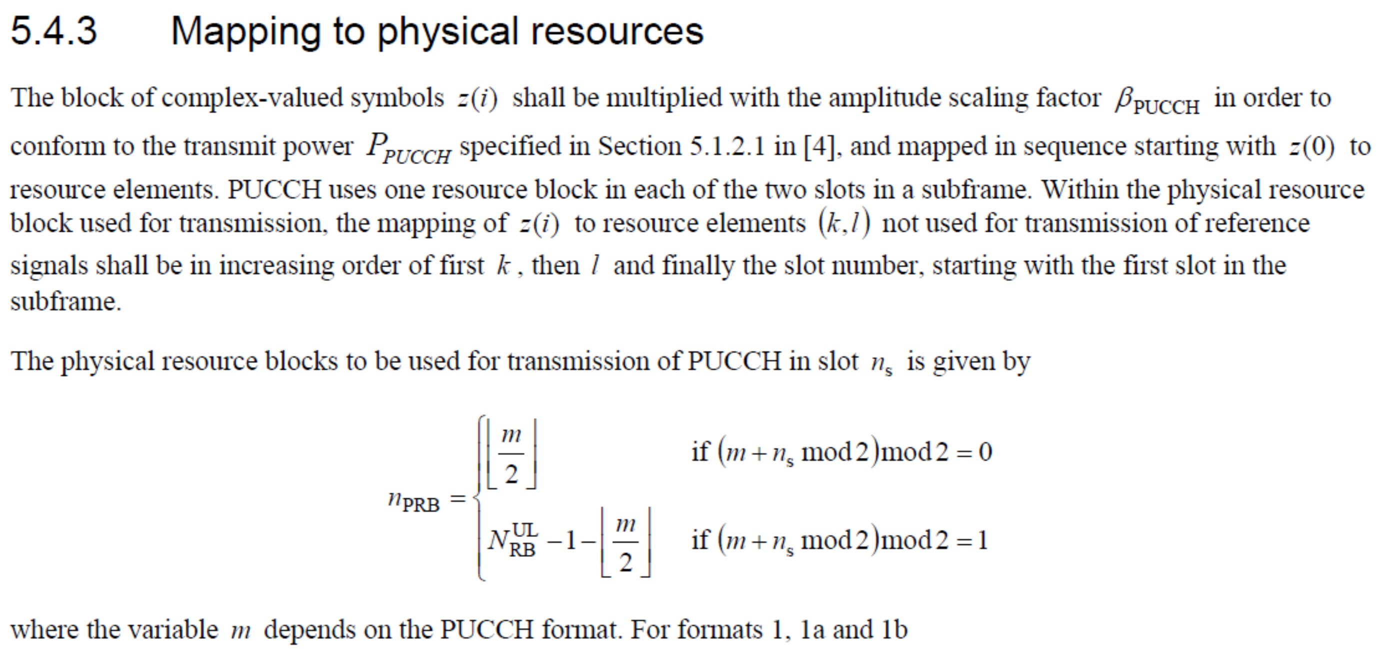
See also Claim 3.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Ford’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c\cdot N_{\mathrm{cs}}^{(1)}/\Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c\cdot N_{\mathrm{cs}}^{(1)}/\Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c\cdot N_{\mathrm{sc}}^{\mathrm{RB}}/\Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)}/\mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

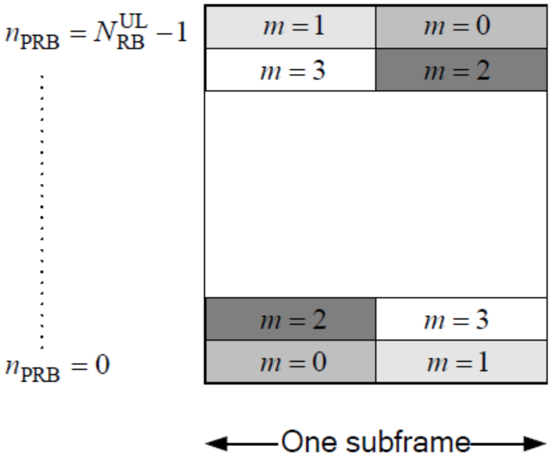


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

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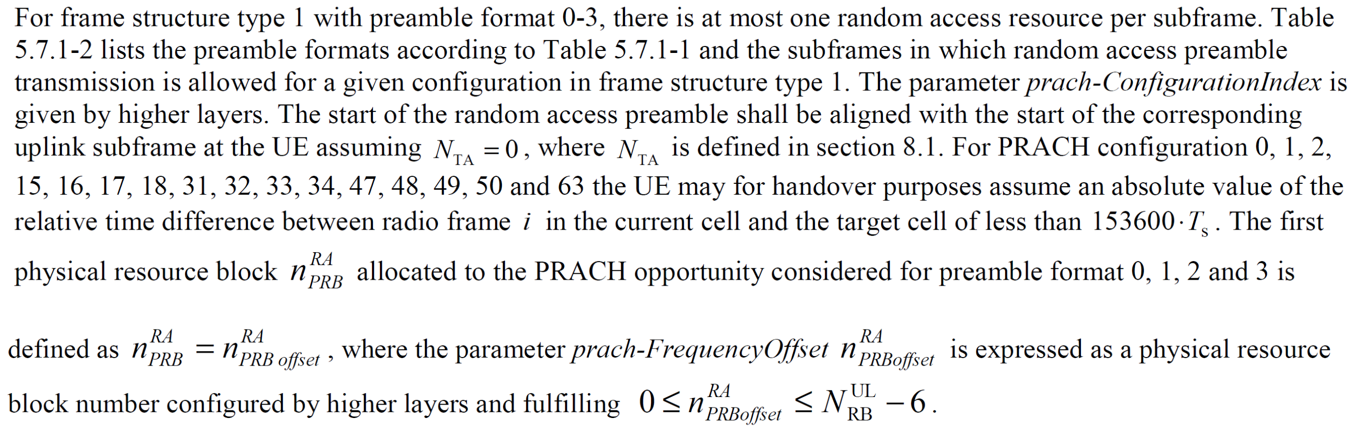
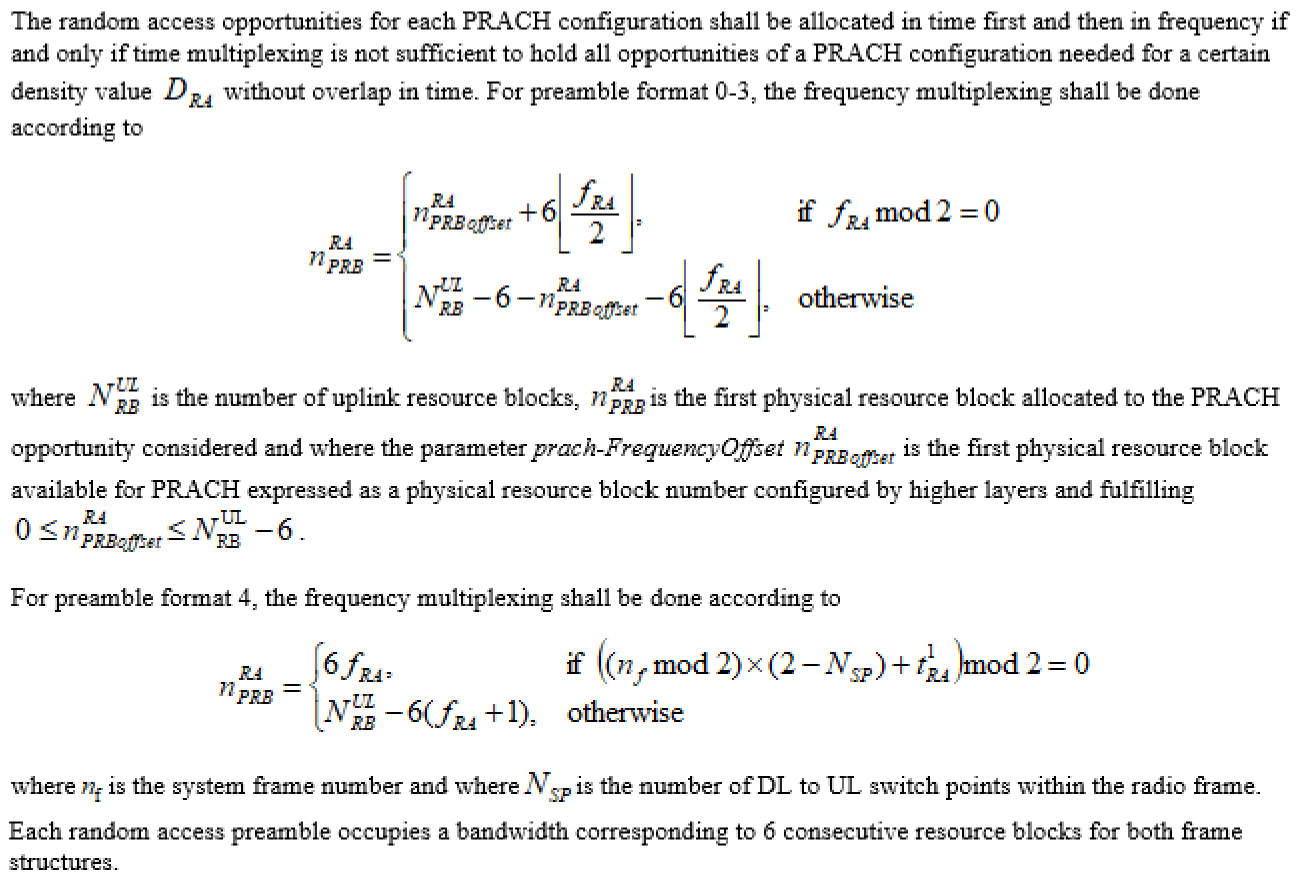


For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\ offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\text{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\text{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\text{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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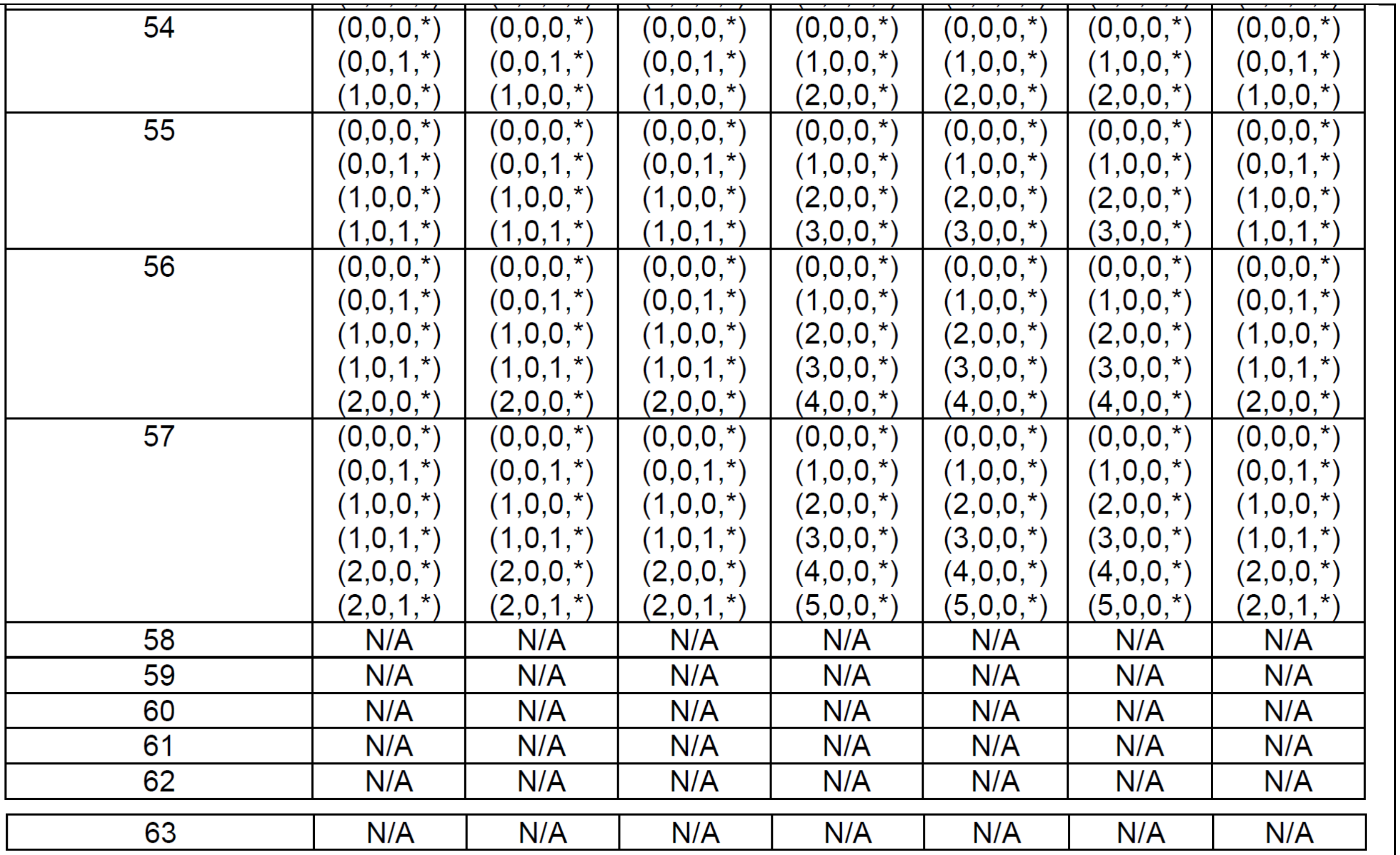
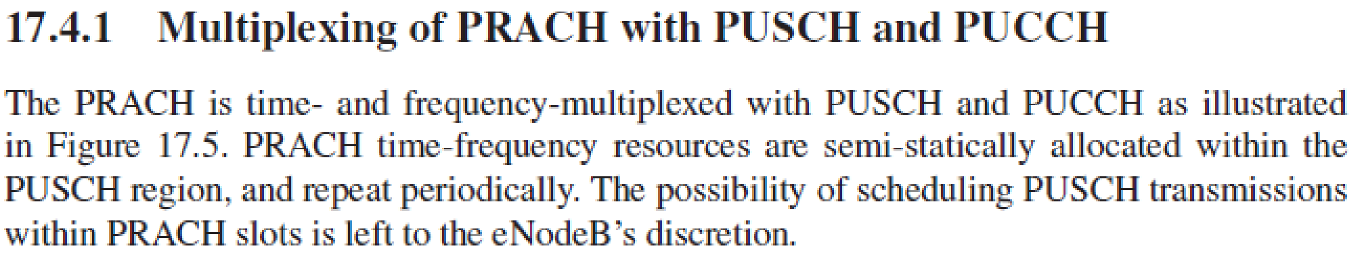


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

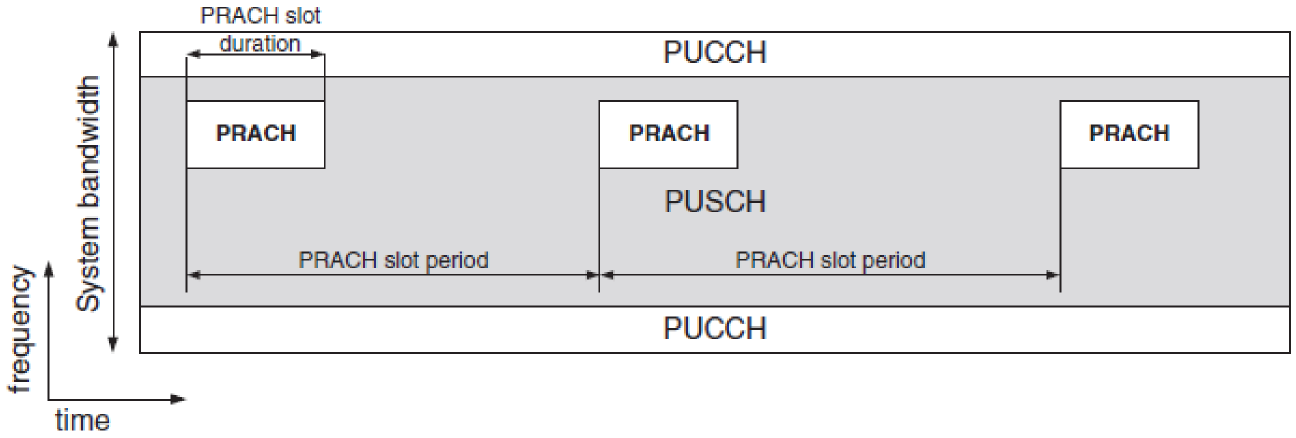


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

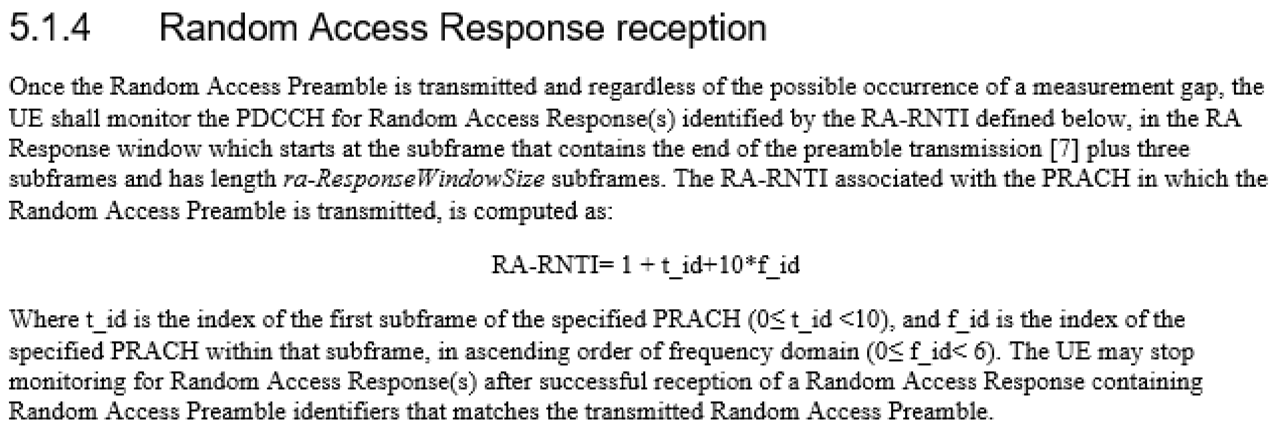
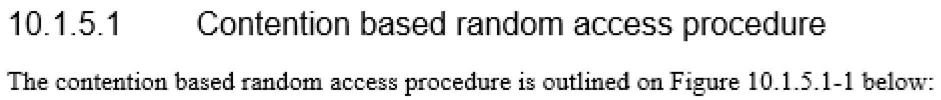
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 24

" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

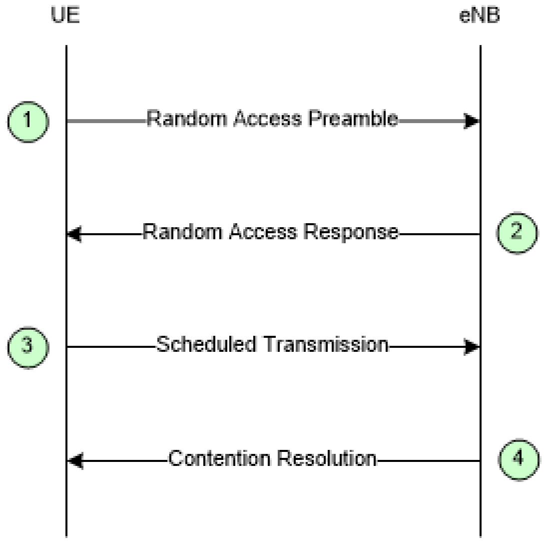
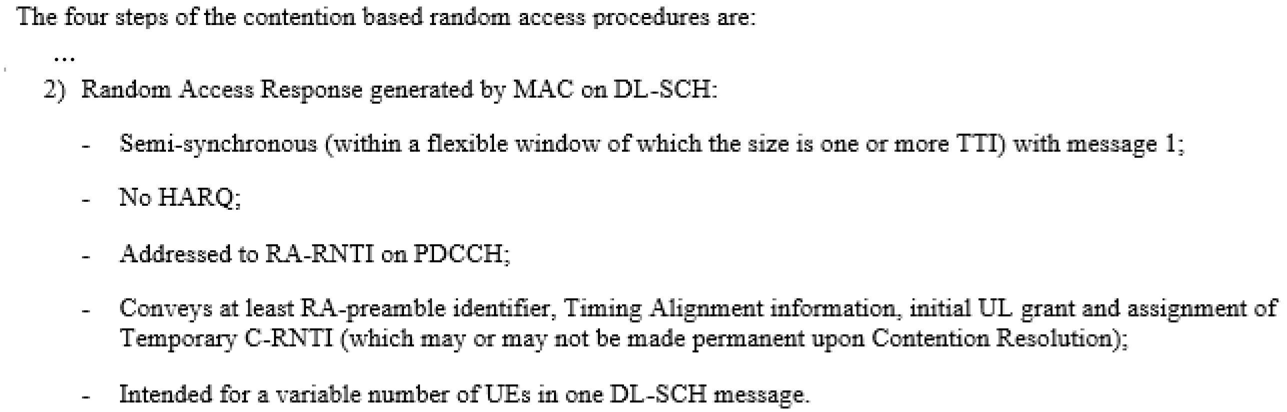
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

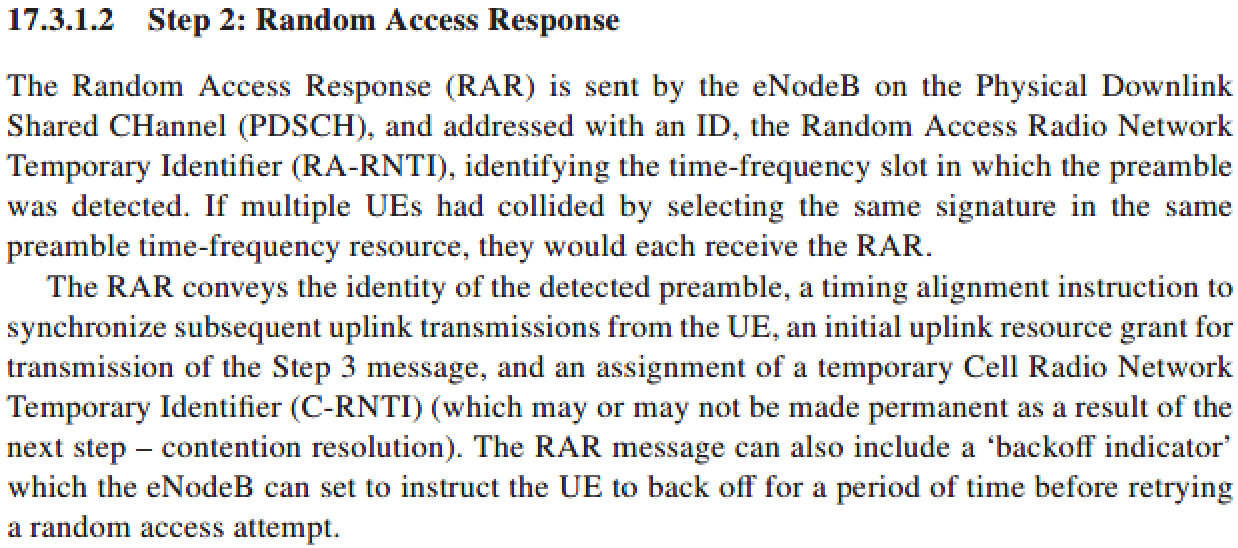
25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Ford's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure**  The four steps of the contention based random access procedures are: ... 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
“The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.”

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Ford’s Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

<table>
<tr>
<td>27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.</td>
<td>

See Claim 1.

The frequency band used with Ford's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,*

For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.

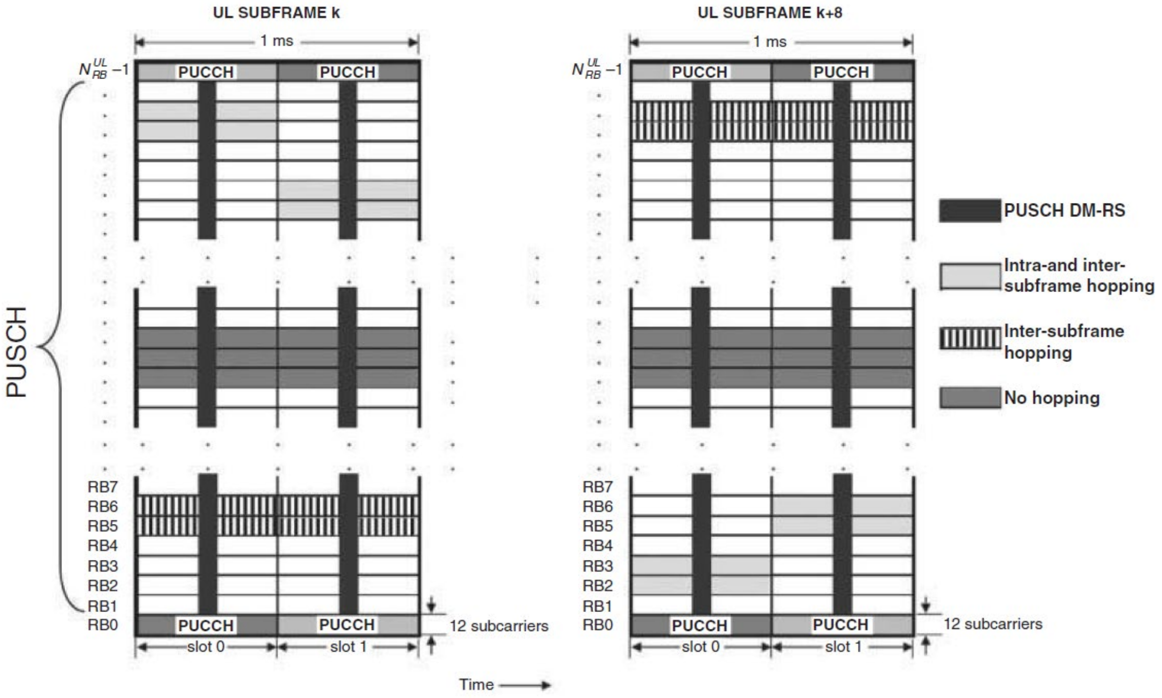


Figure 16.3: Uplink physical data channel processing.

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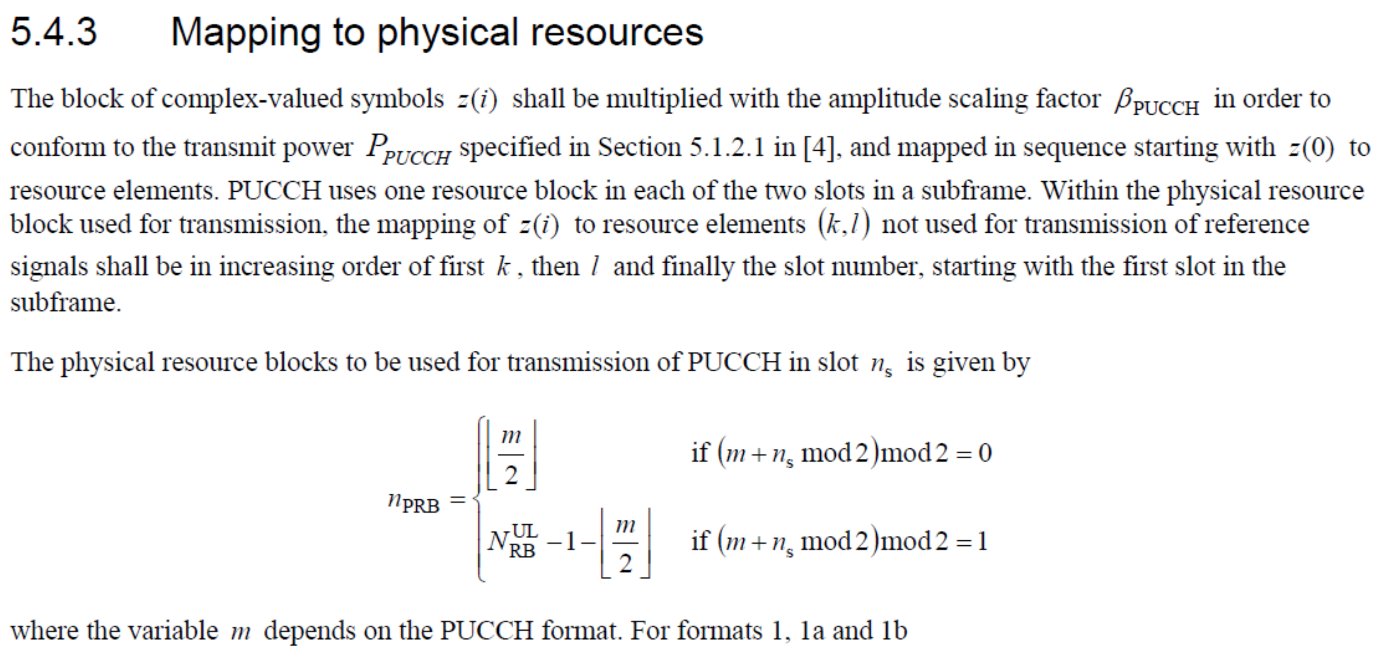
</tr>
</table>

US Patent No. 10,833,908: Claim 27

“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

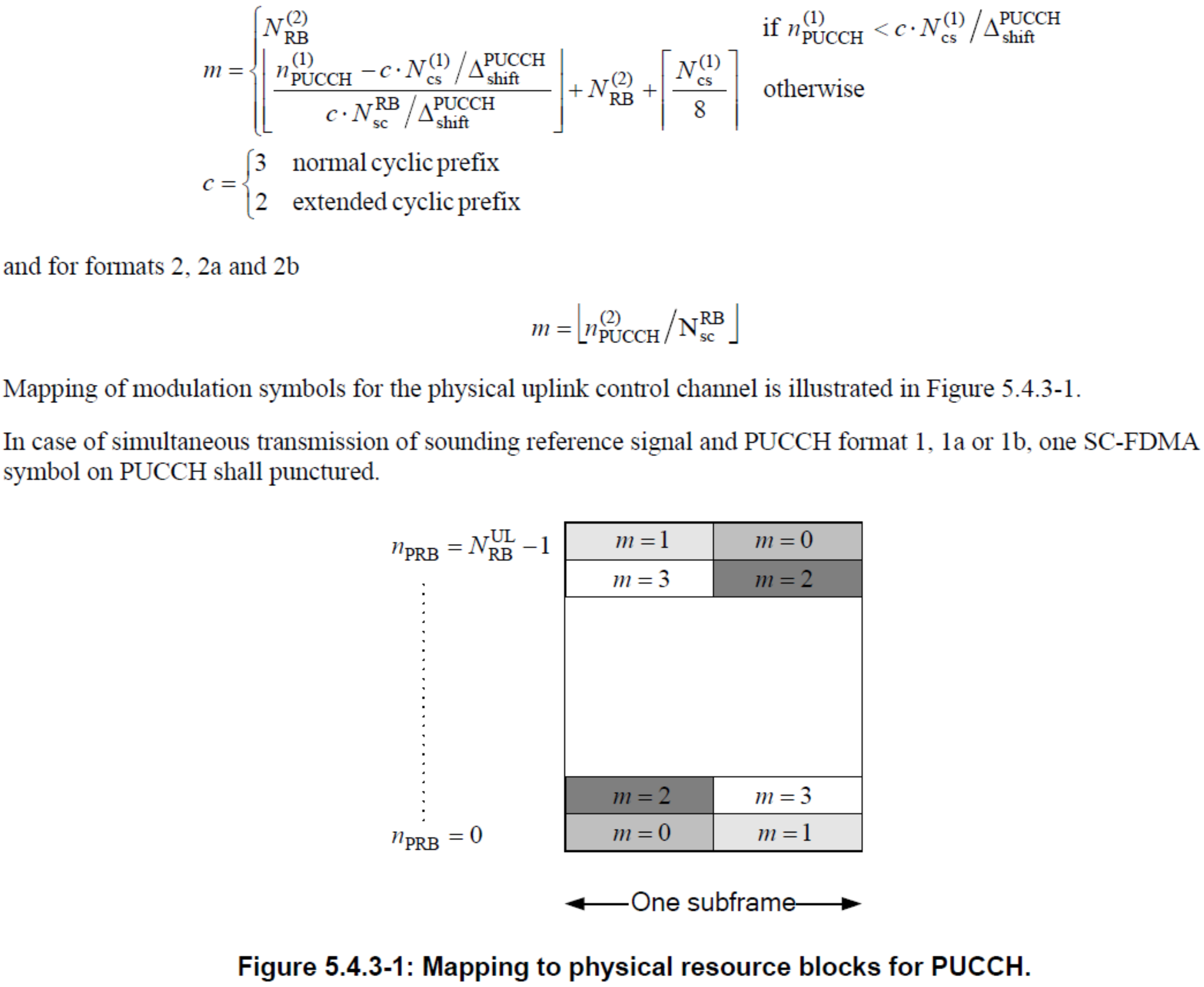
The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

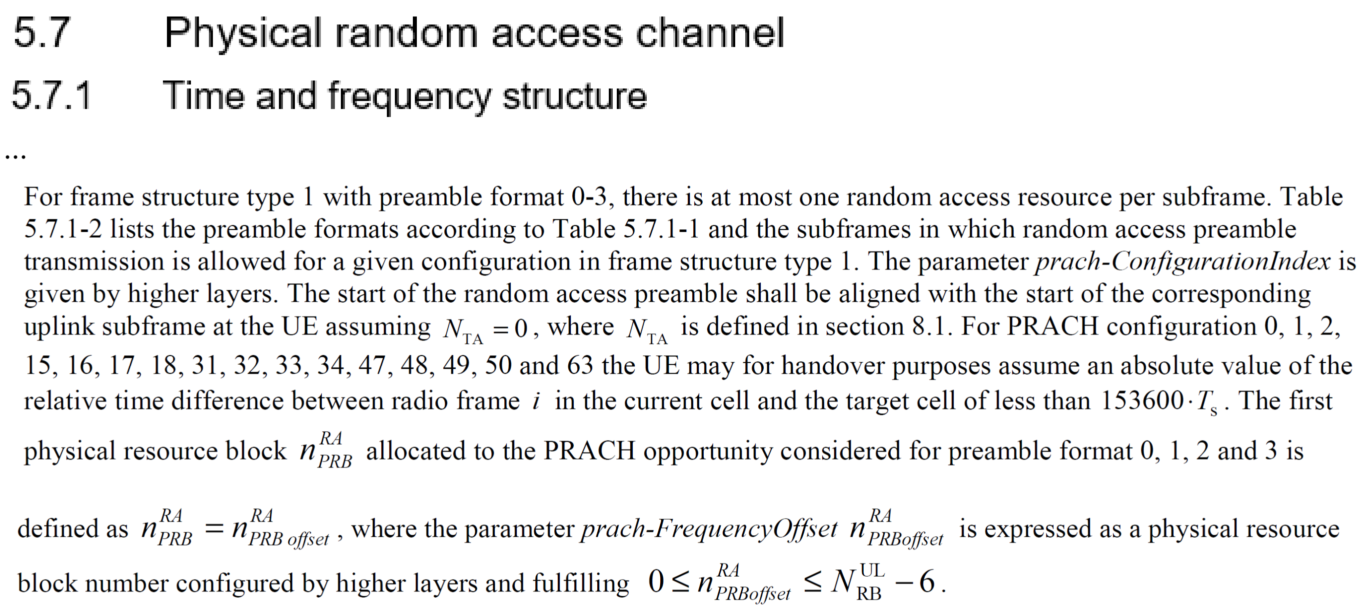
In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

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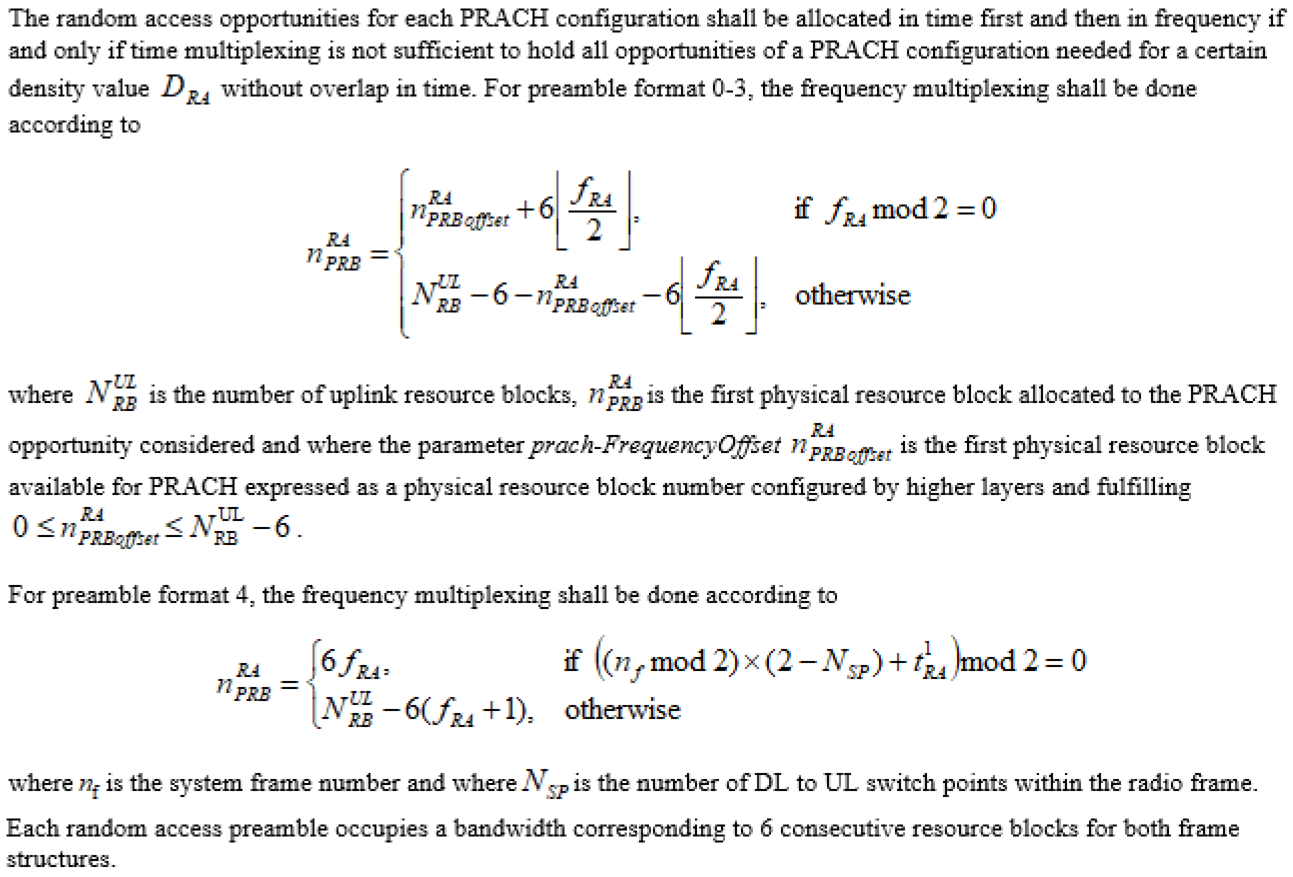
For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 27

“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

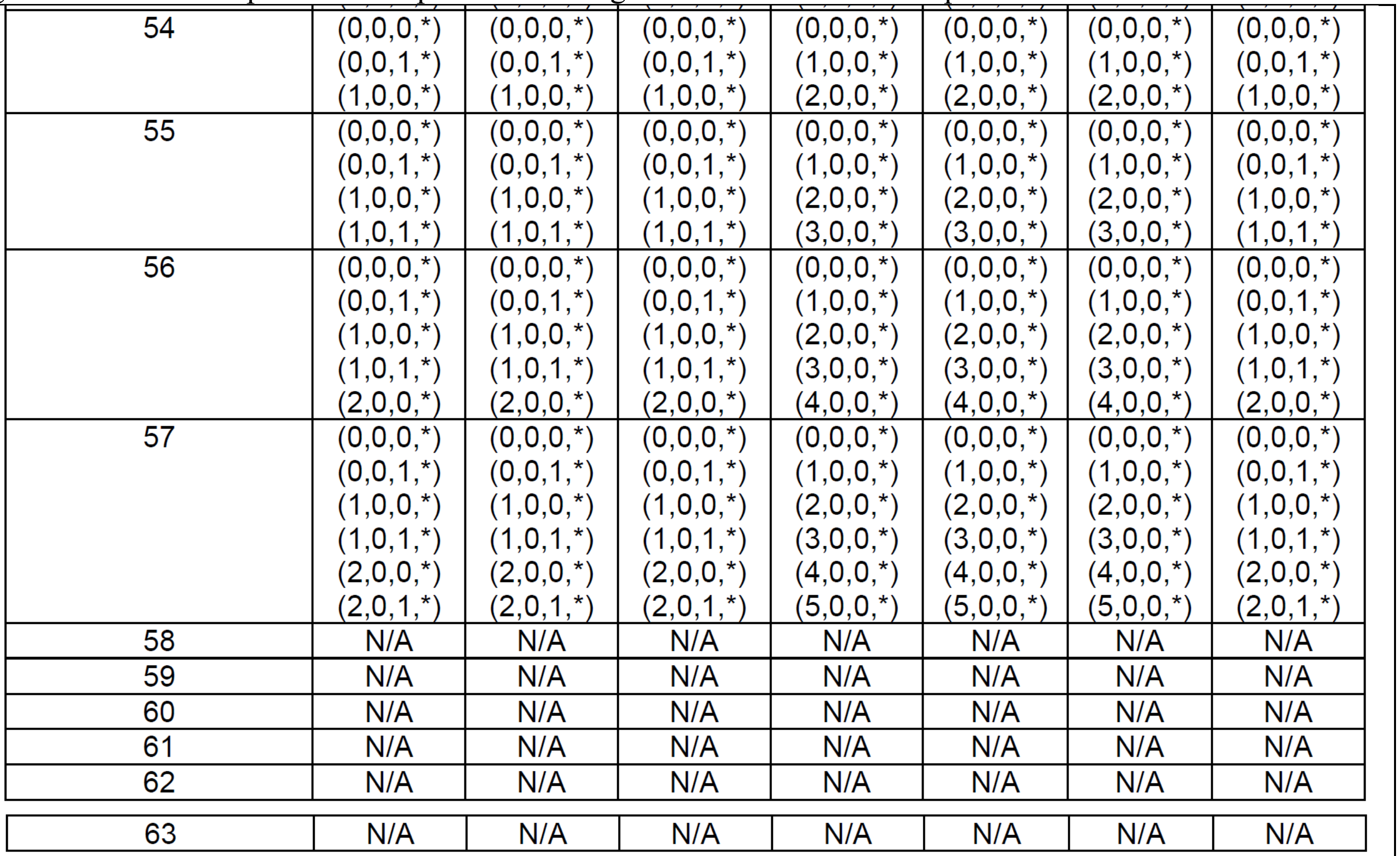
Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

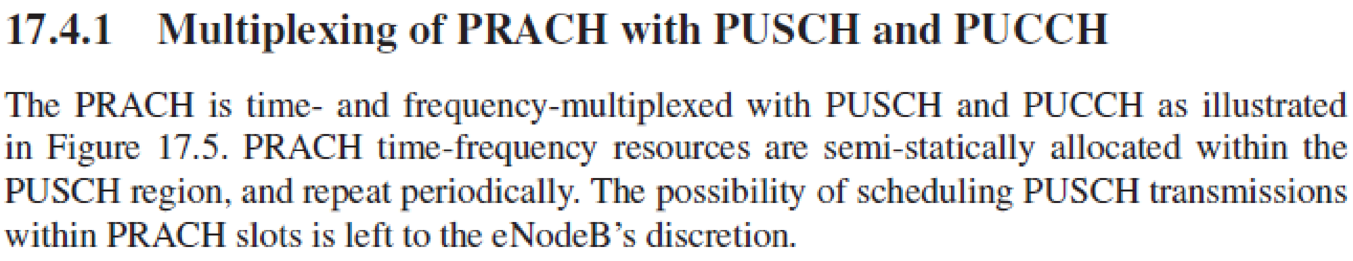
.
.
.

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

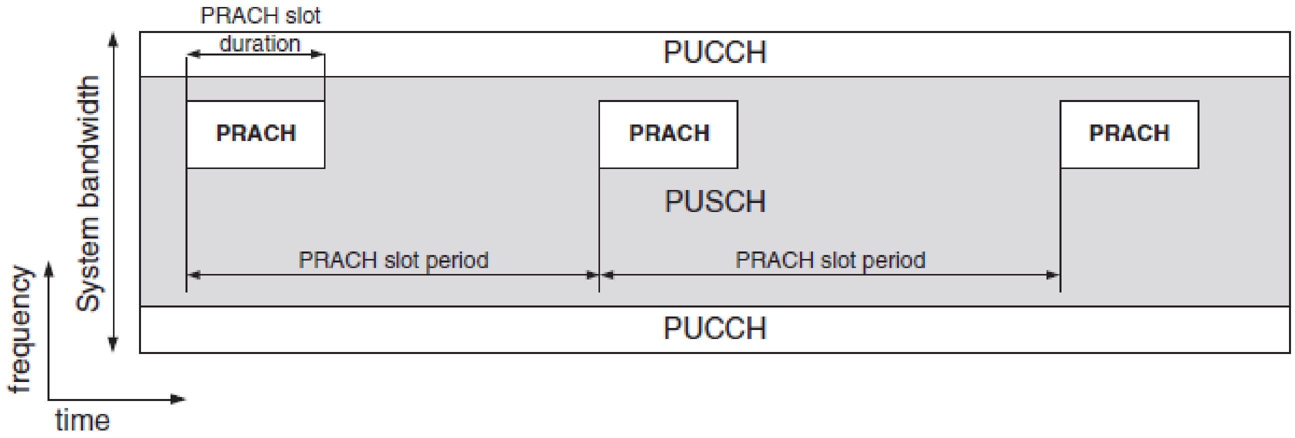
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



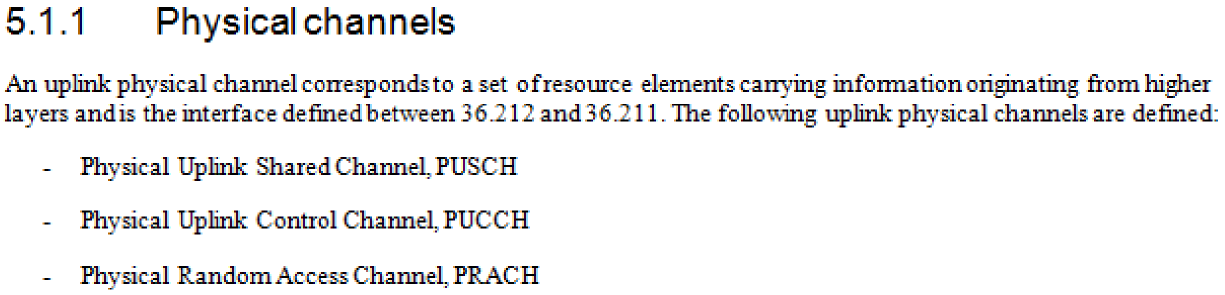
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

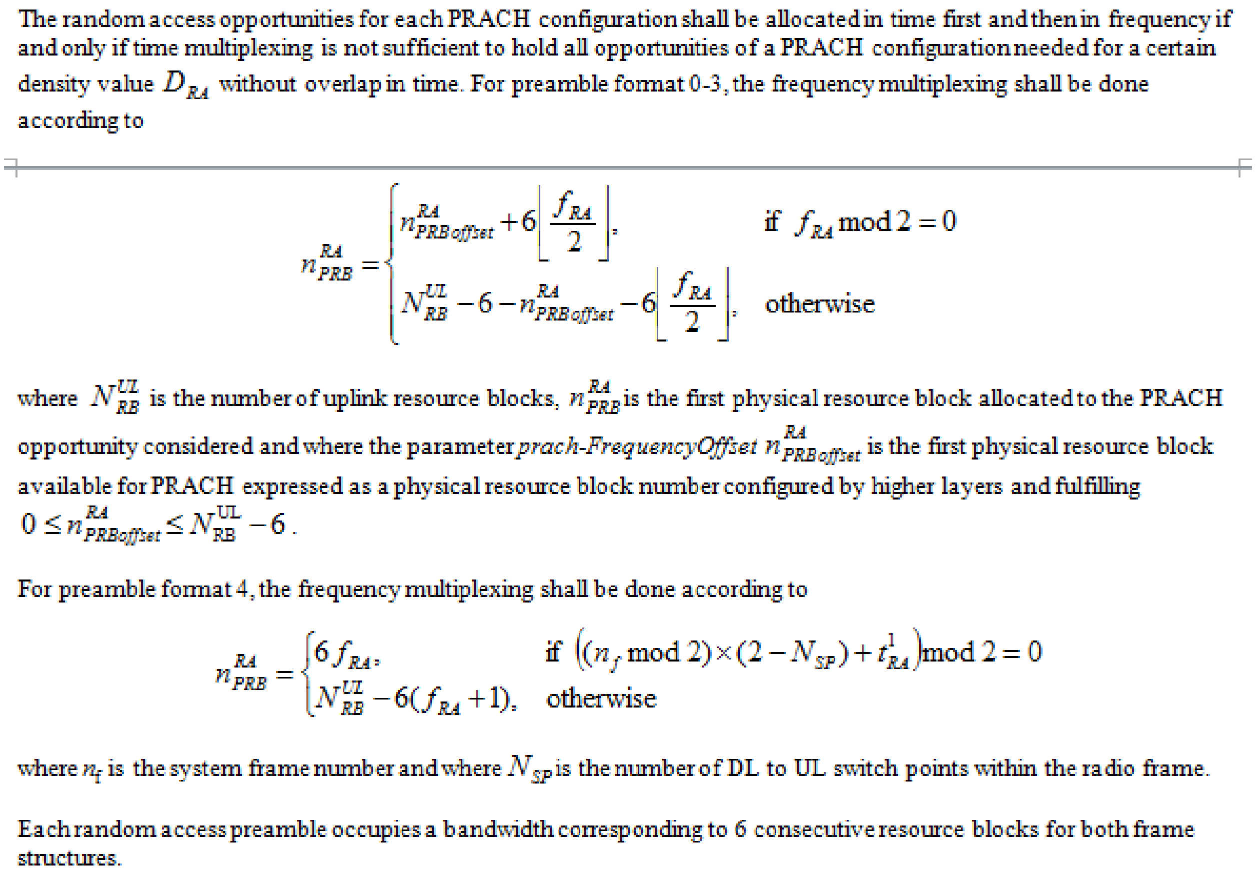
US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with Ford's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

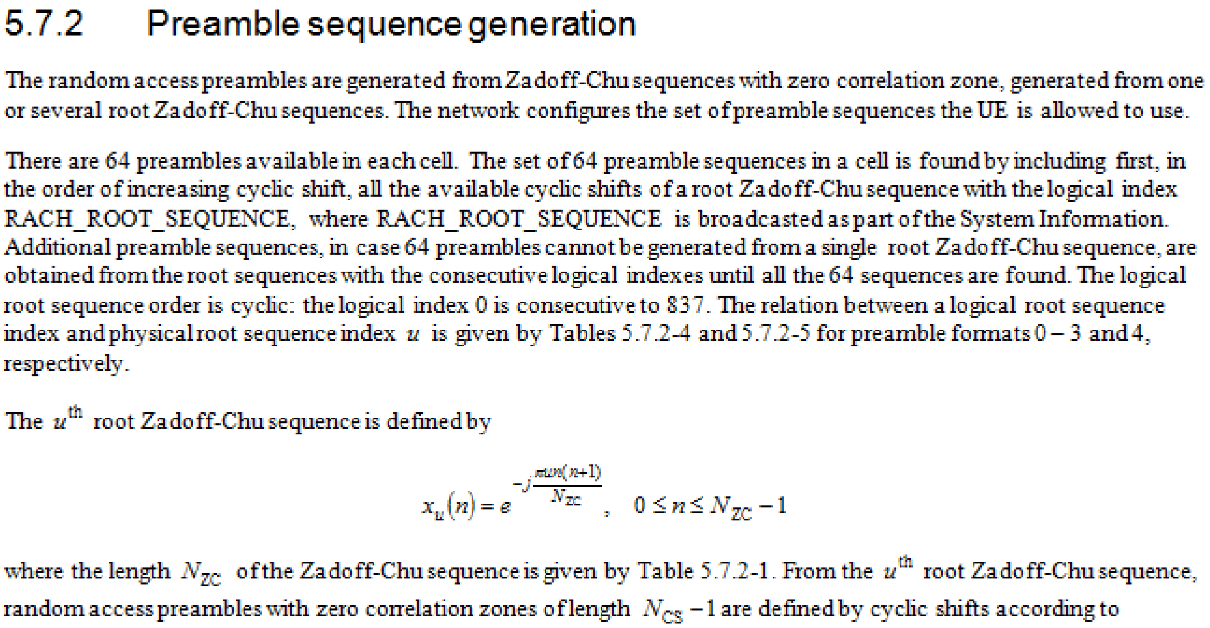
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

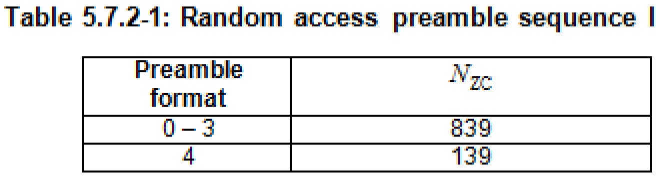
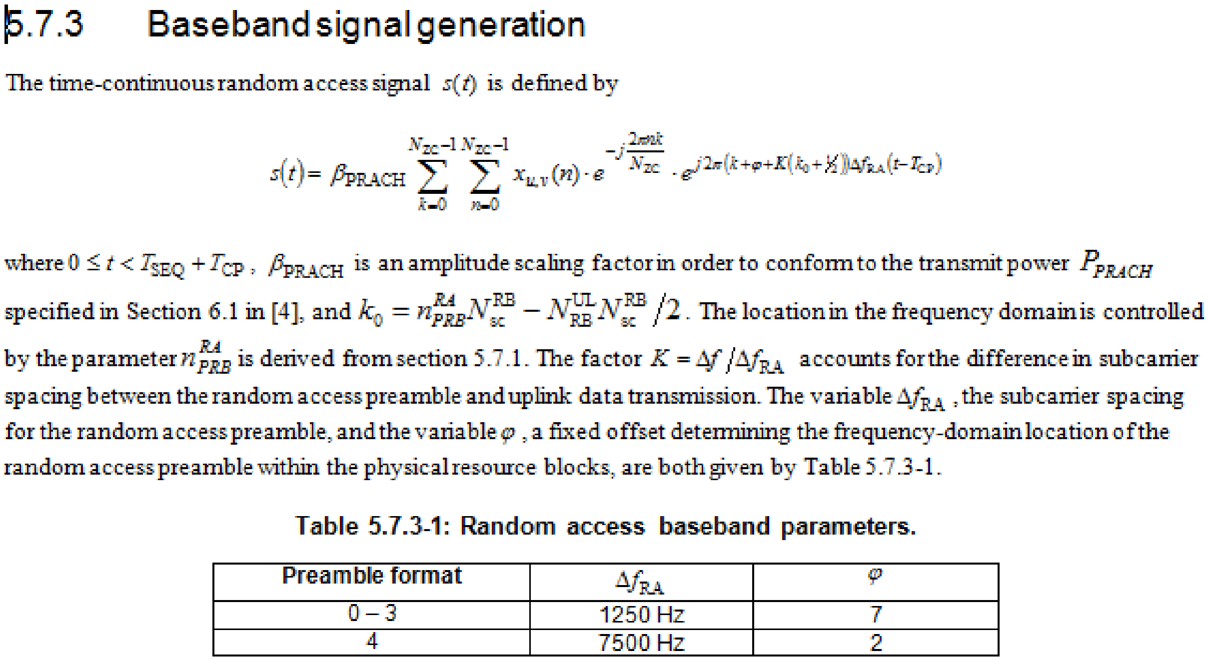


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

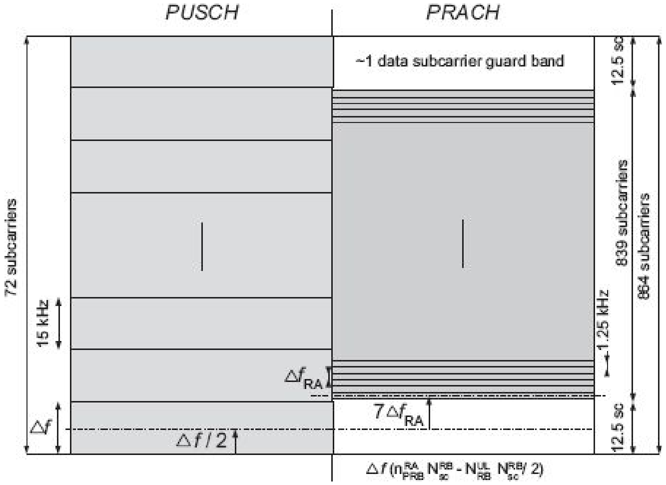
$$s(t) = \beta_{\mathrm{PRACH}} \sum_{k=0}^{N_{\mathrm{ZC}}-1} \sum_{n=0}^{N_{\mathrm{ZC}}-1} x_{u,v}(n) \cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}} \cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

where $0 \le t < T_{\mathrm{SEQ}} + T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\mathrm{sc}}^{\mathrm{RB}} - N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

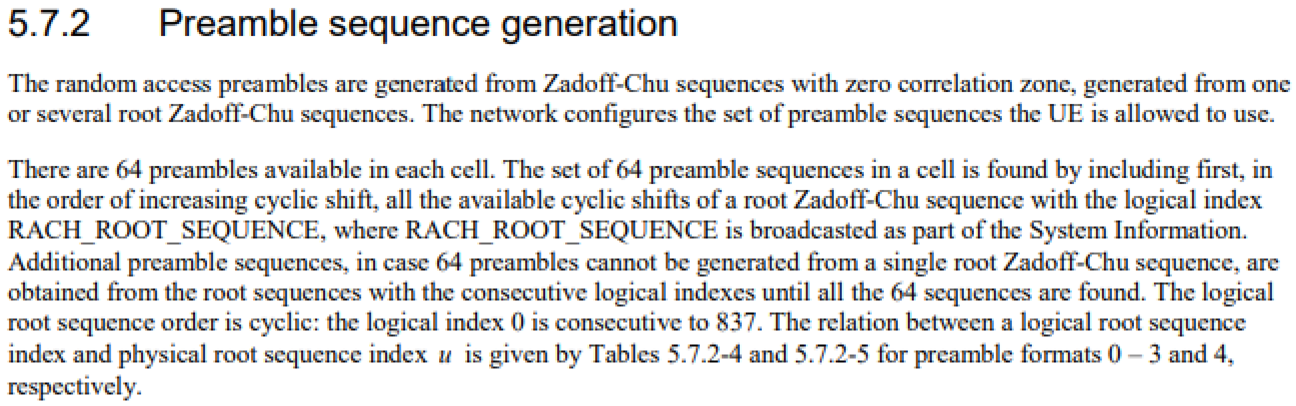
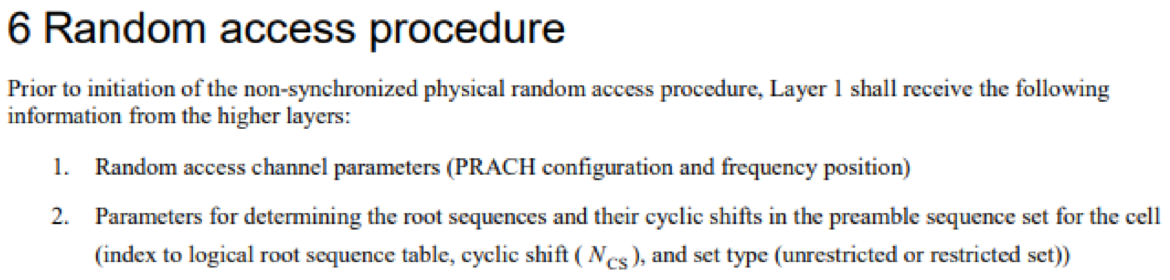
Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Ford's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information. 5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39. 6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

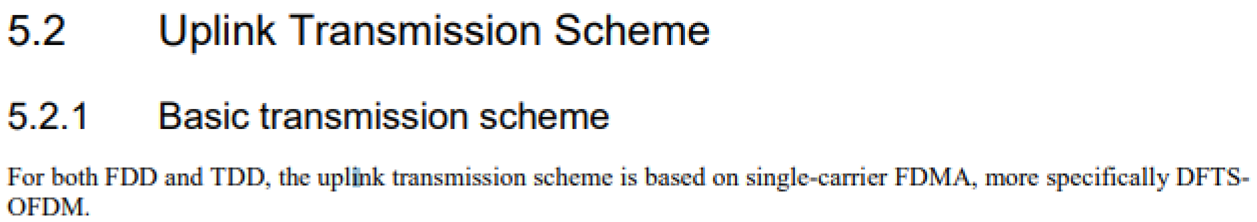
```
-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

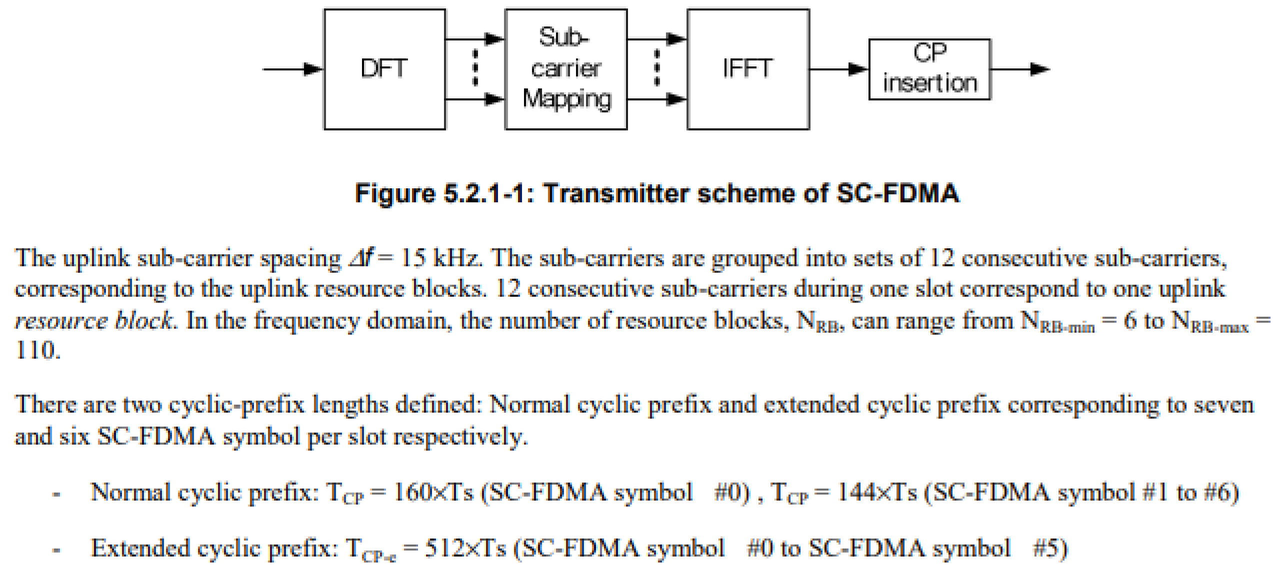
See also Claim 9.

US Patent No. 10,833,908: Claim 30
"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 Ford's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Ford's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

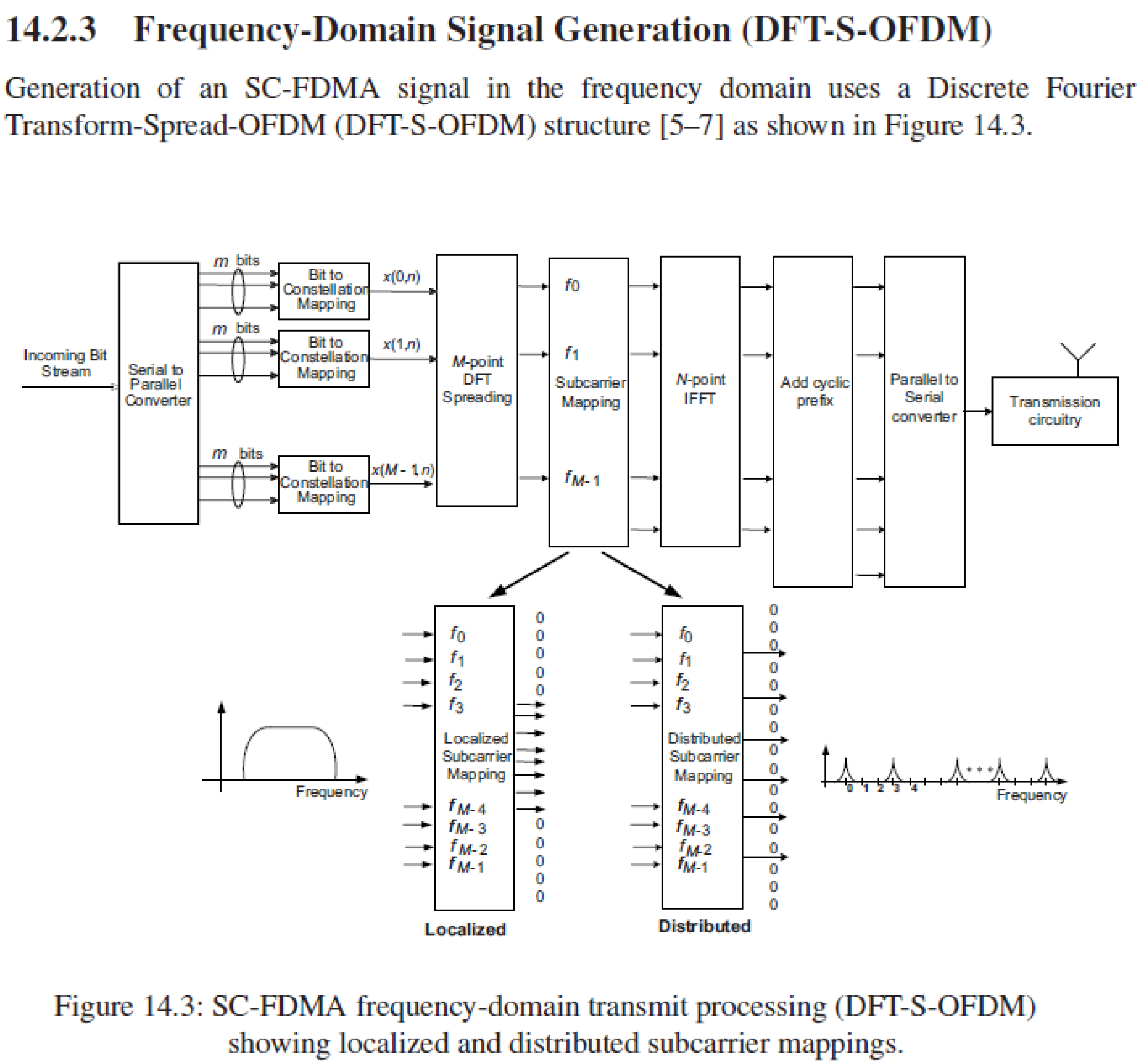
US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

	 **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

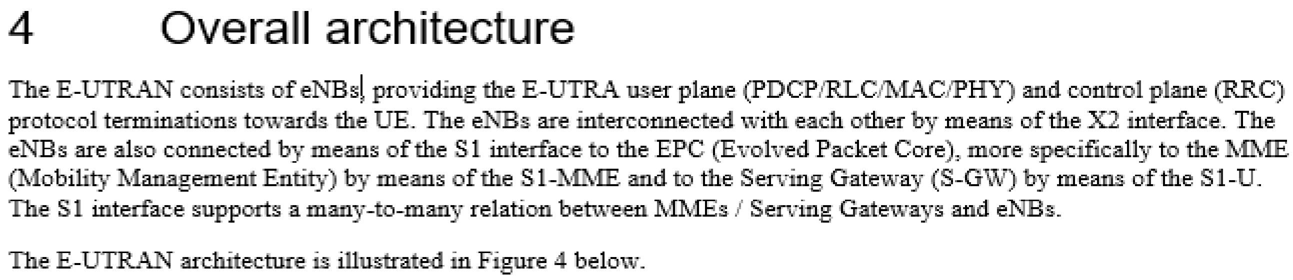
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

See also Claim 10.

Plaintiff's Infringement Contentions to Honda

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, Honda's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* Honda's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Honda offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

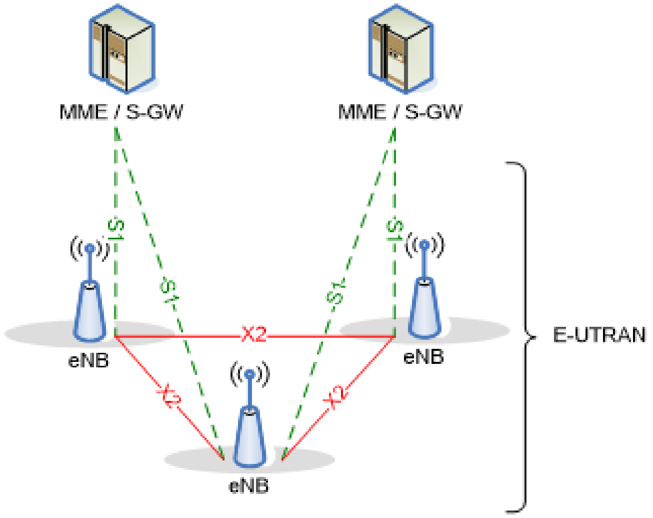


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

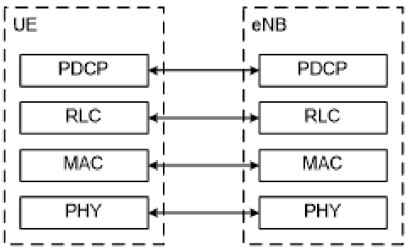


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

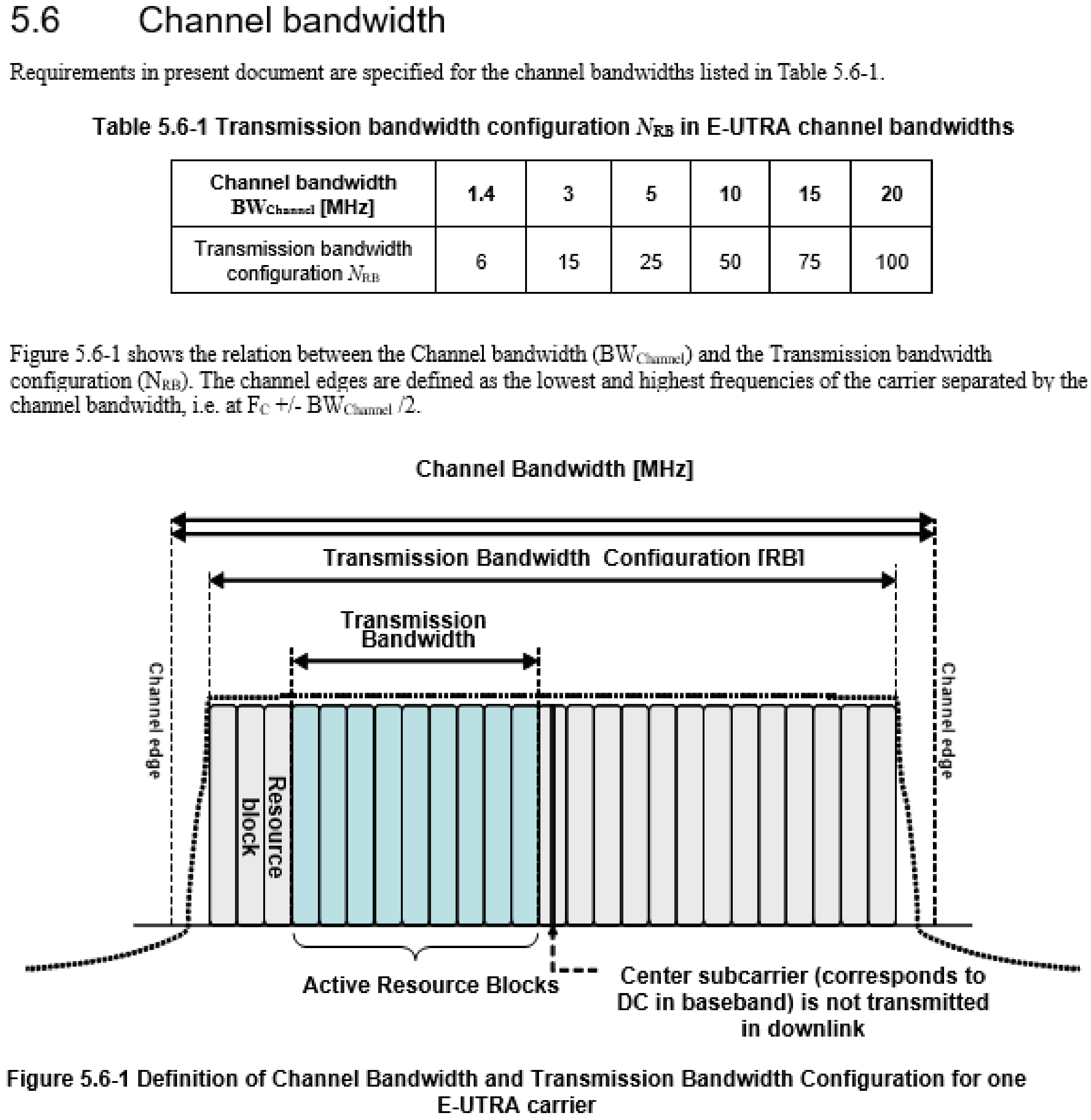
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Honda's Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, Honda's Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

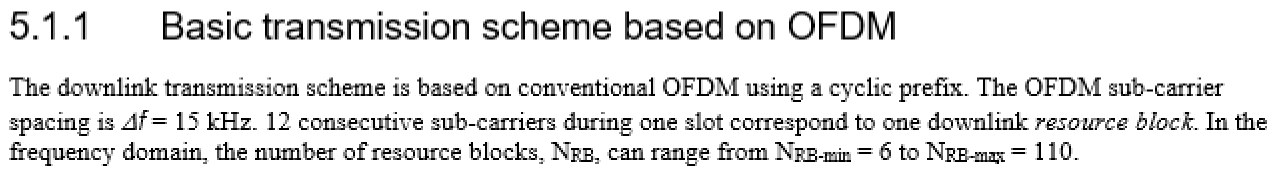
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

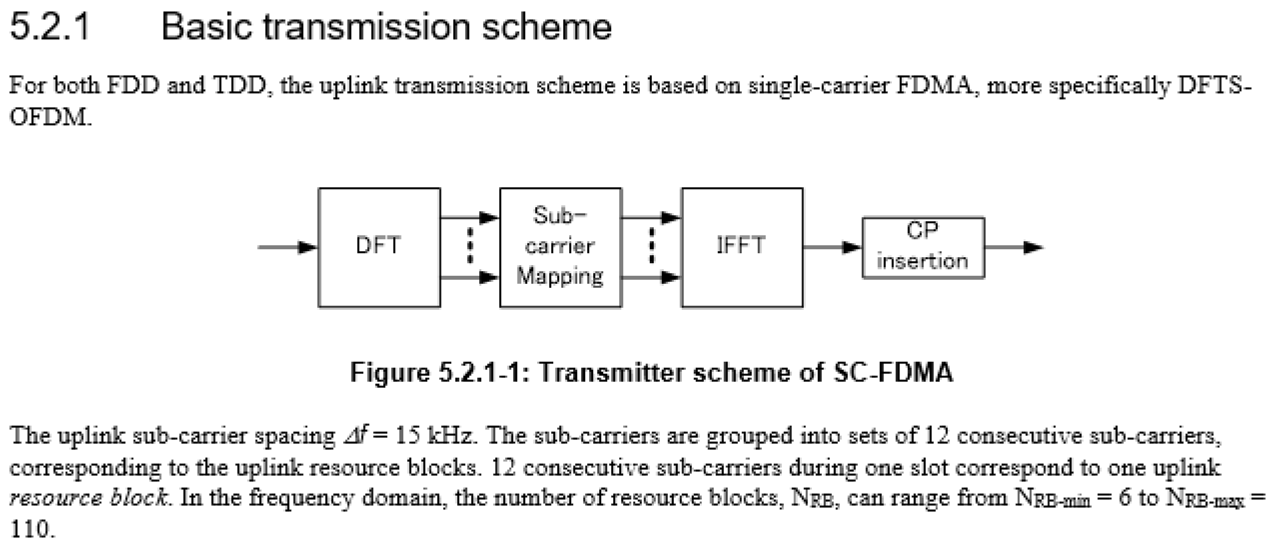
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

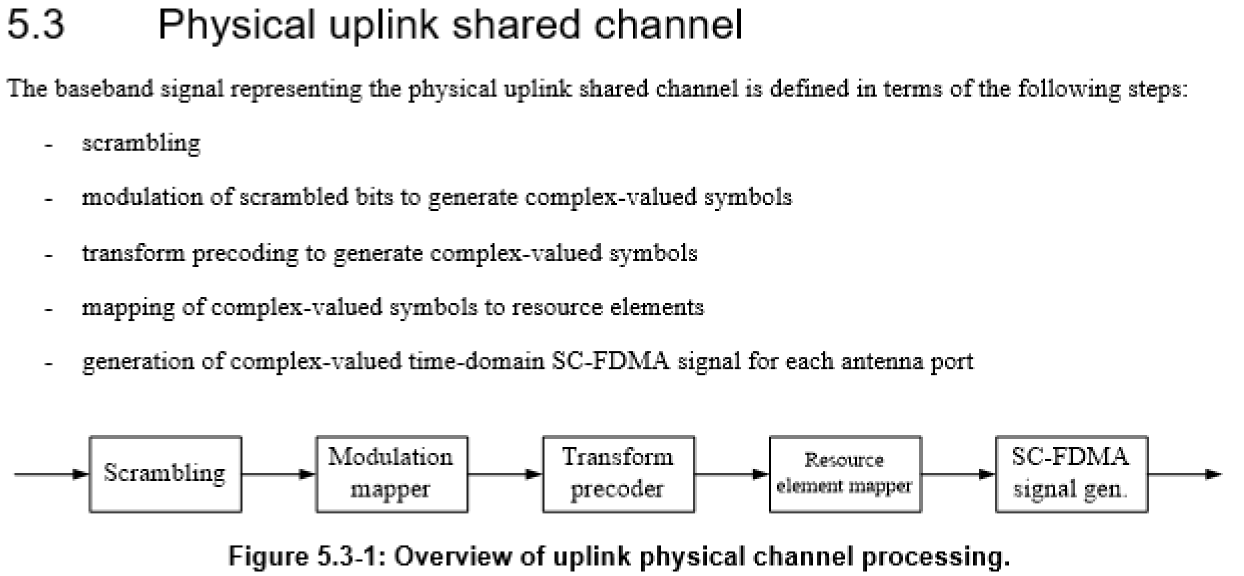
The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”



5.3 Physical uplink shared channel

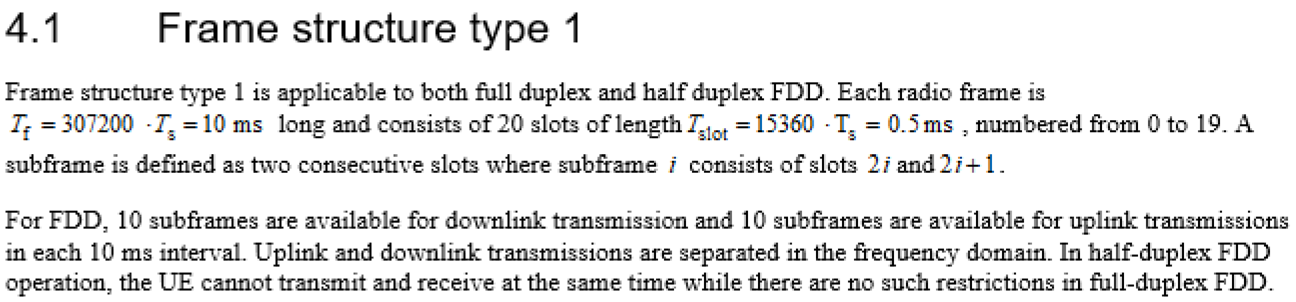
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

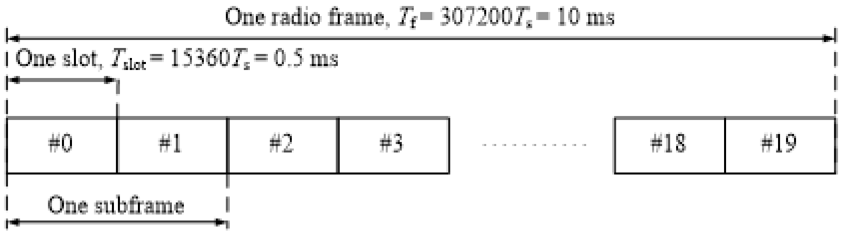
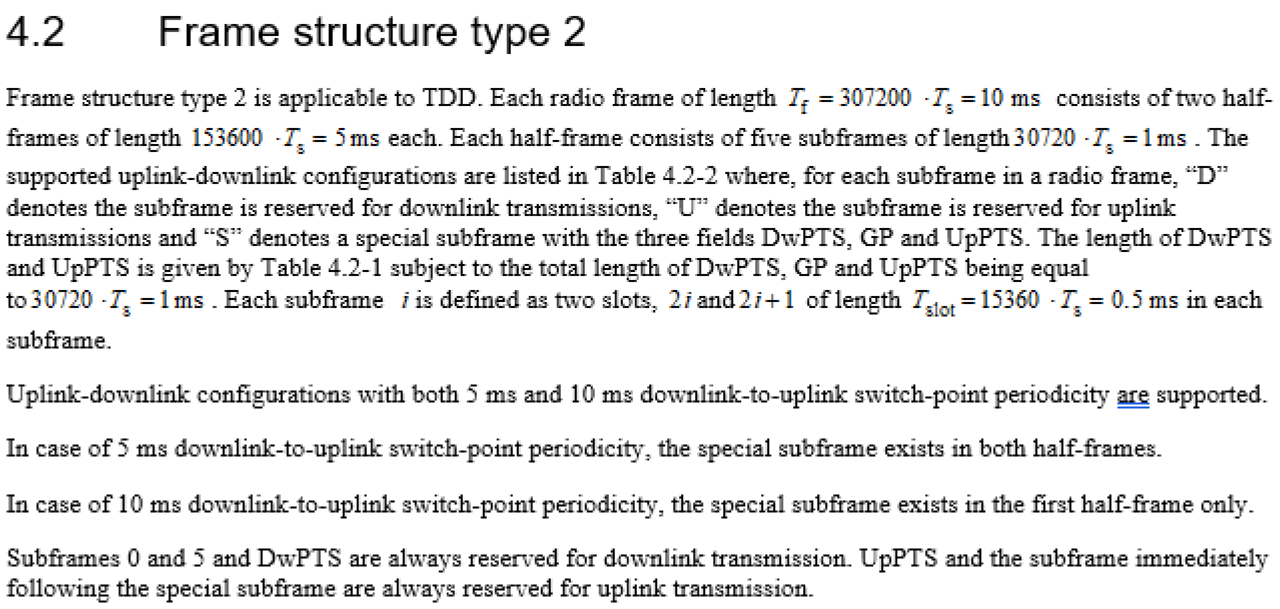


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

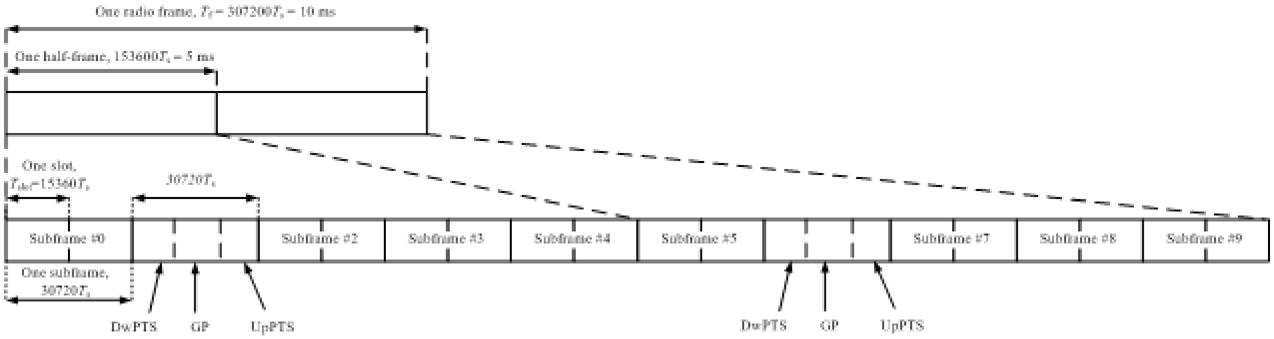
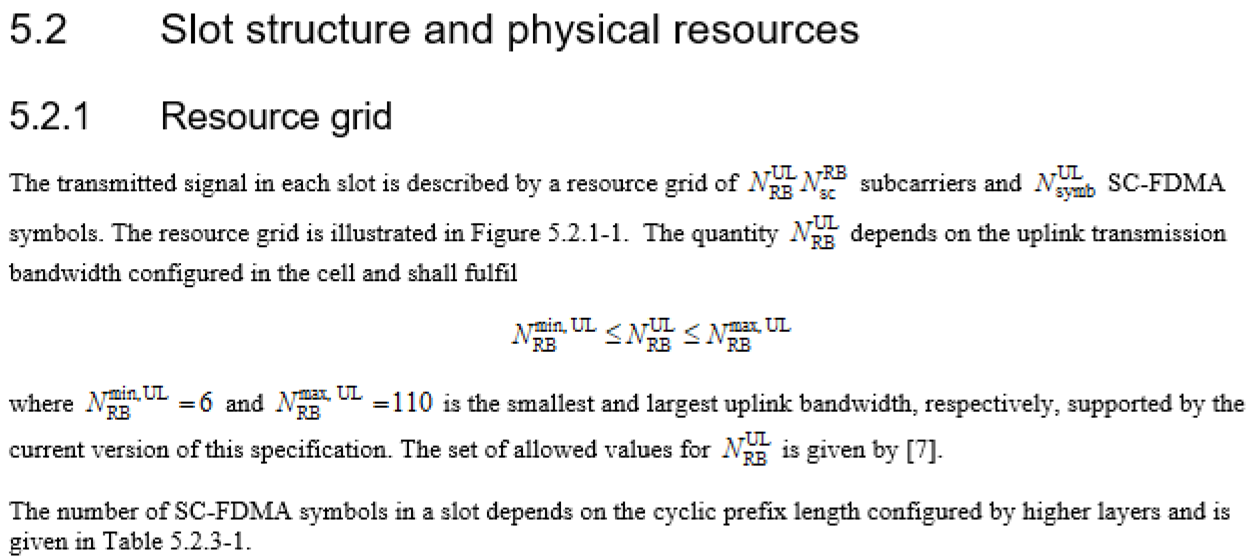


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

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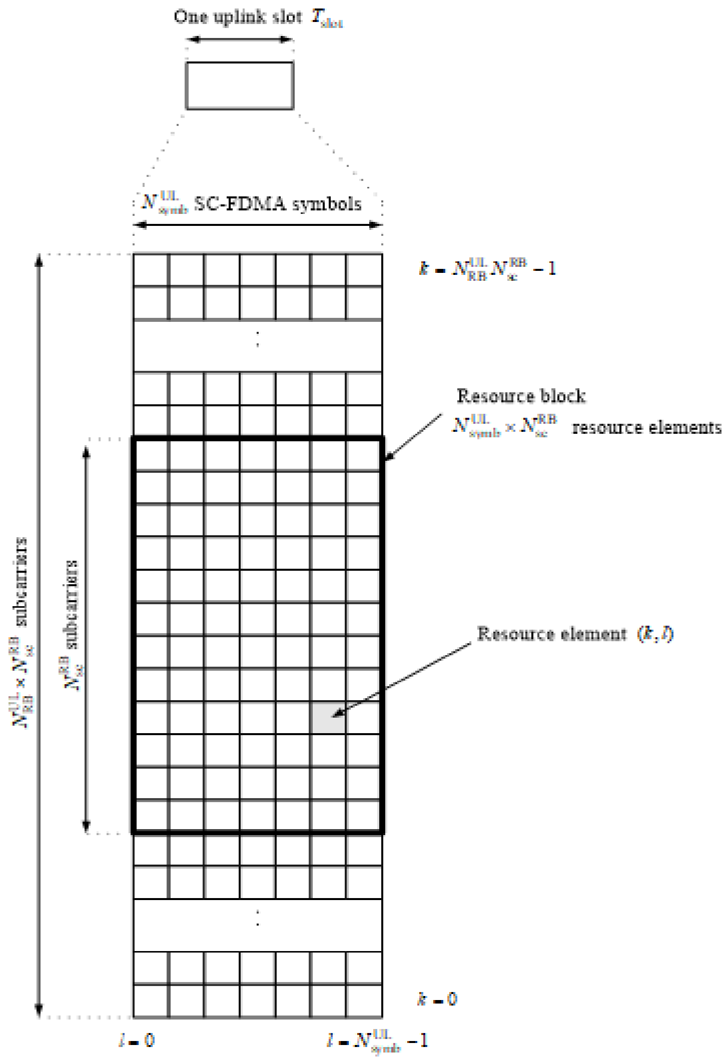
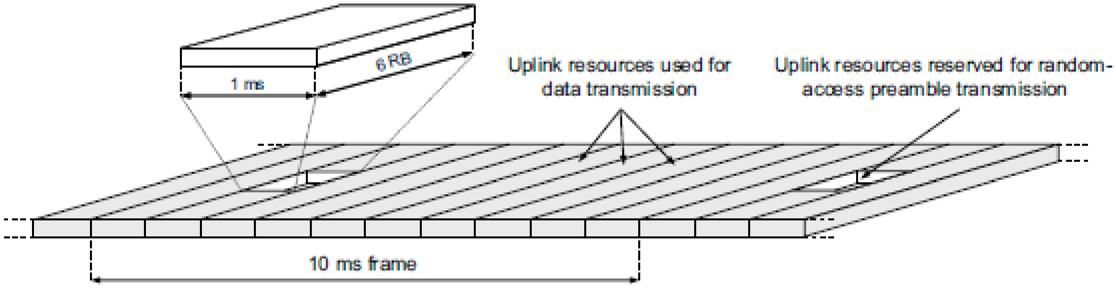
<tr>
<td></td>
<td>


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.
</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 1(b)

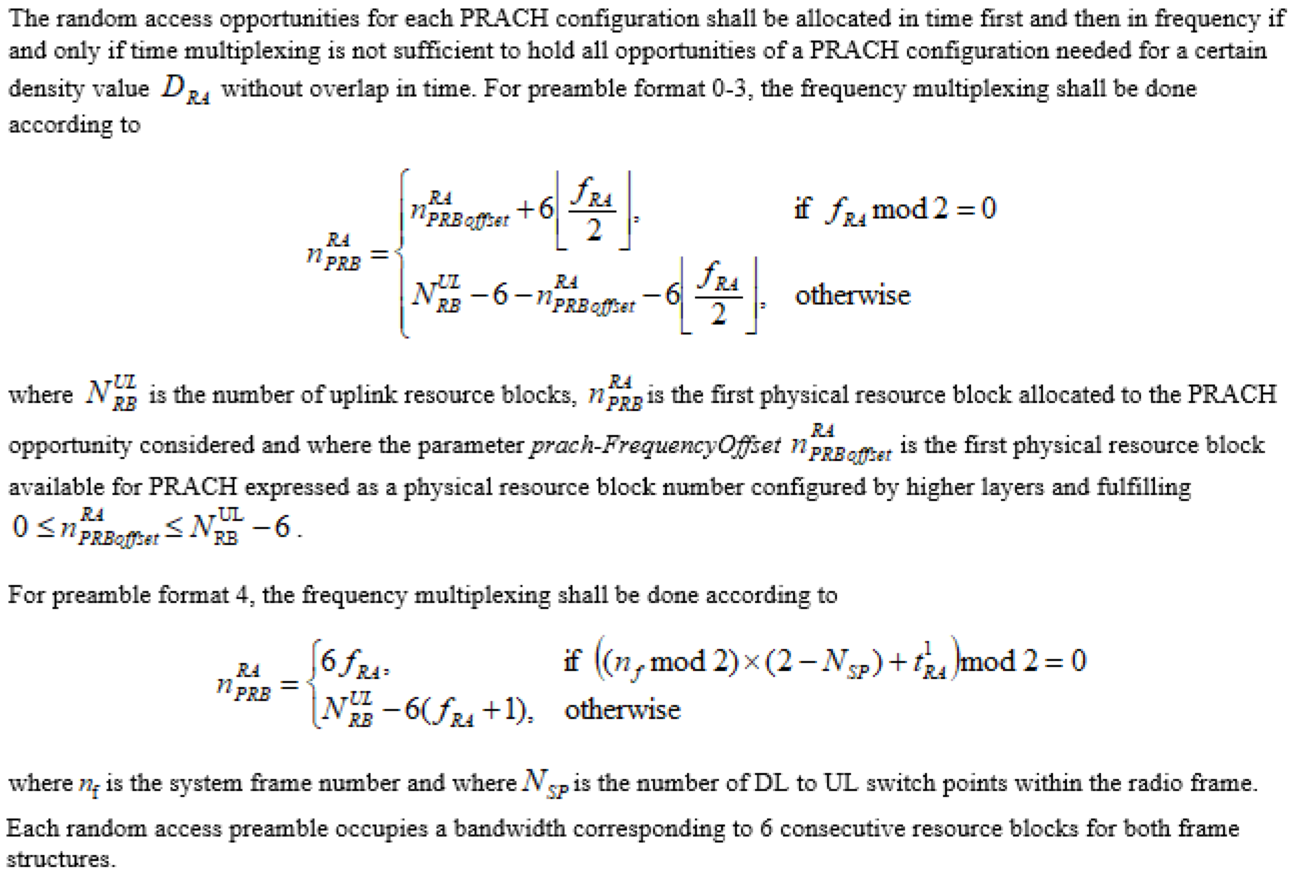
"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

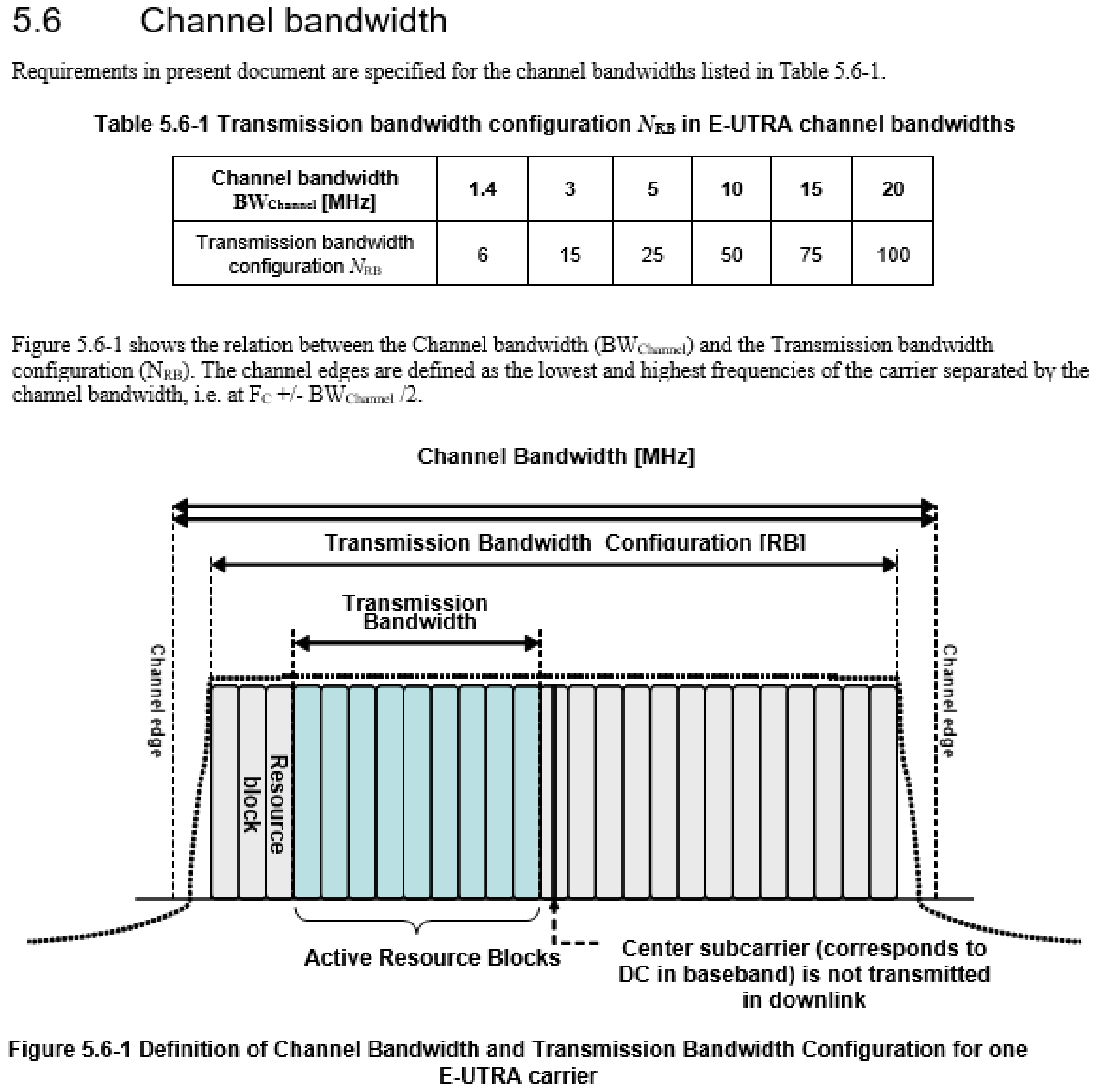
US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	Honda’s Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

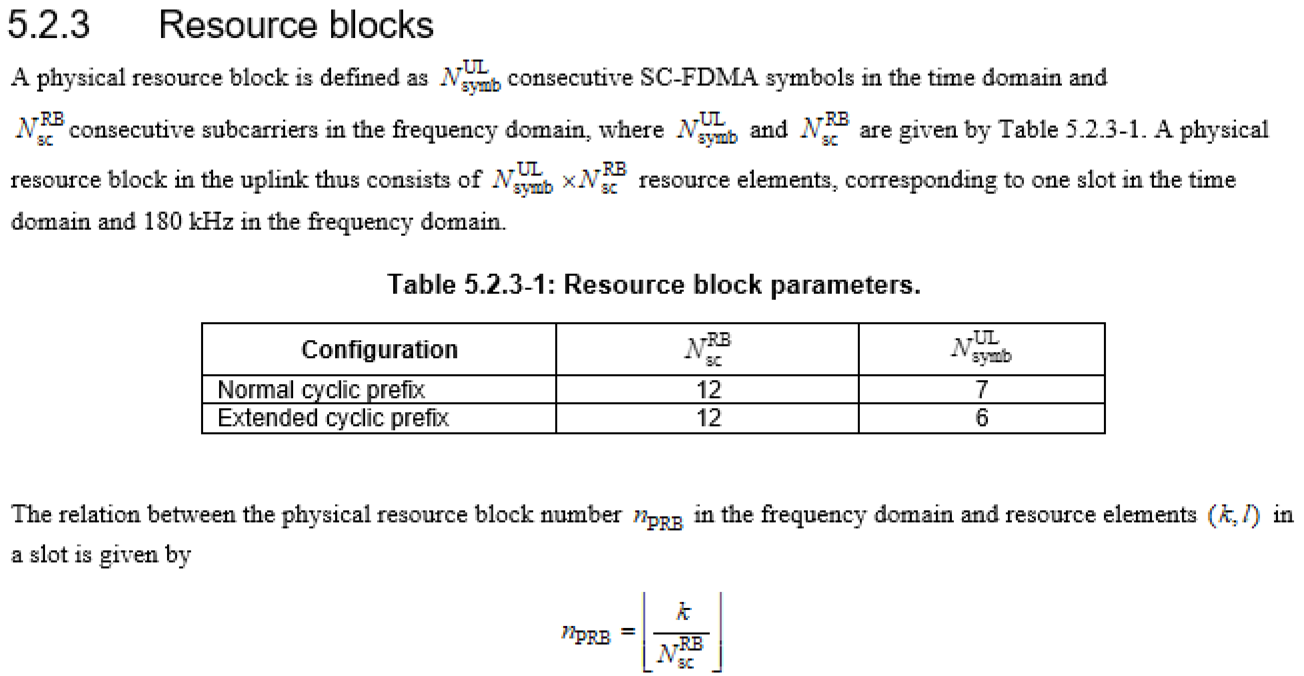
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

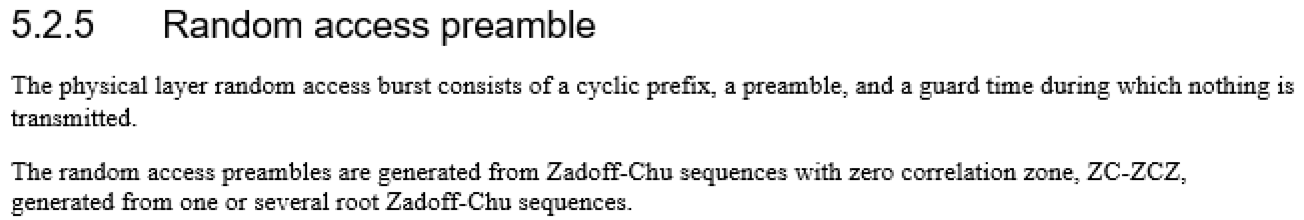
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

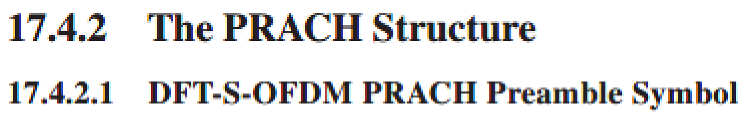


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

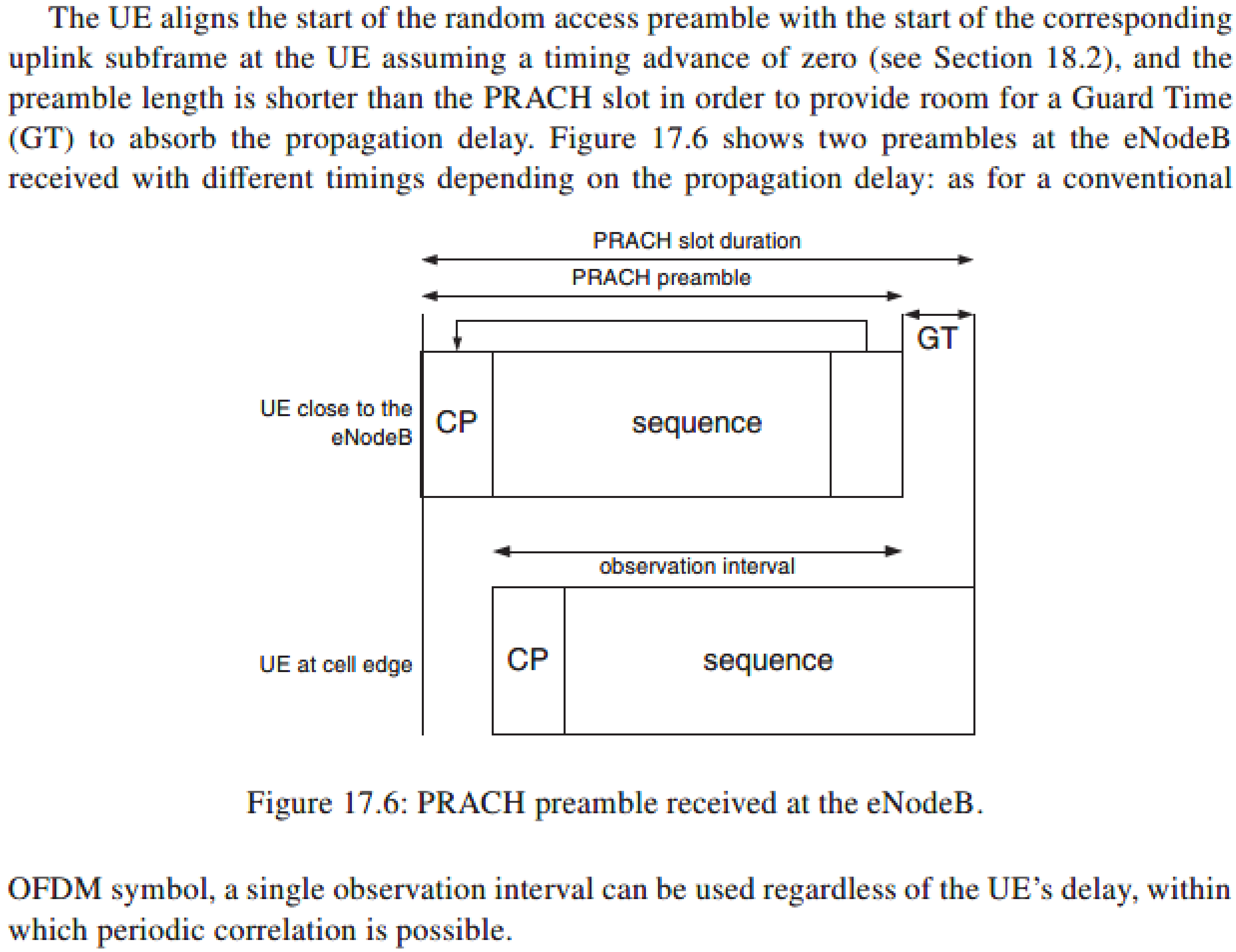


17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional

Figure 17.6: PRACH preamble received at the eNodeB.

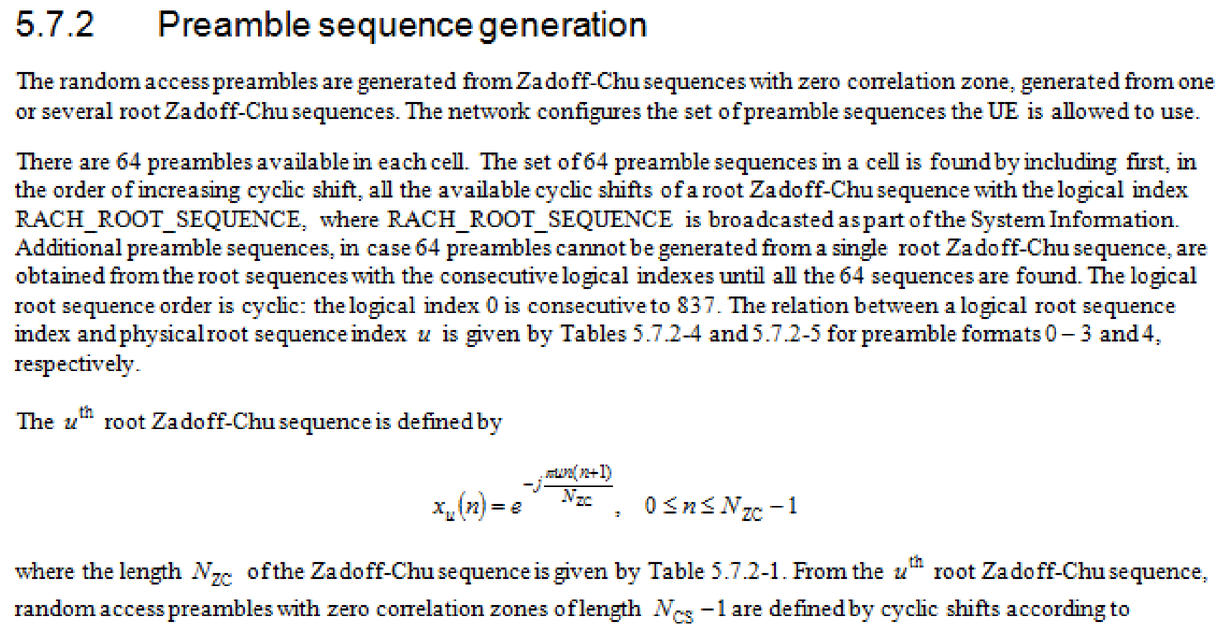
OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378.

The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)

"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

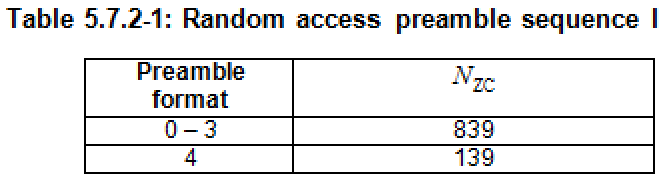
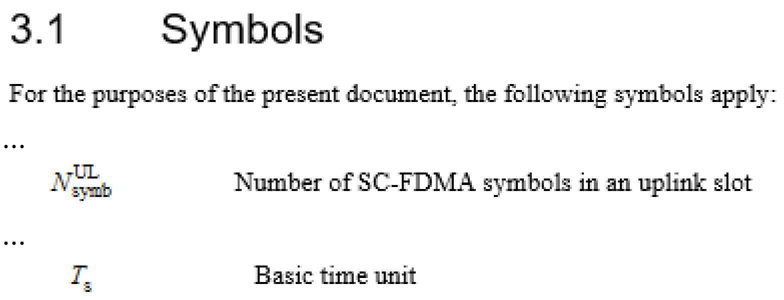
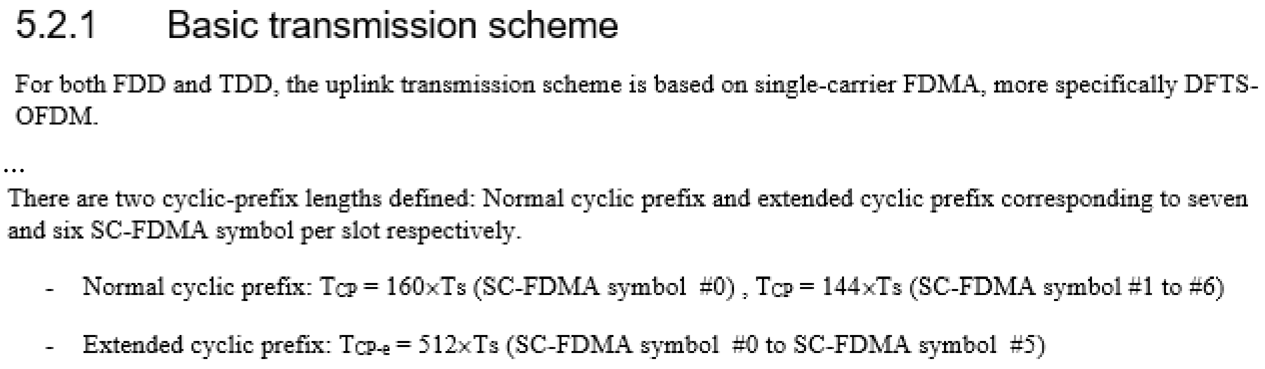


Table 5.7.2-1: Random access preamble sequence length.

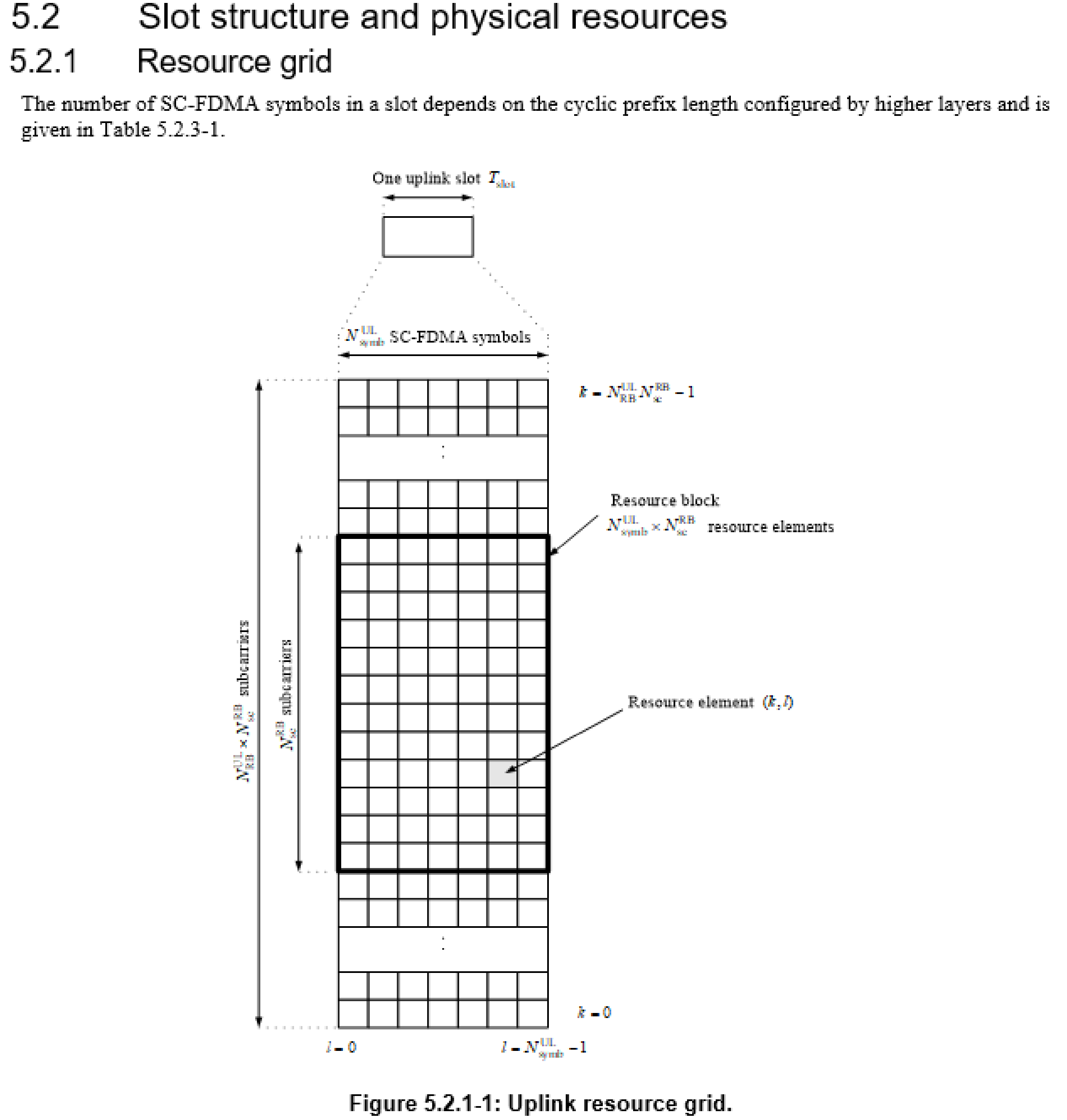
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using Honda's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"



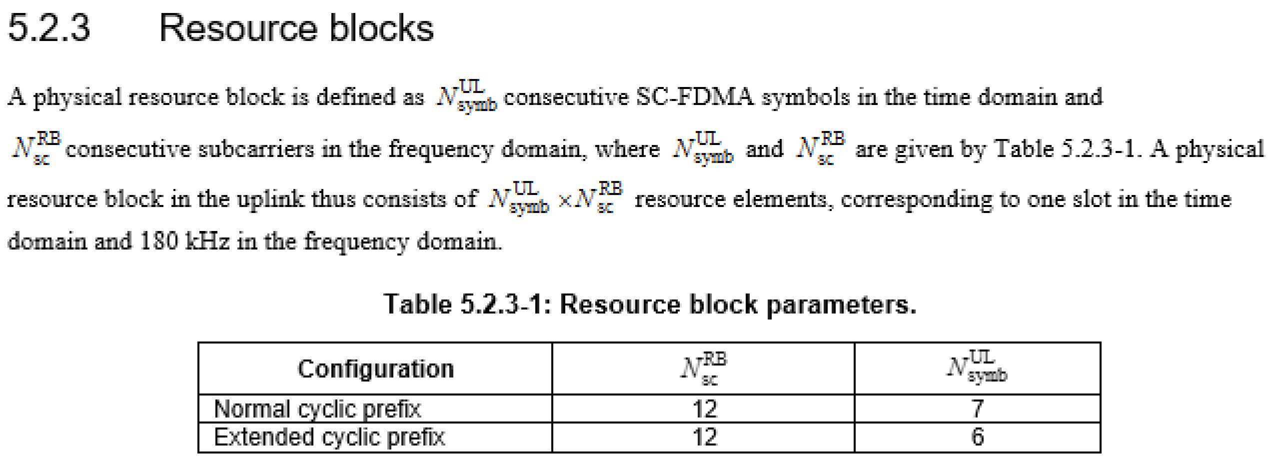
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

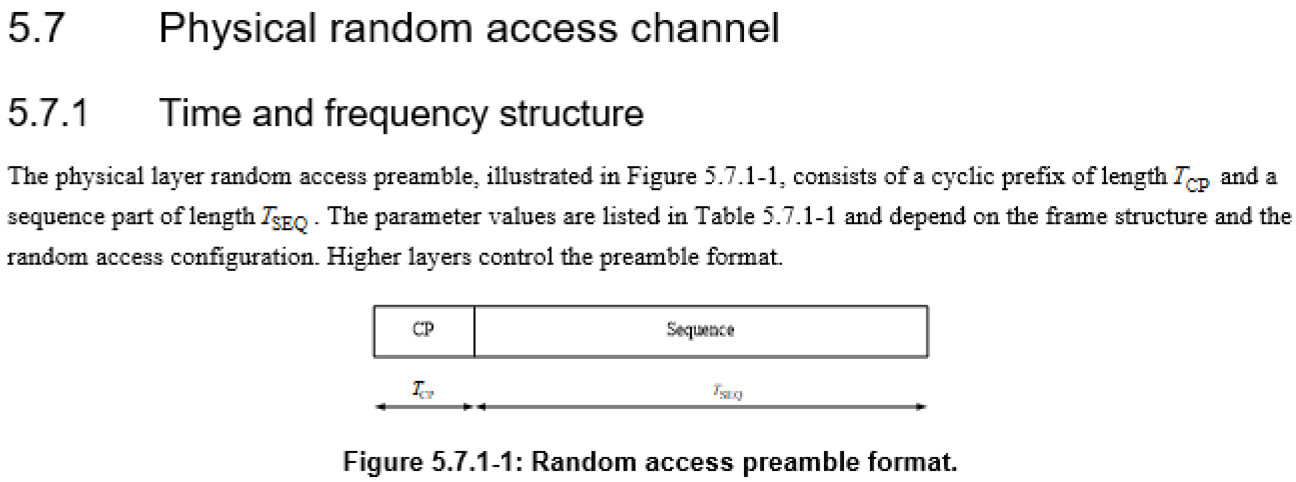
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

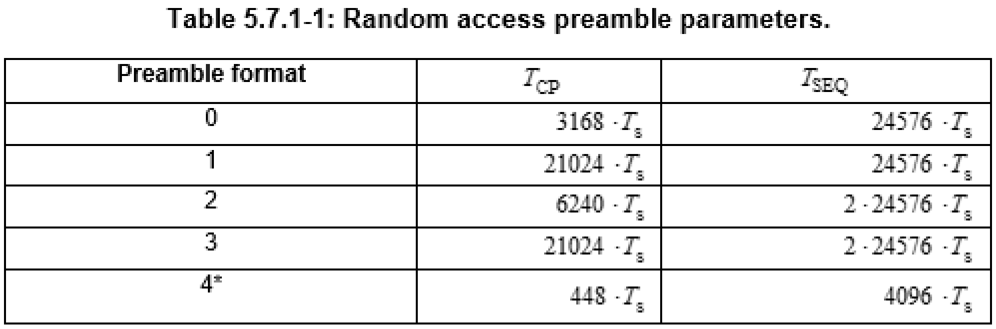
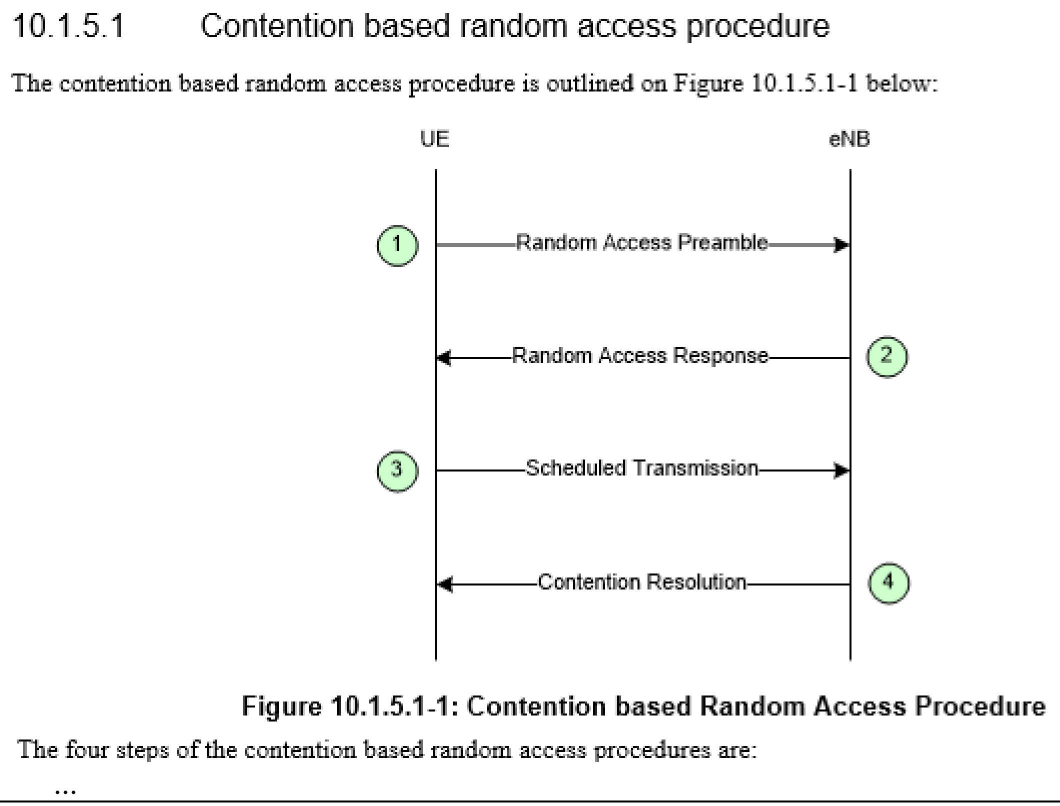


Table 5.7.1-1: Random access preamble parameters.

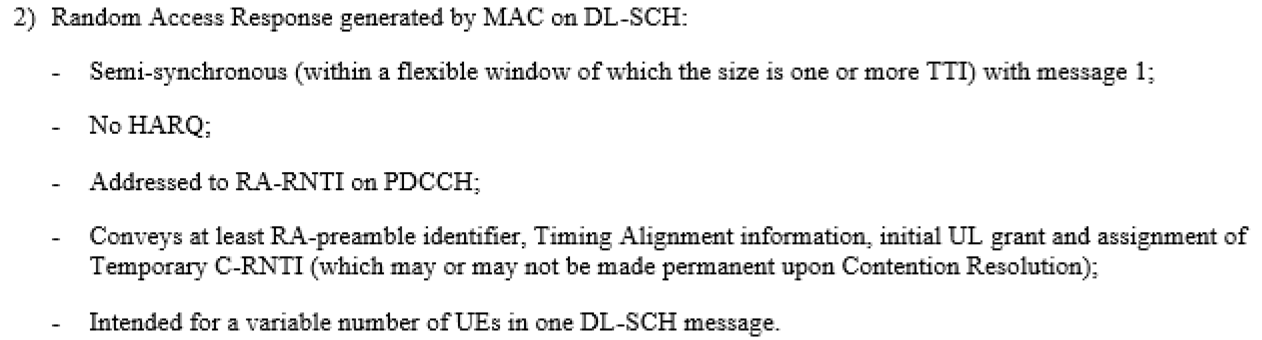
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

a receiver configured to receive, from the base station, a response message.	Honda’s Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

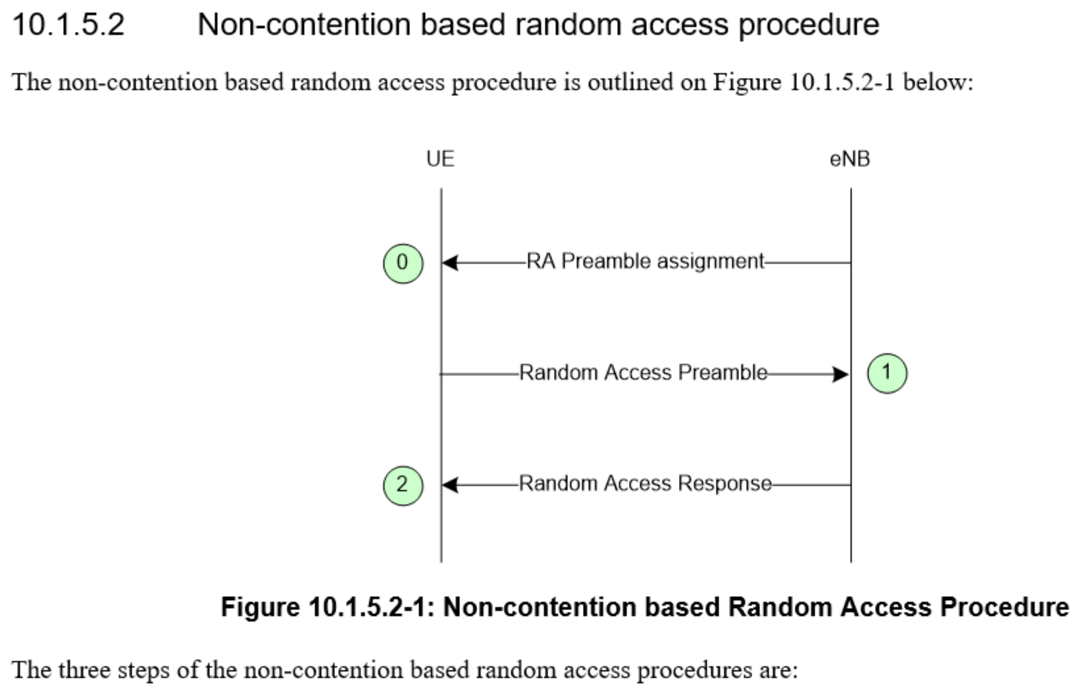
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



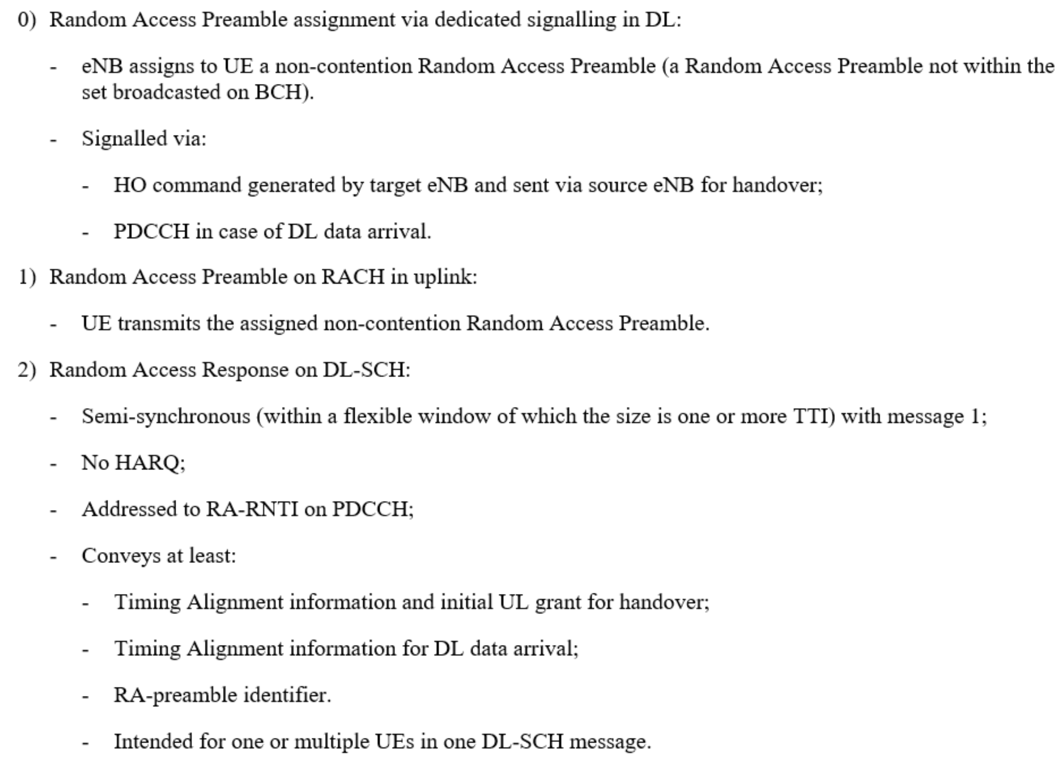
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

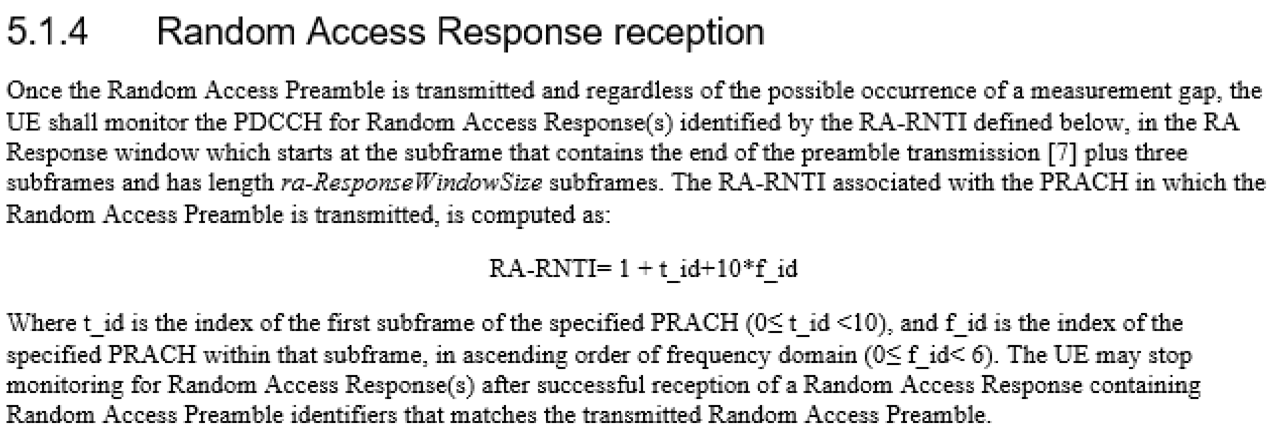


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

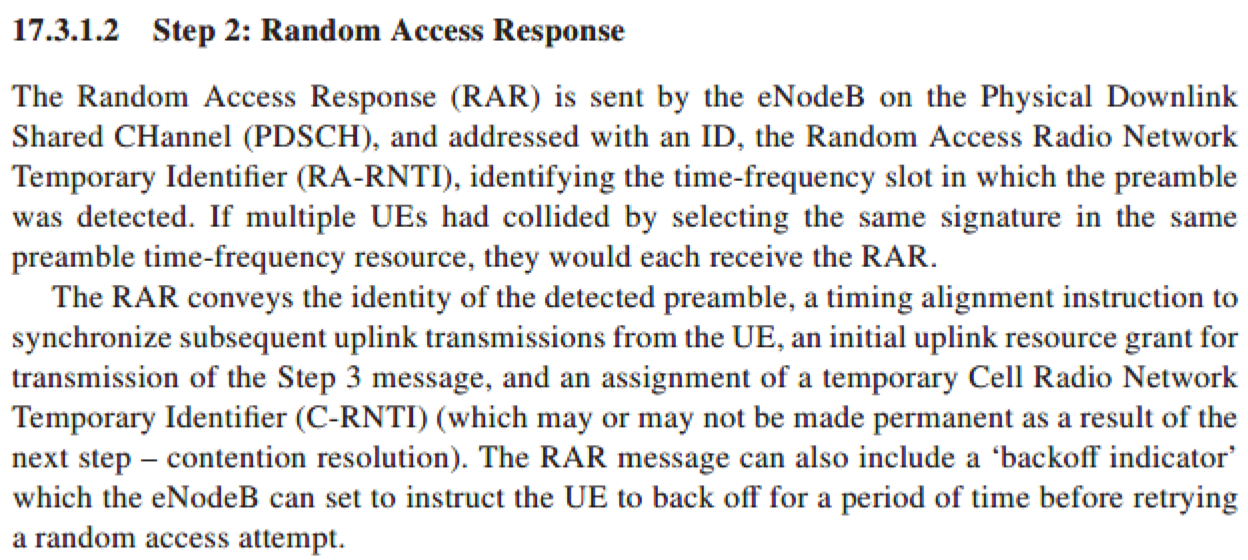
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

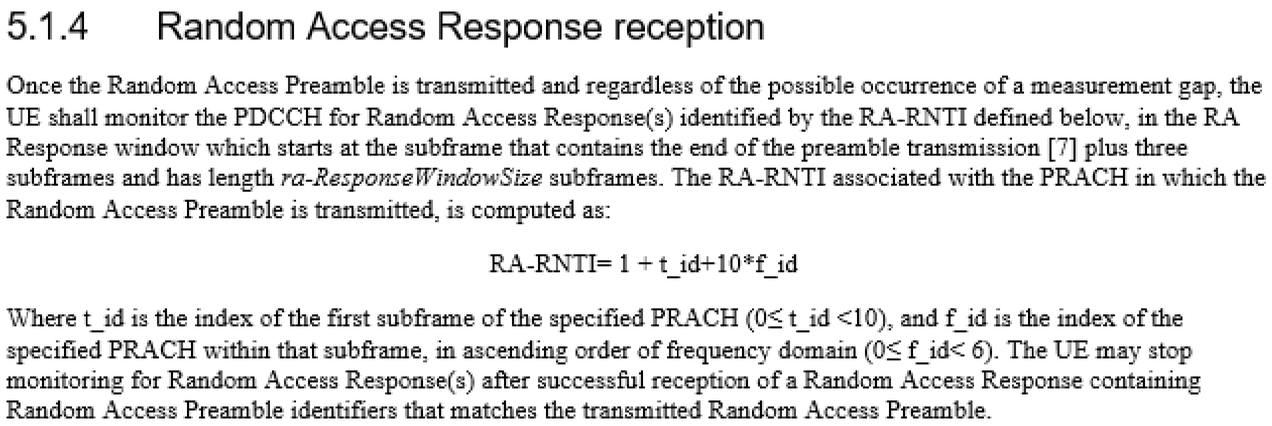
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

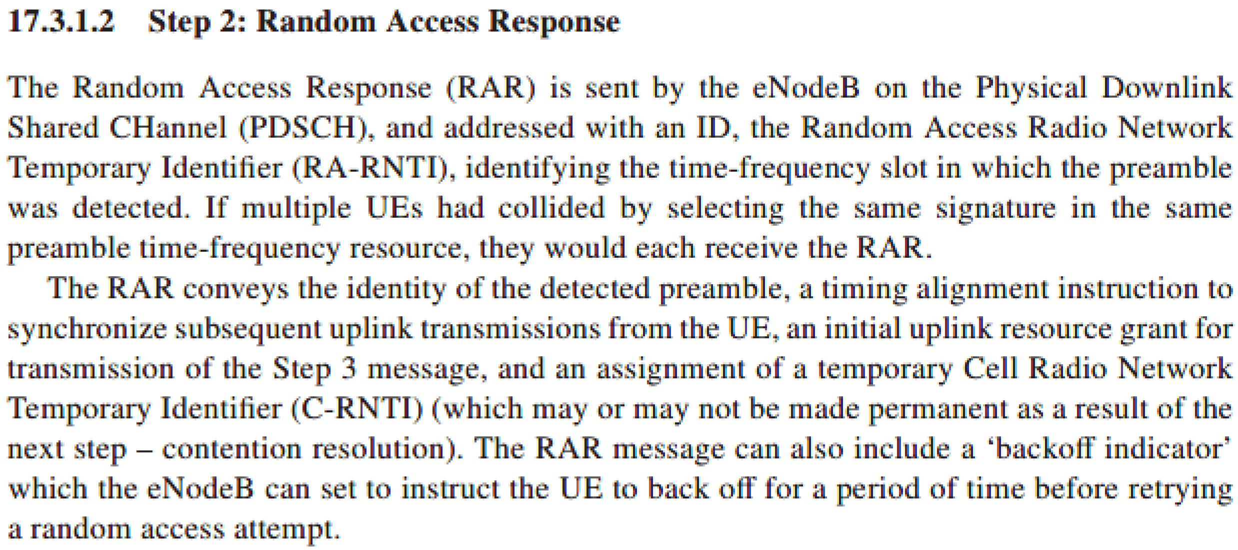
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

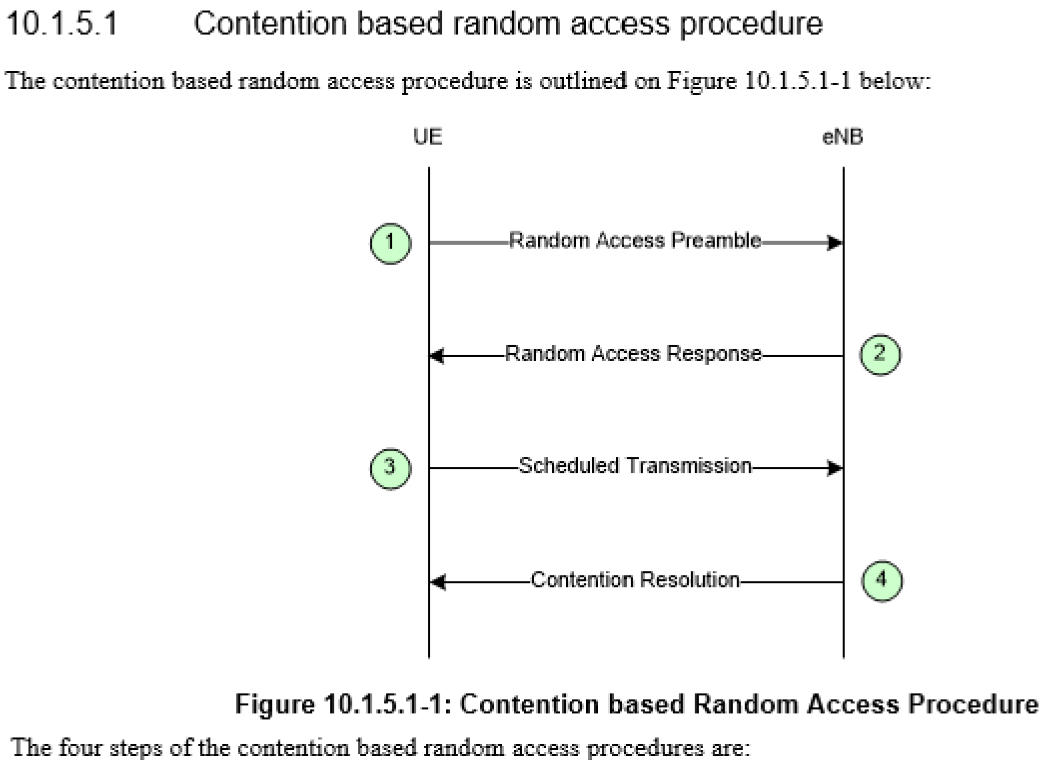
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of Honda’s Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

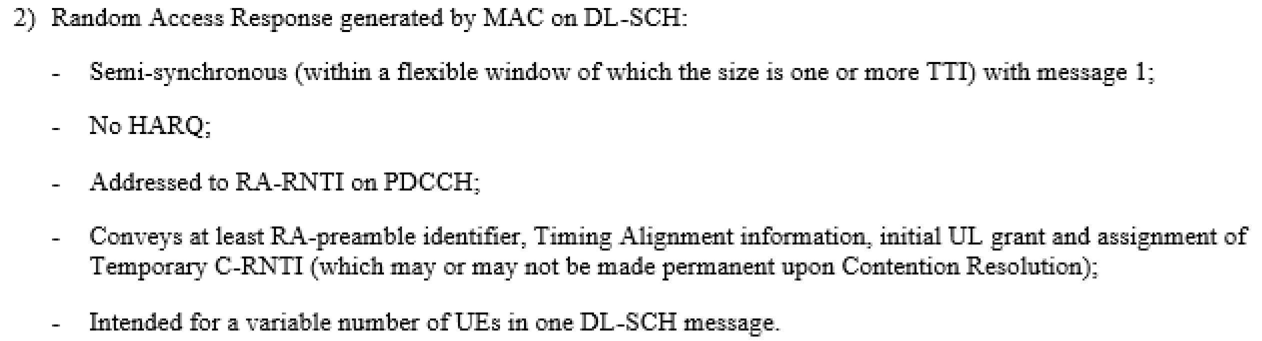
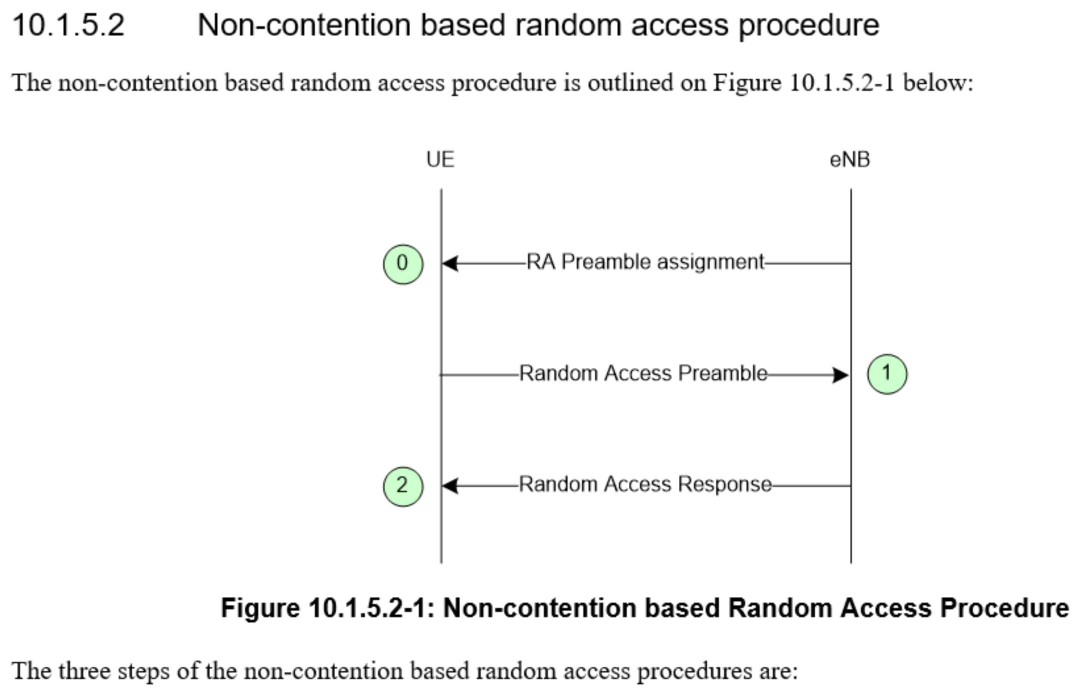
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

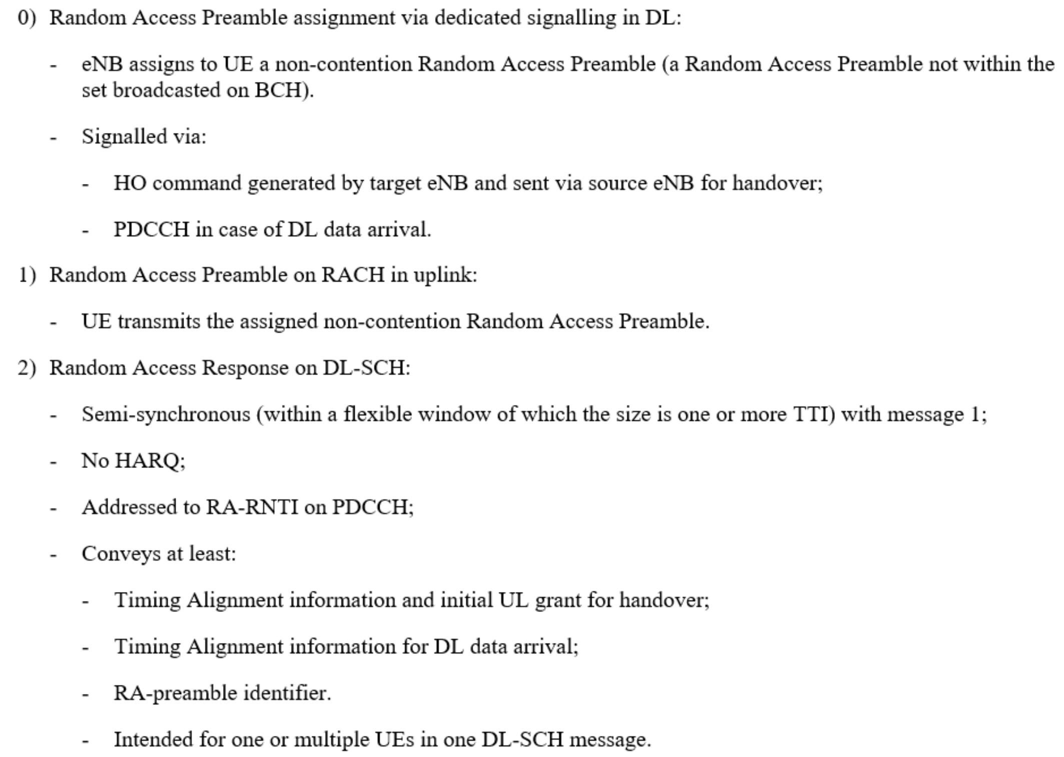
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in Honda’s Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.*, When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

	 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

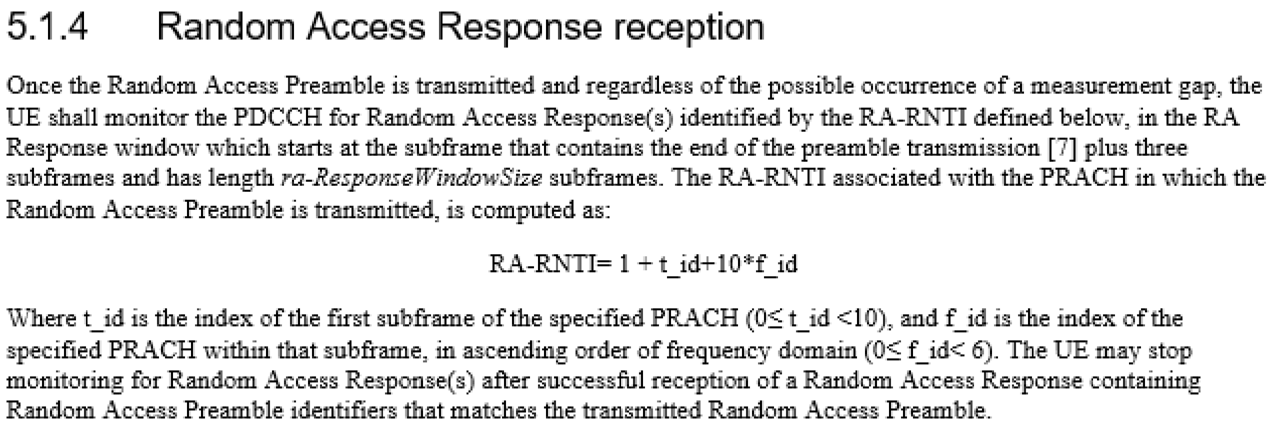


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

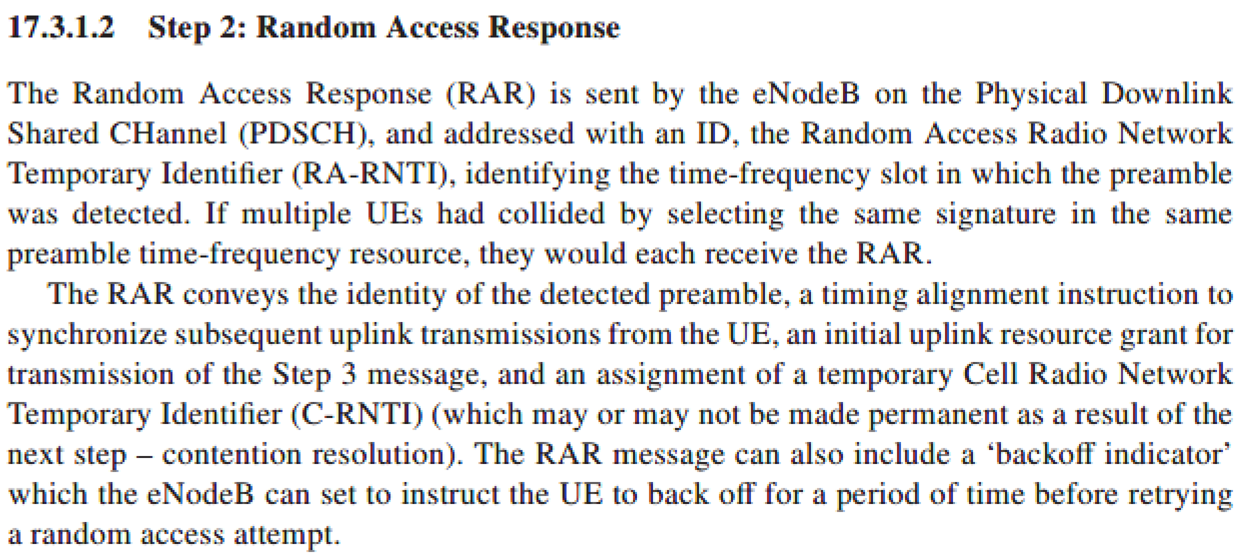
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

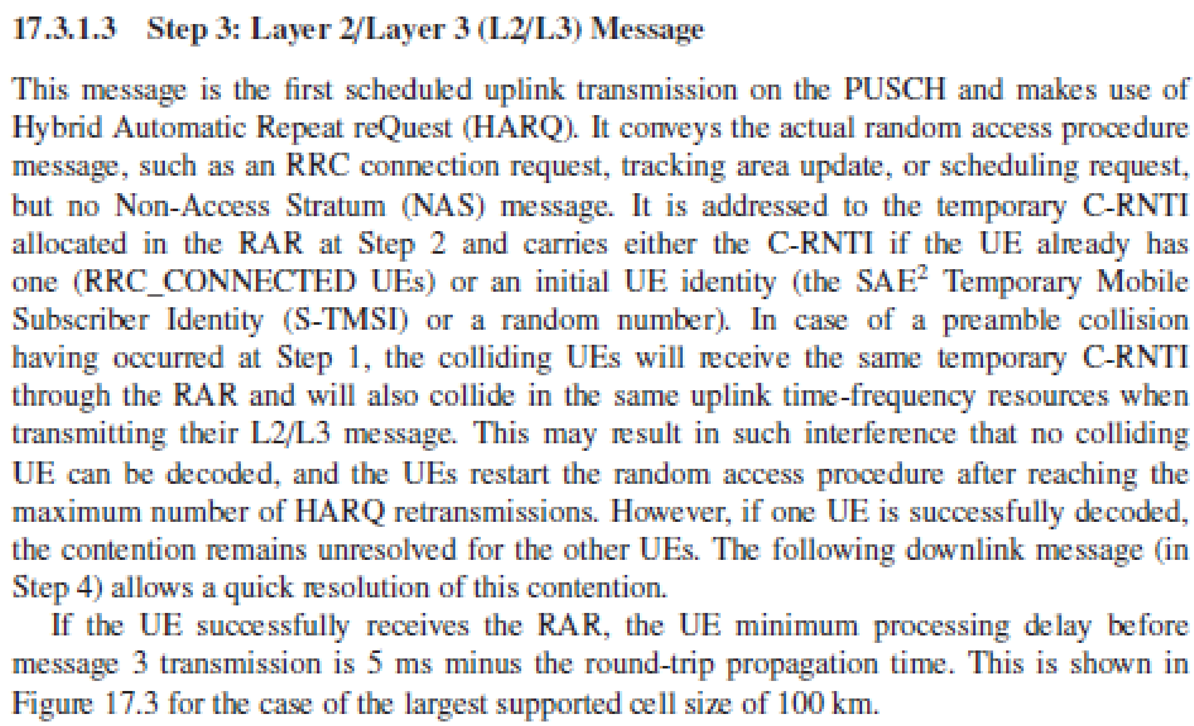
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

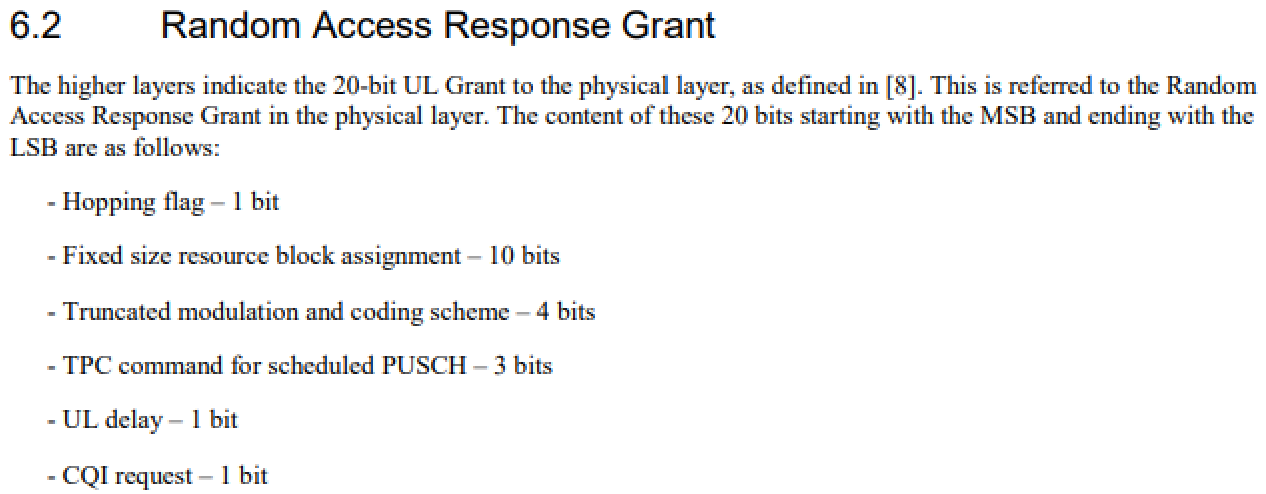
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

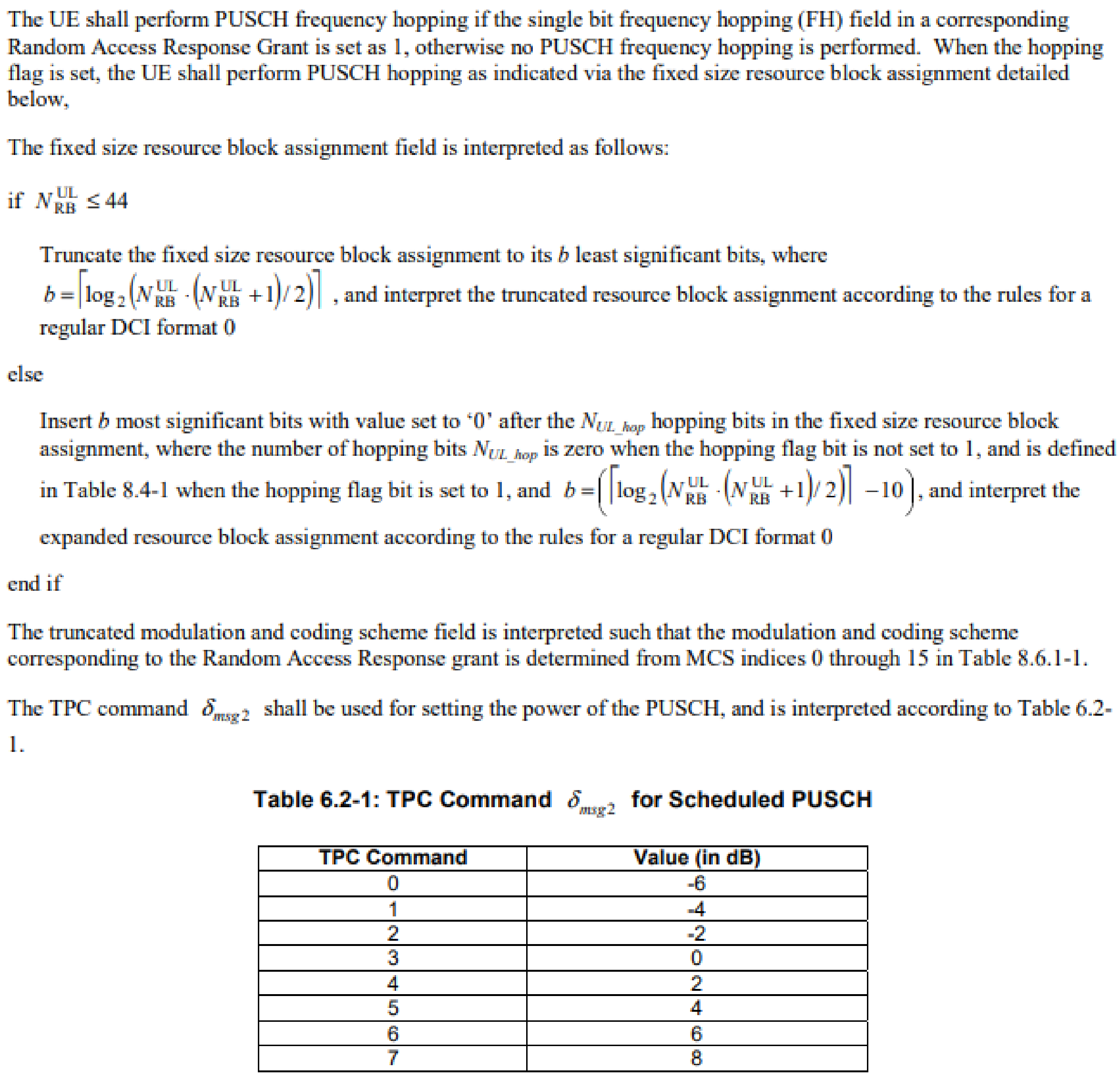
US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of Honda's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
“The mobile station of claim 2, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

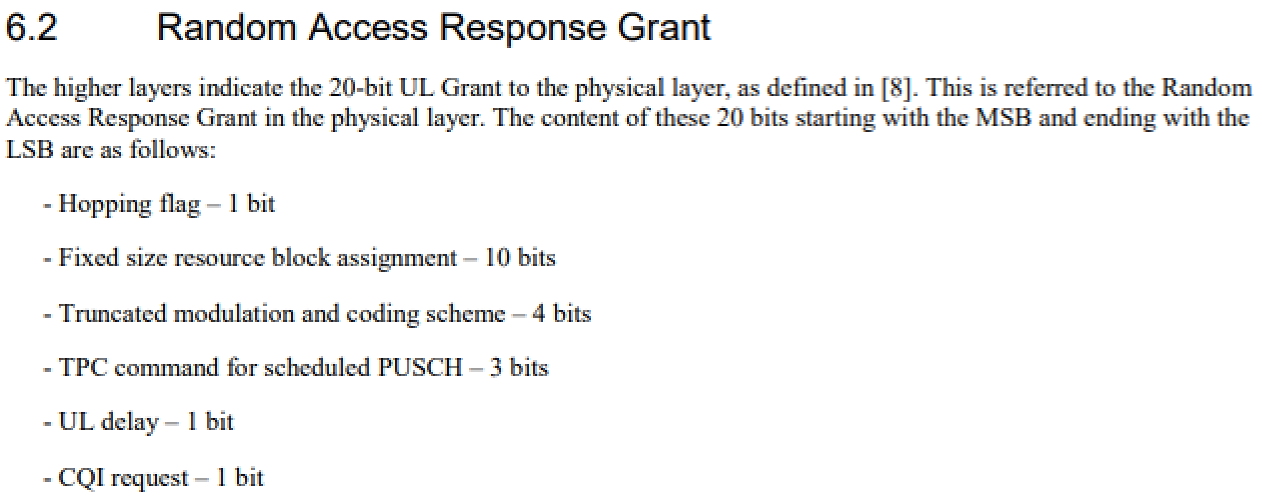
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

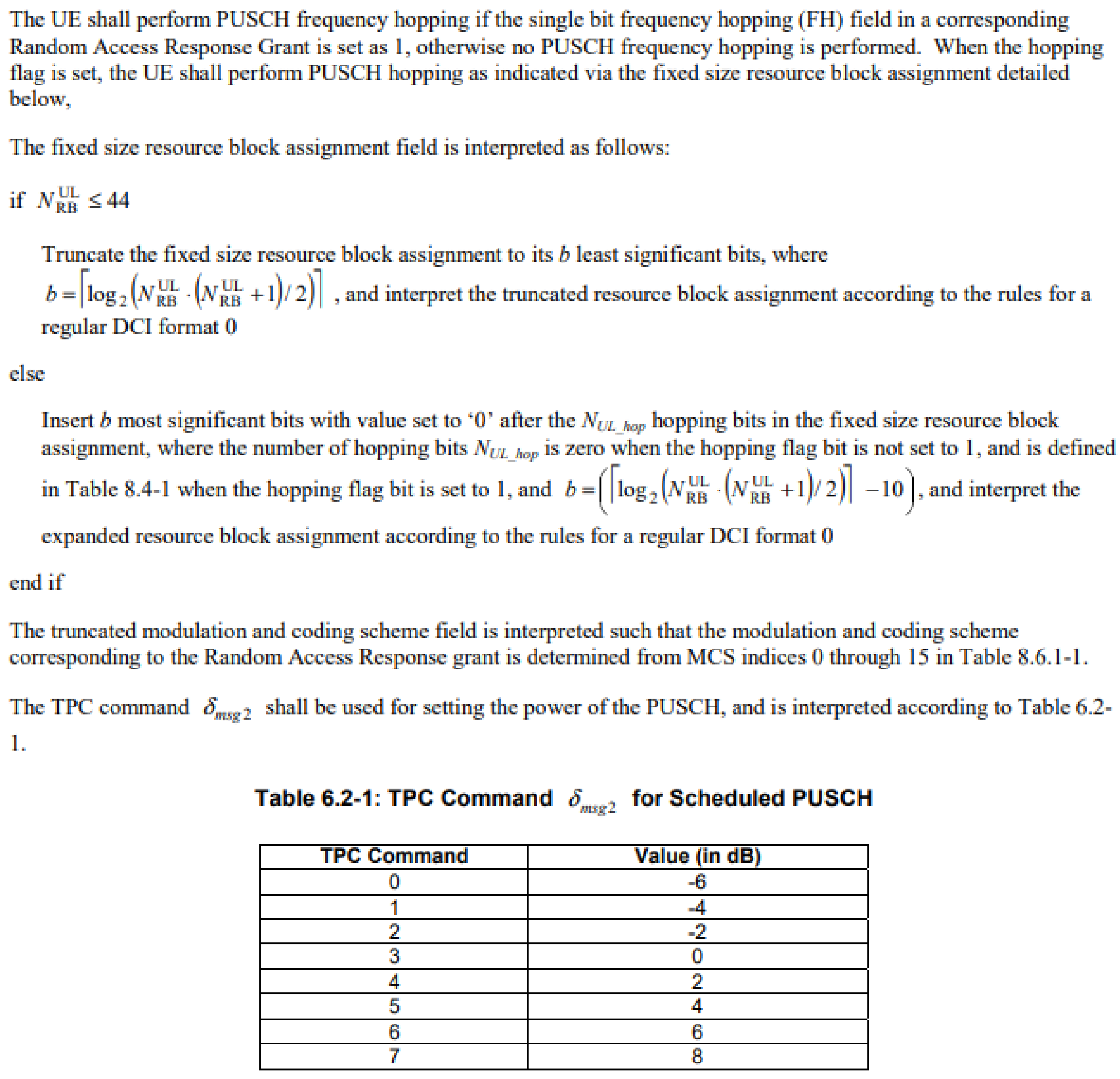
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
"wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information"

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of Honda's Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

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0	-6
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2	-2
3	0
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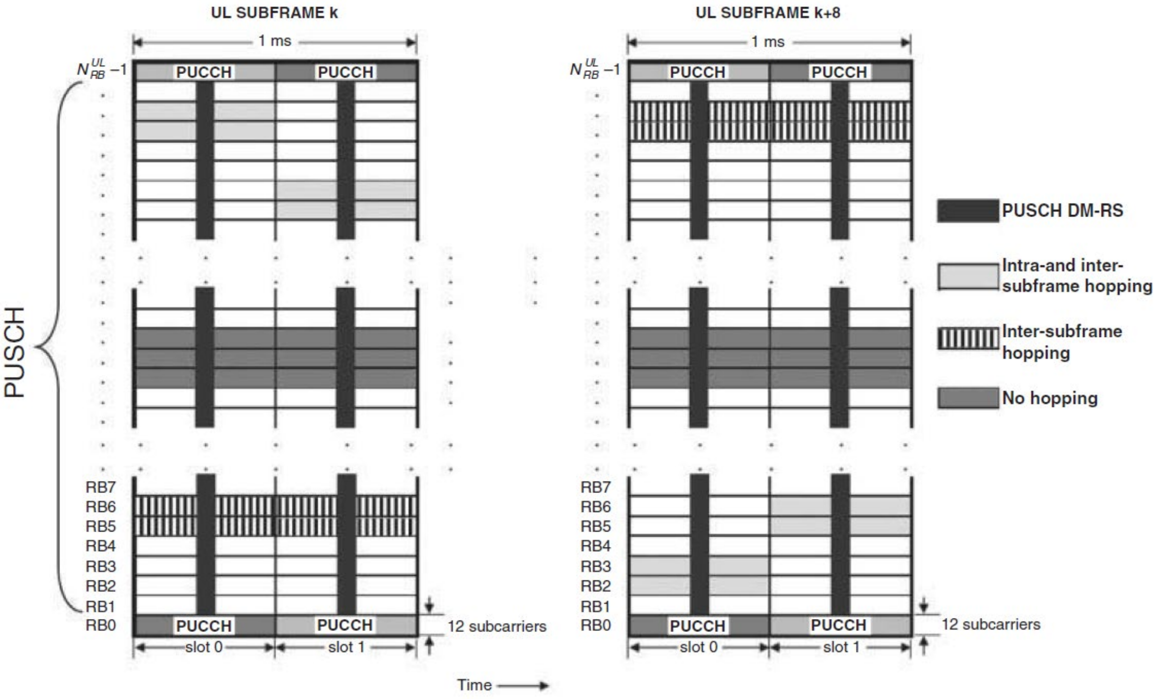
5	4
6	6
7	8

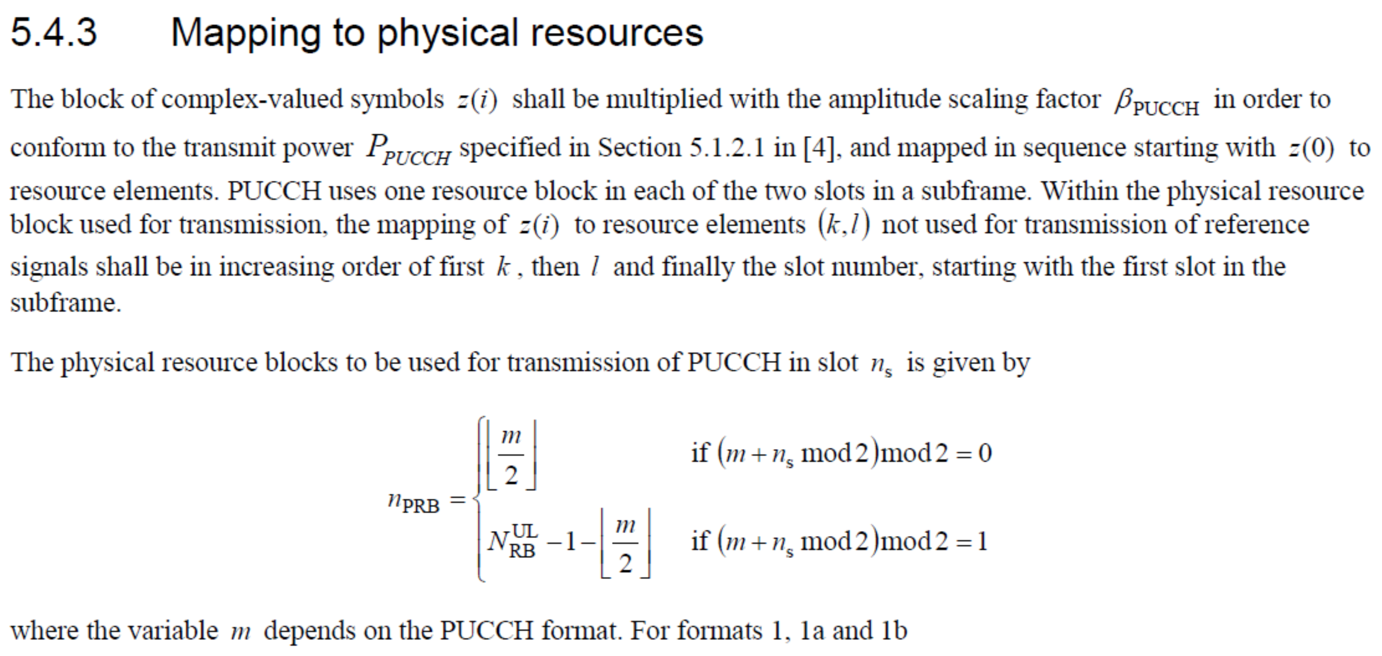
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of Honda’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

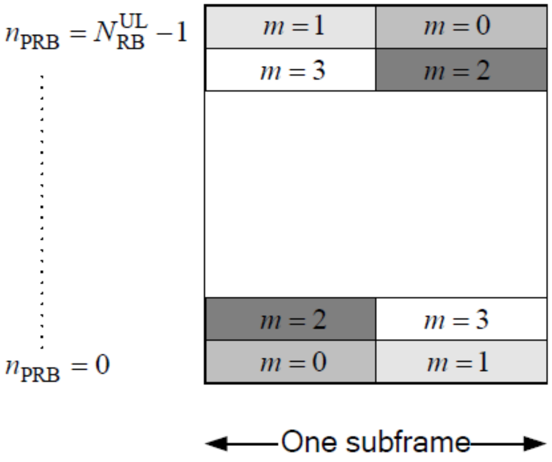


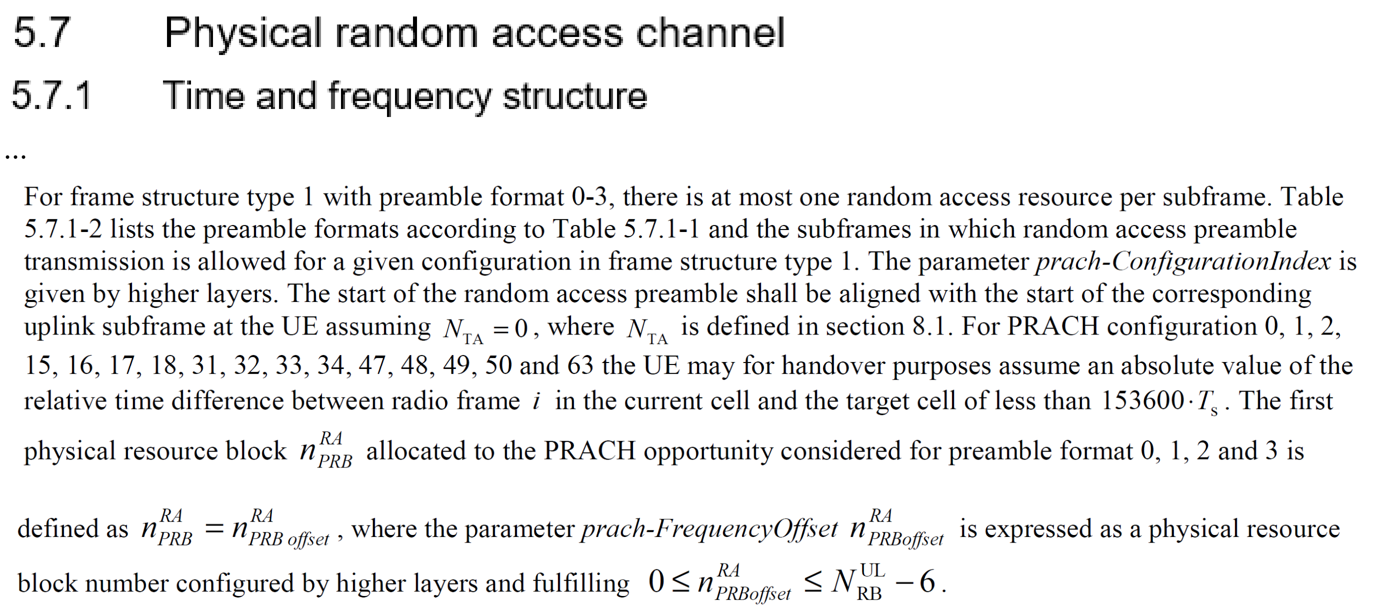
Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 4
“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

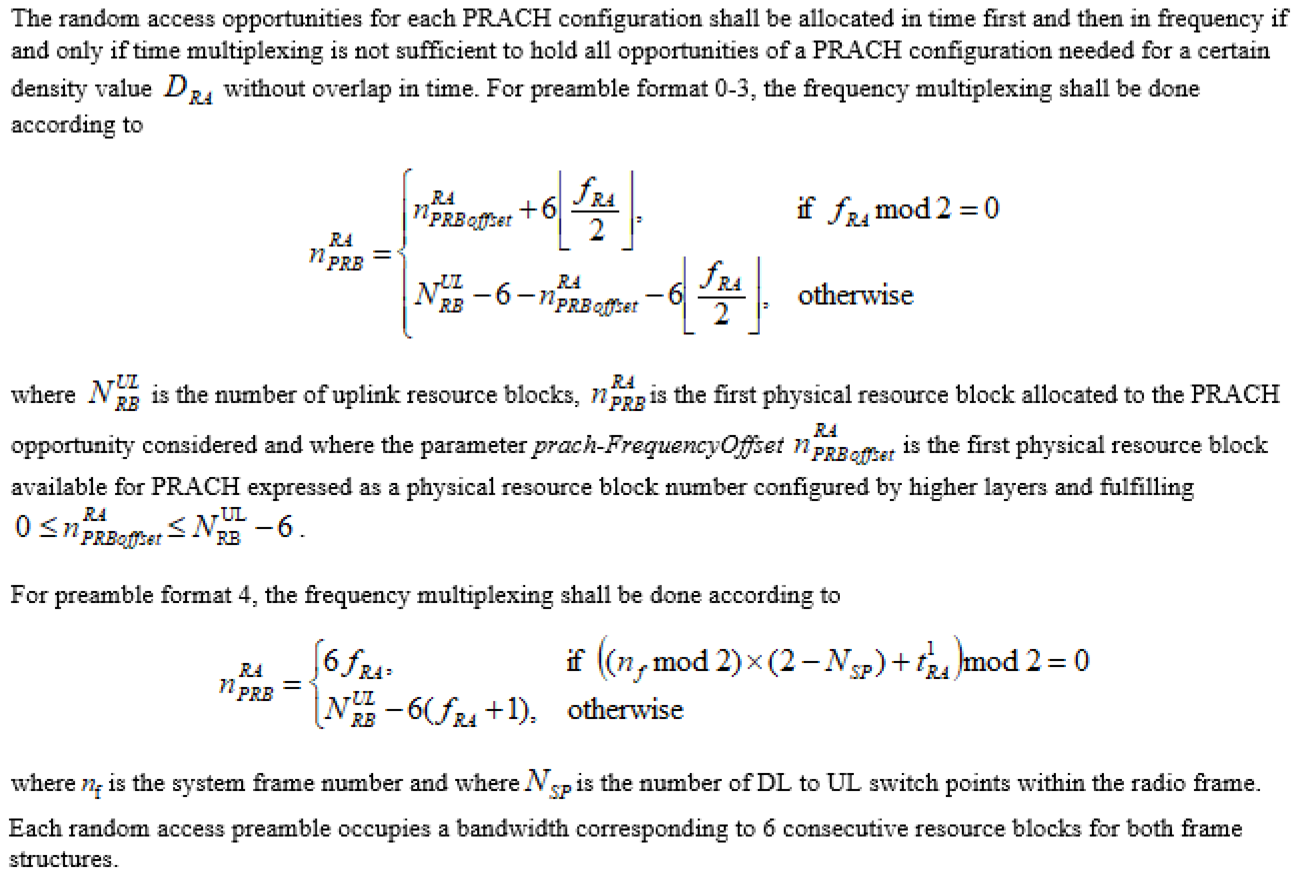
5.7.1 Time and frequency structure

…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t^{0}_{RA}, t^{1}_{RA}, t^{2}_{RA})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t^{0}_{RA} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t^{1}_{RA} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t^{2}_{RA} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t^{2}_{RA} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	**UL/DL configuration (See Table 4.2-2)**						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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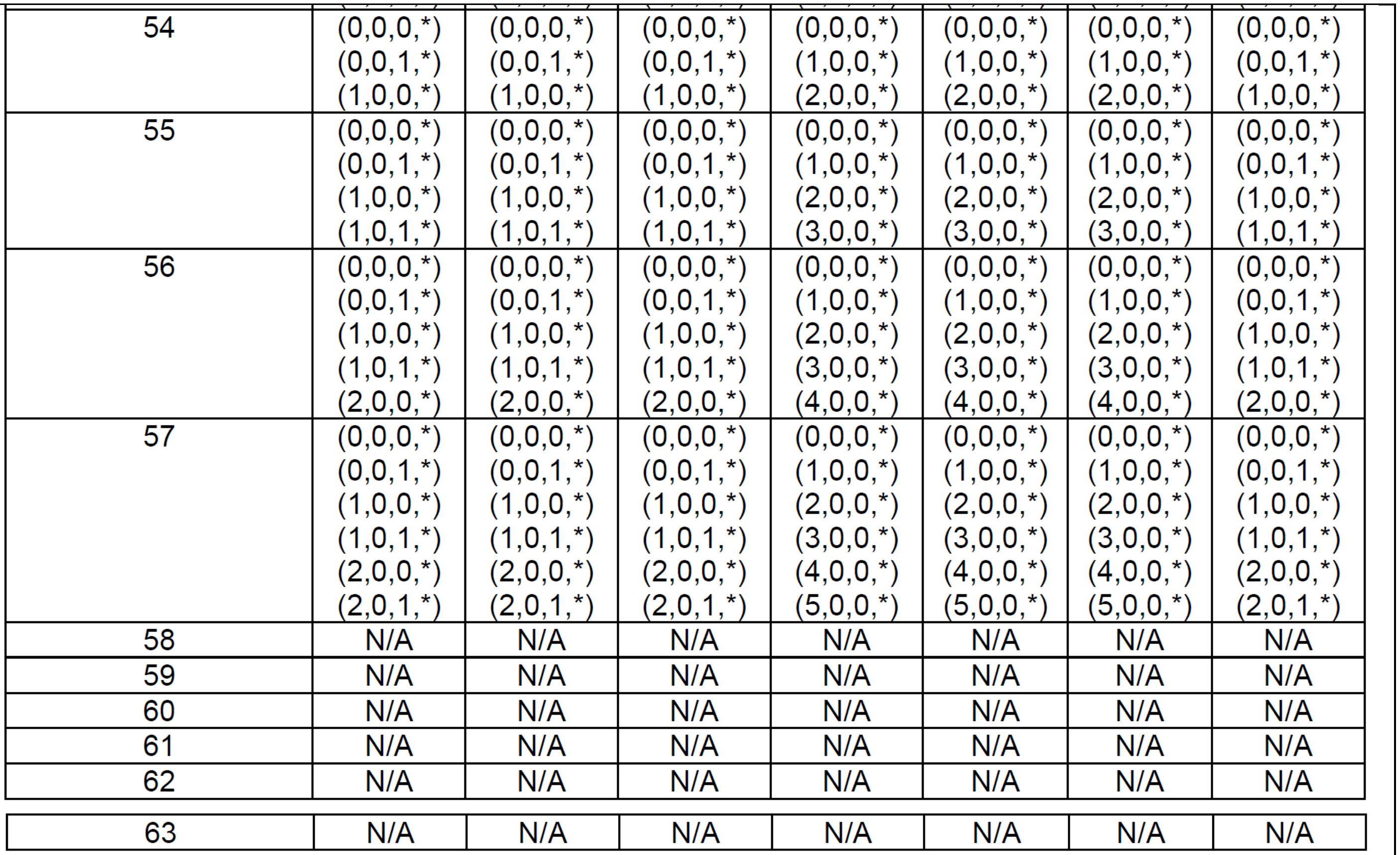
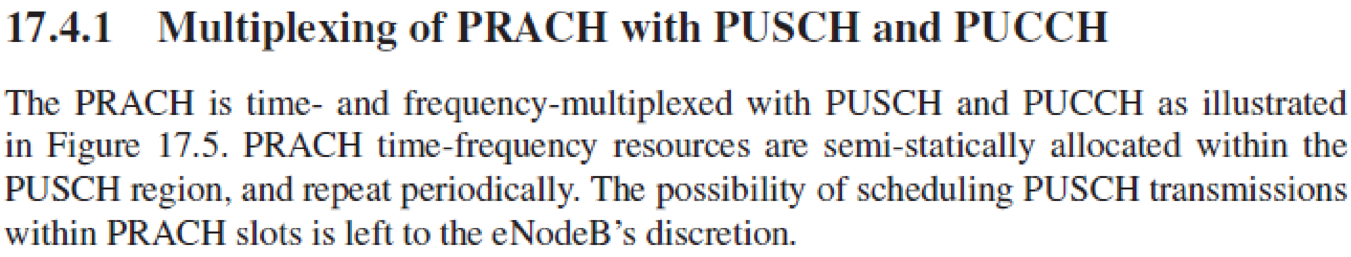
US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

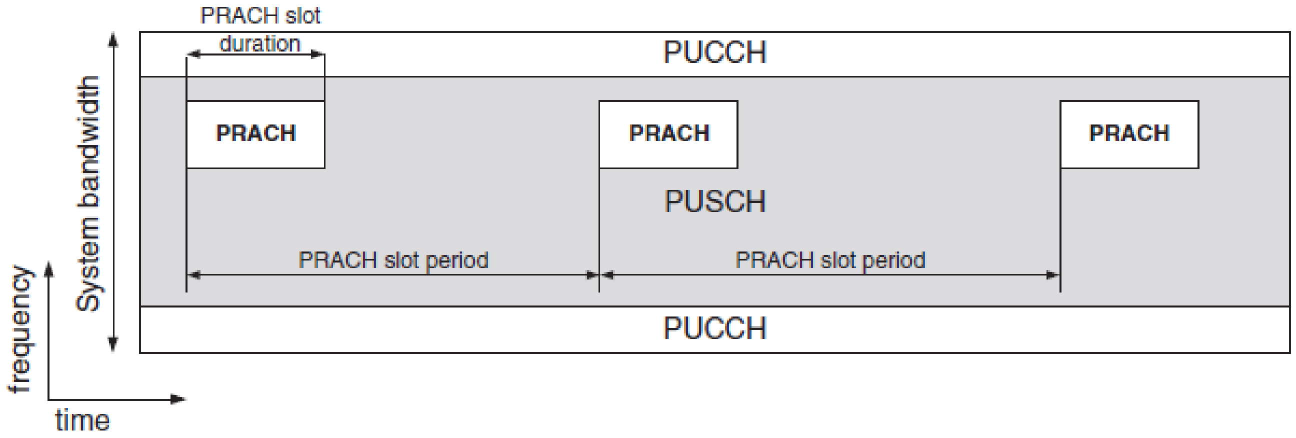
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

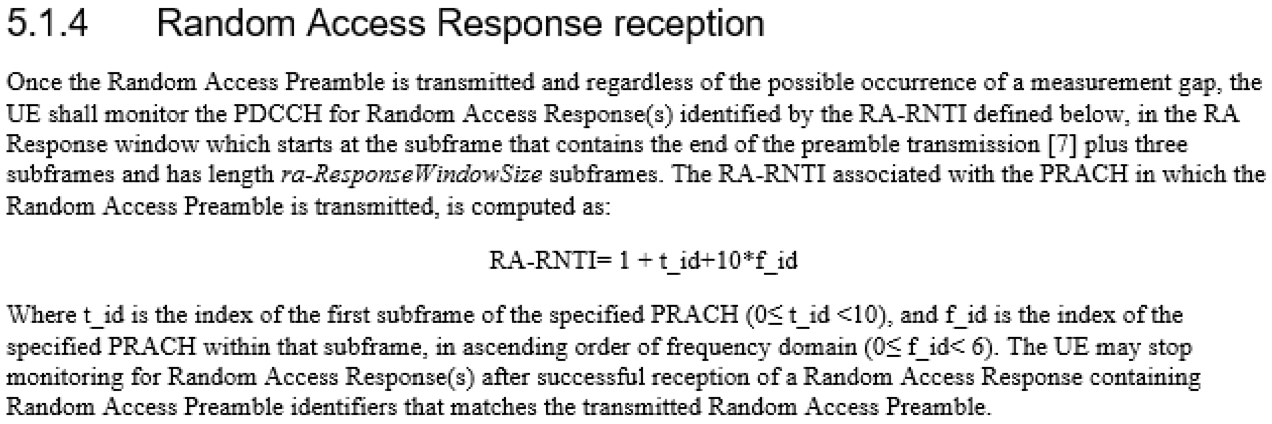
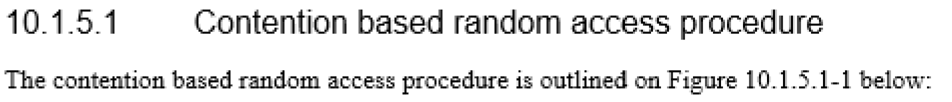
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

US Patent No. 10,833,908: Claim 5

"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Honda's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

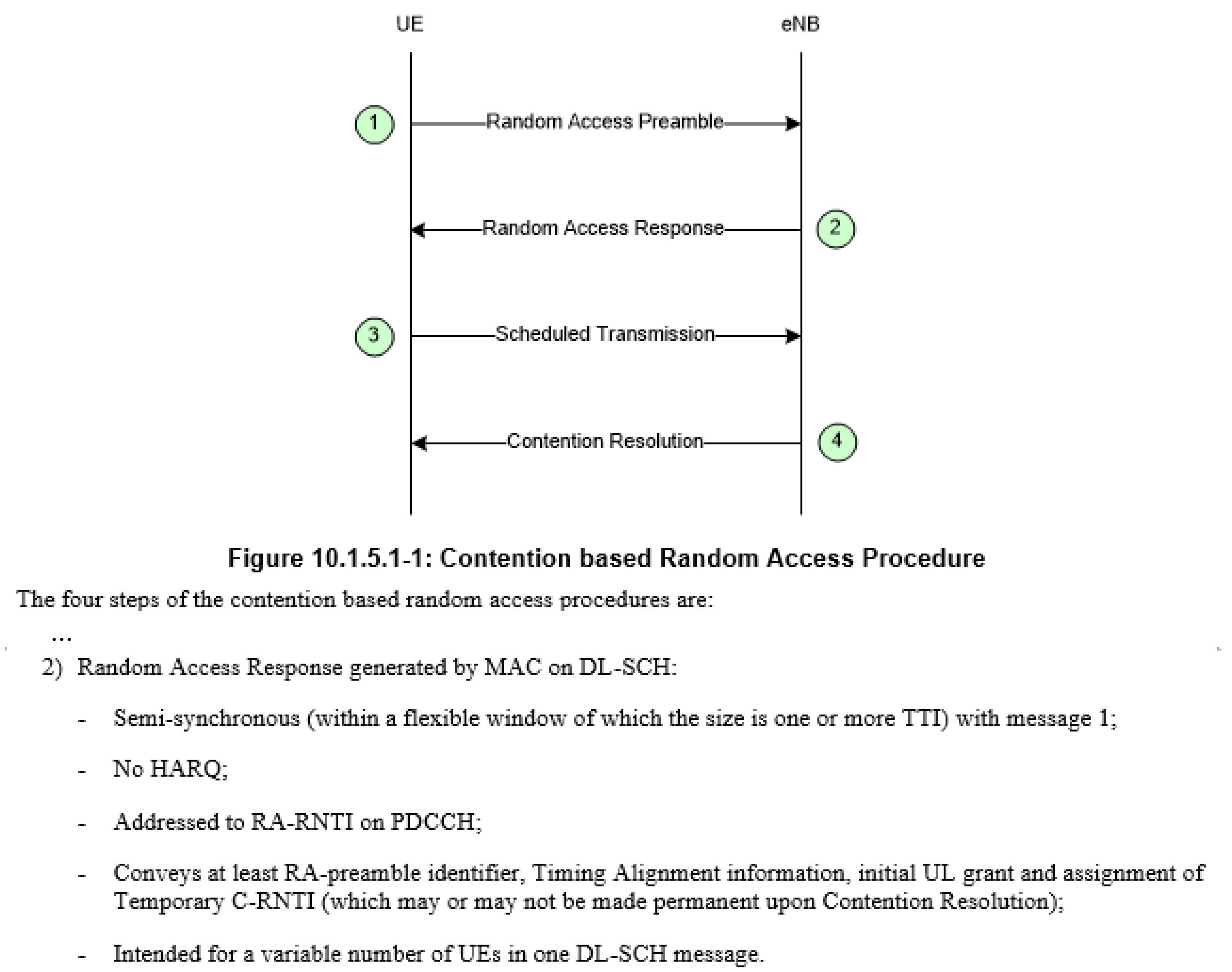


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

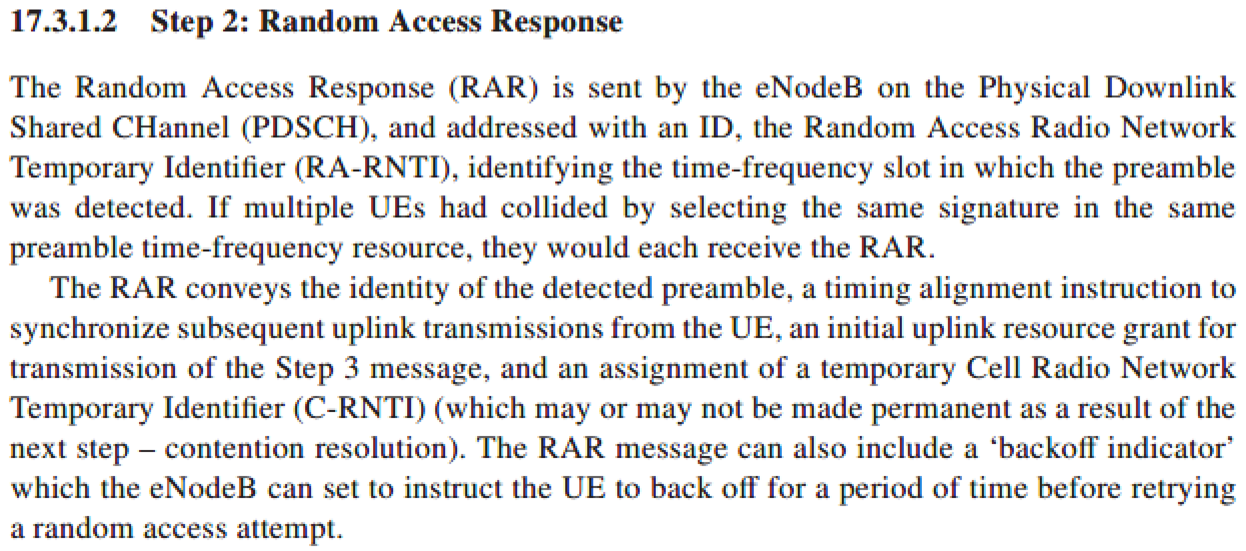
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 6
"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Honda's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

<table>
<tr>
<td>7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.</td>
<td>

See Claim 1.

The frequency band used with Honda's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,*

For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.

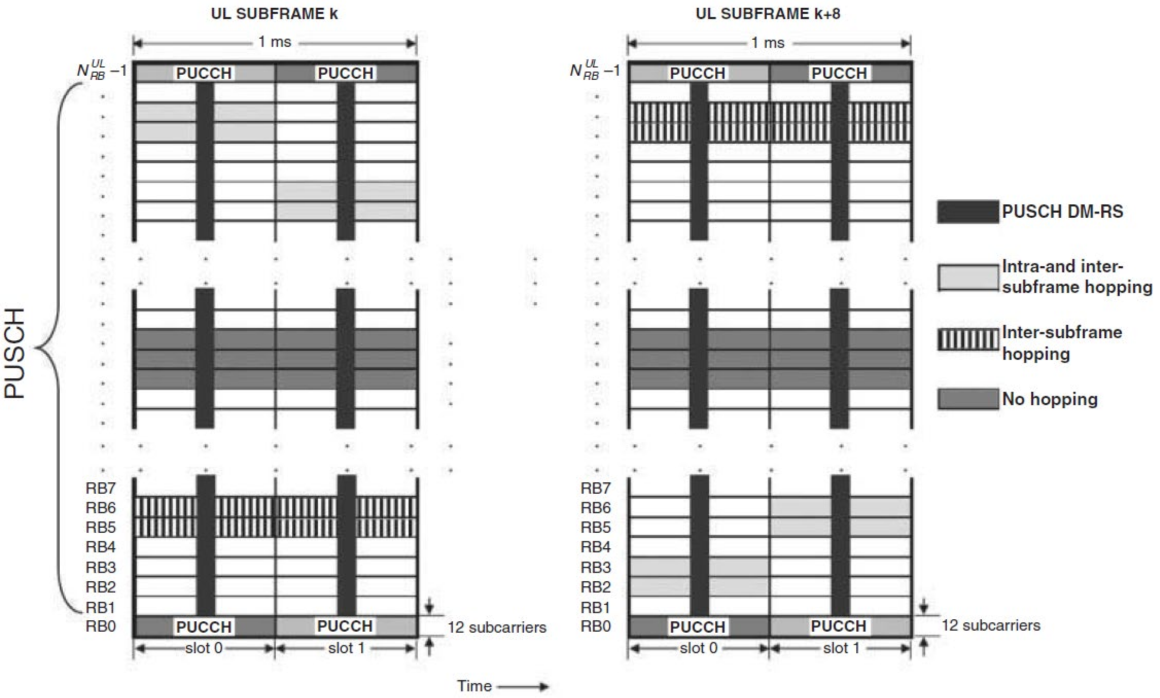
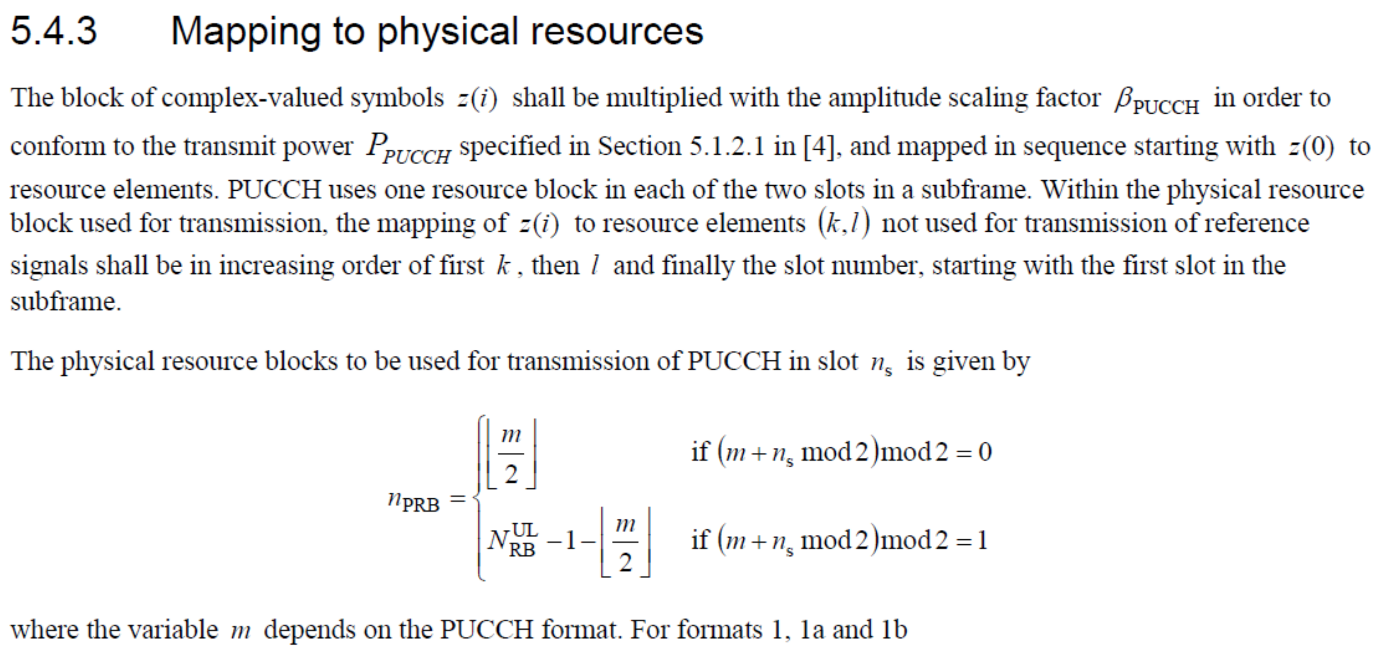


Figure 16.3: Uplink physical data channel processing.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 7
“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

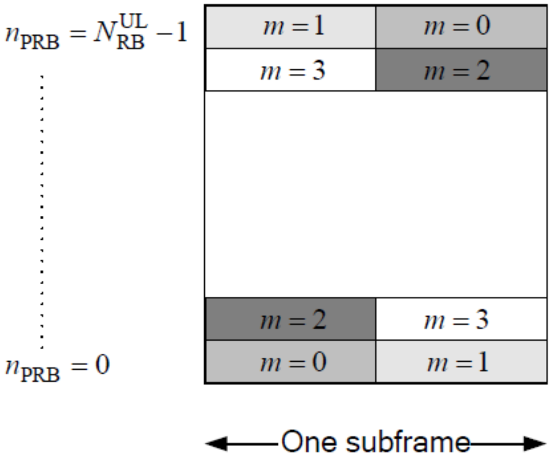


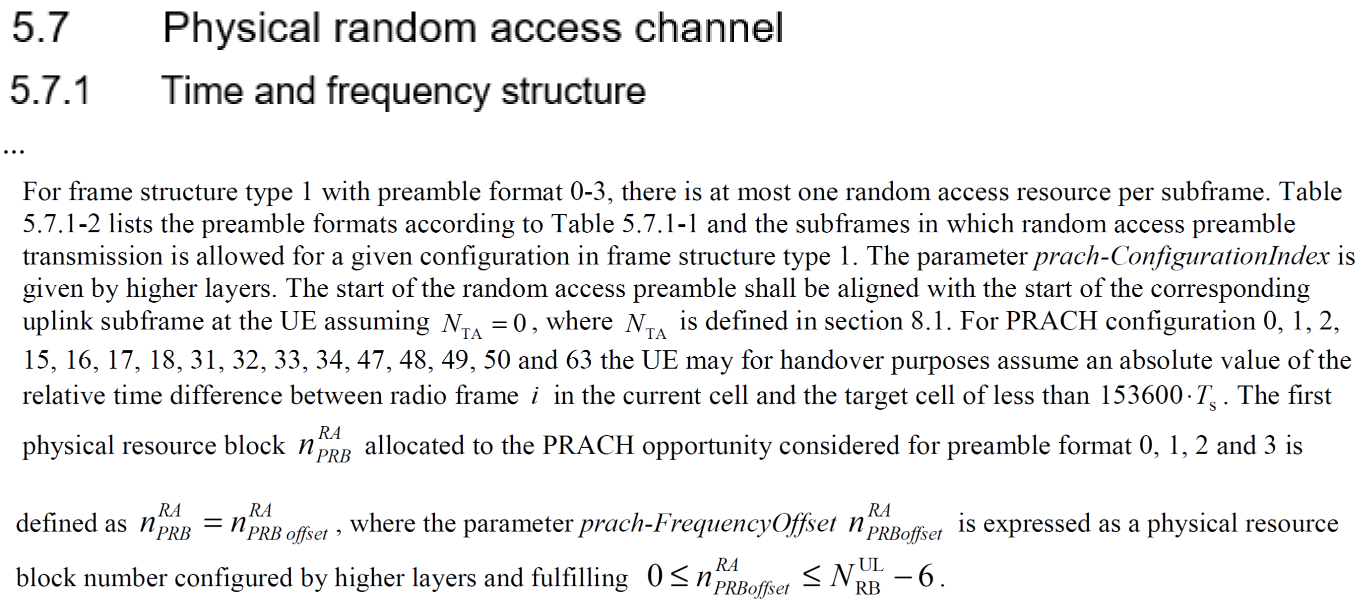
Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

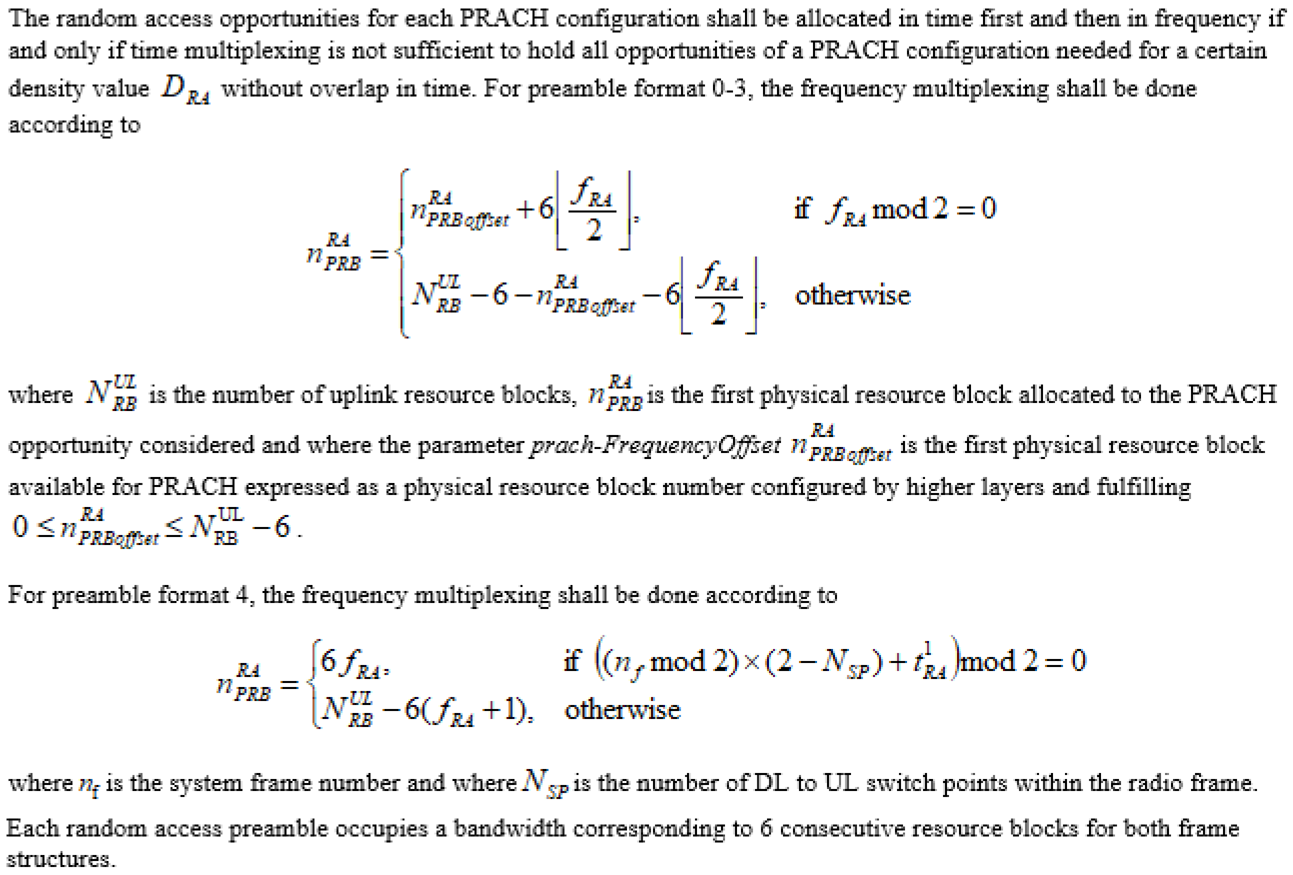
US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$. …

US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^0, t_{RA}^1, t_{RA}^2)$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^0 = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^1 = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^2 is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^2 is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_s$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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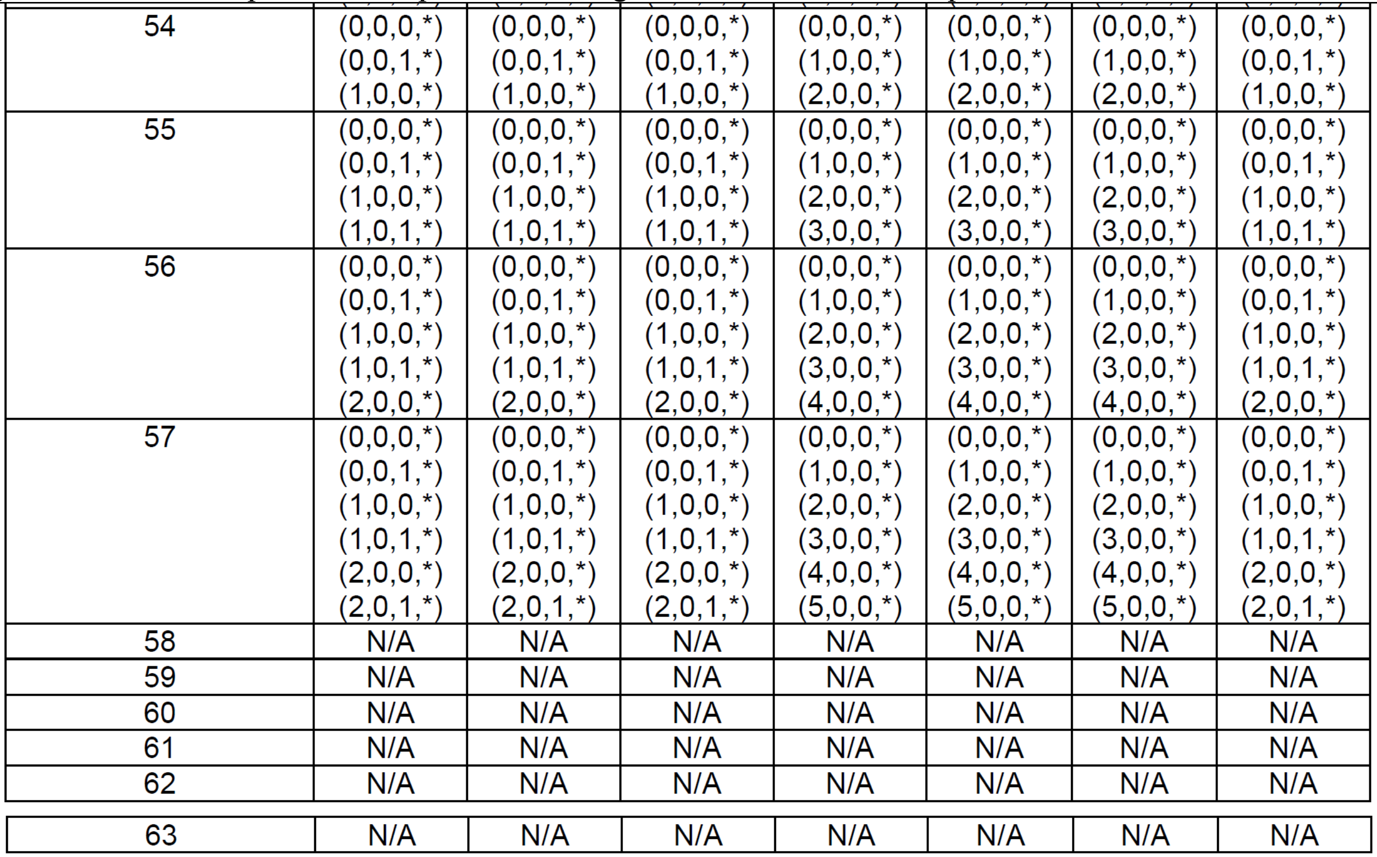
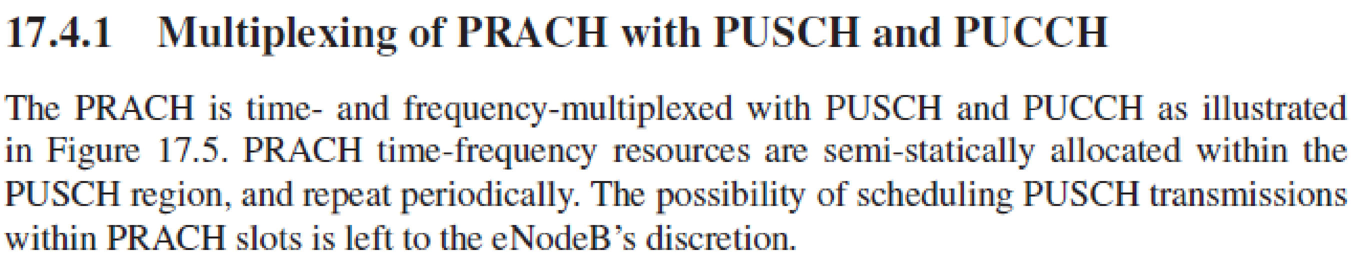


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

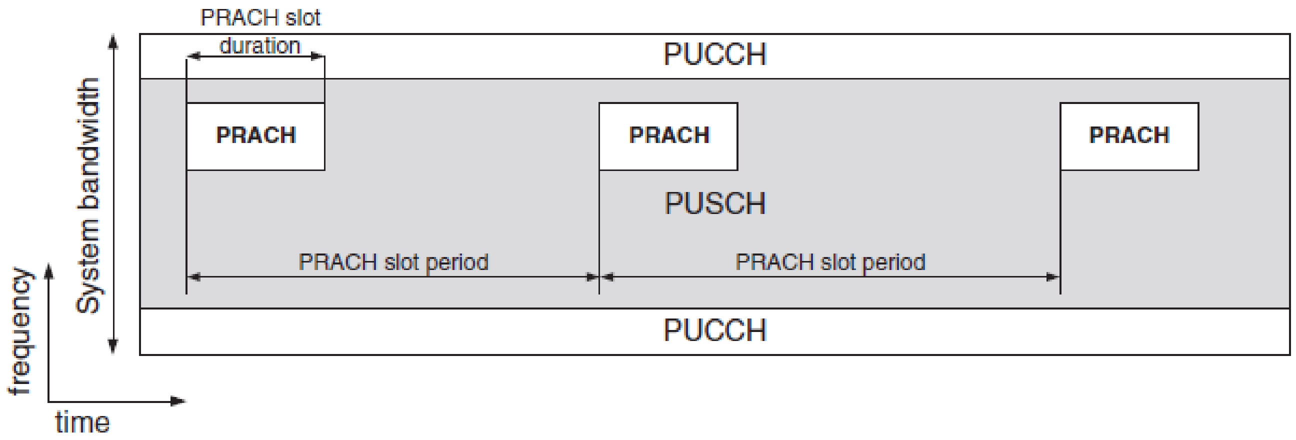


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

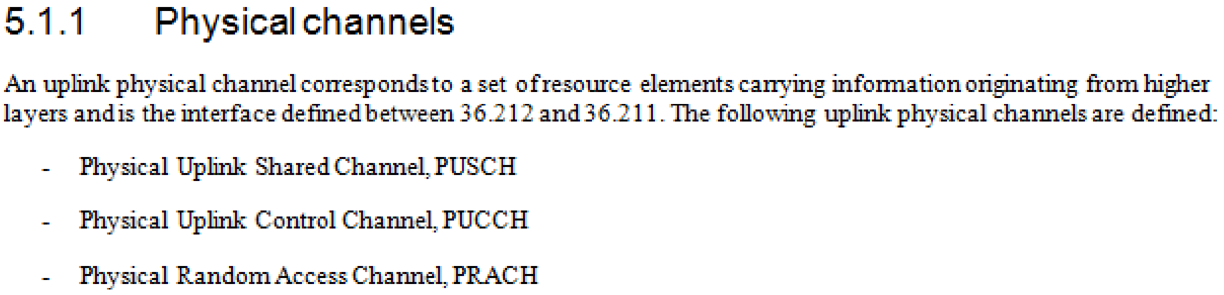
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 7

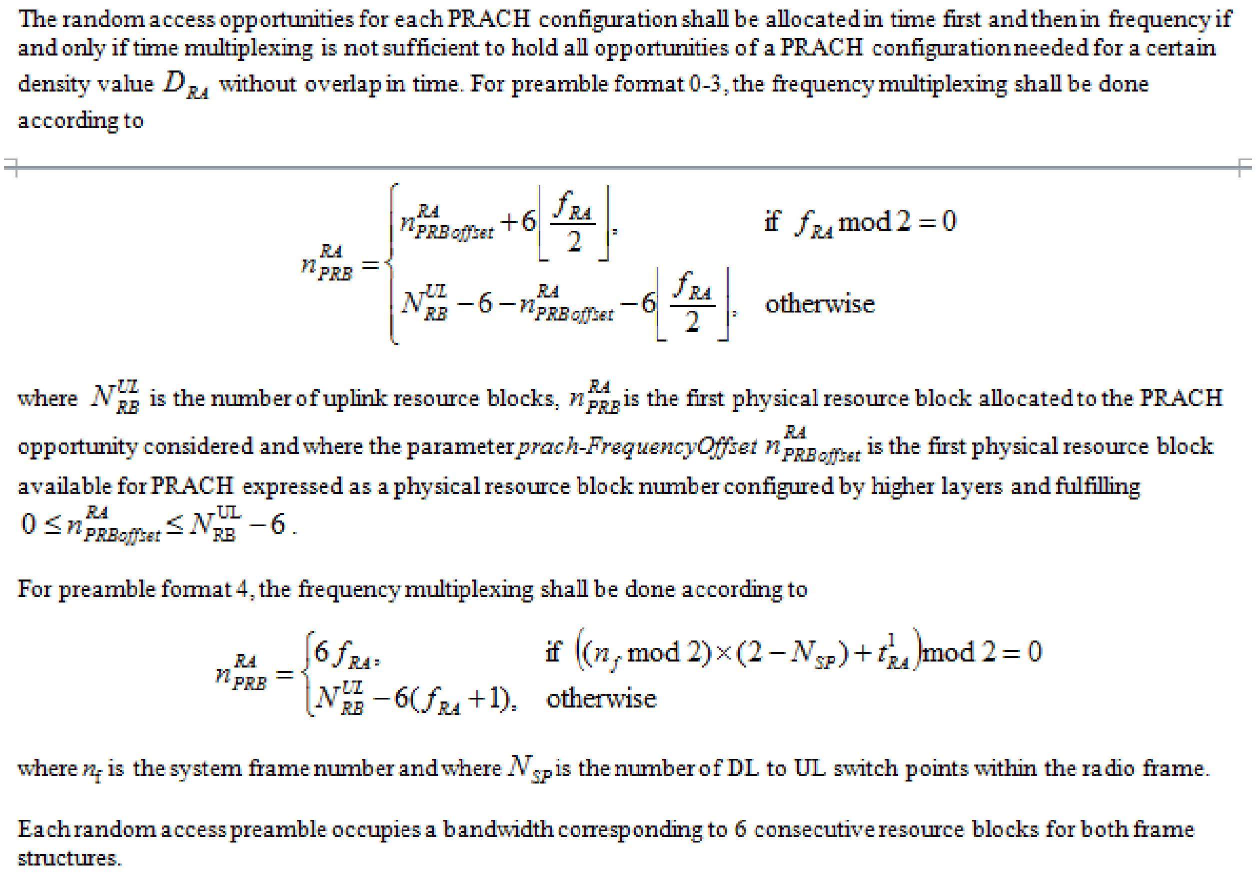
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Honda’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

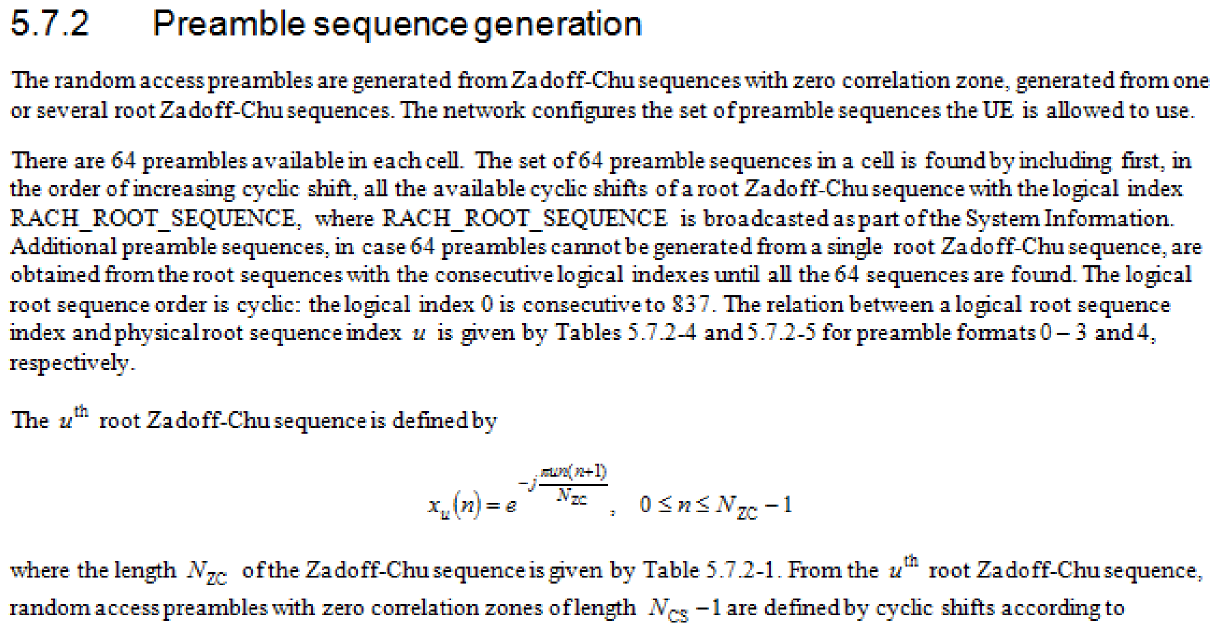
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

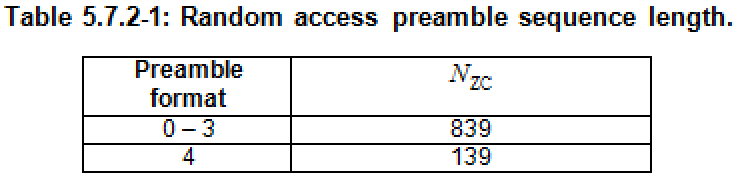
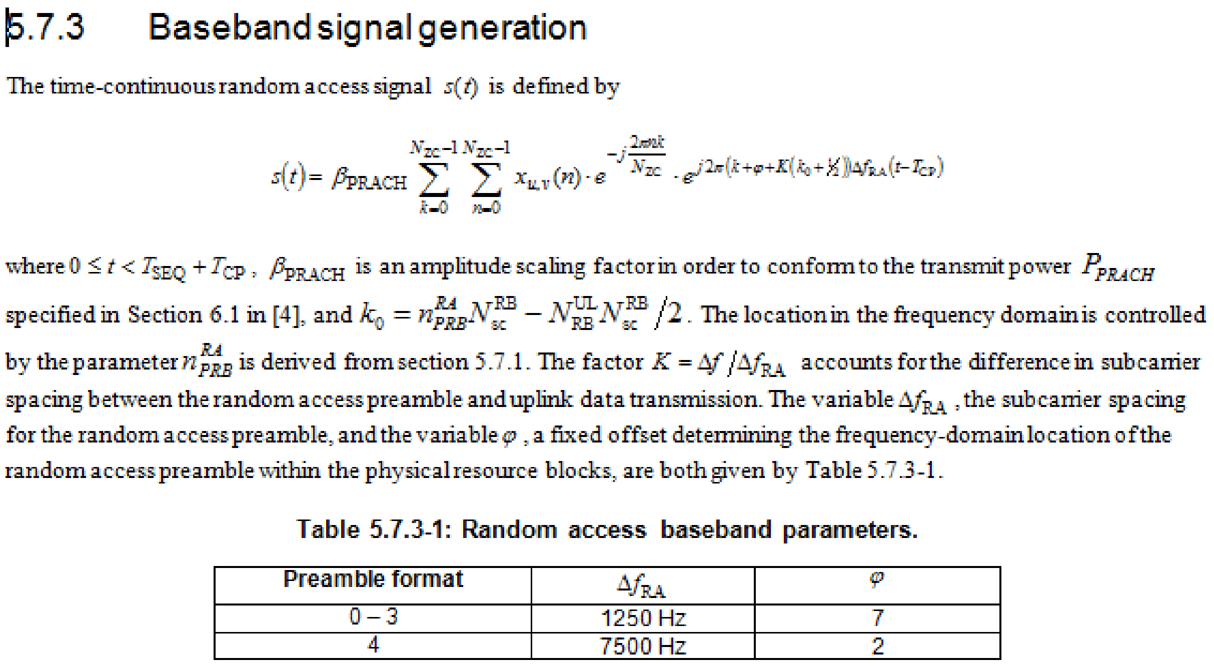


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

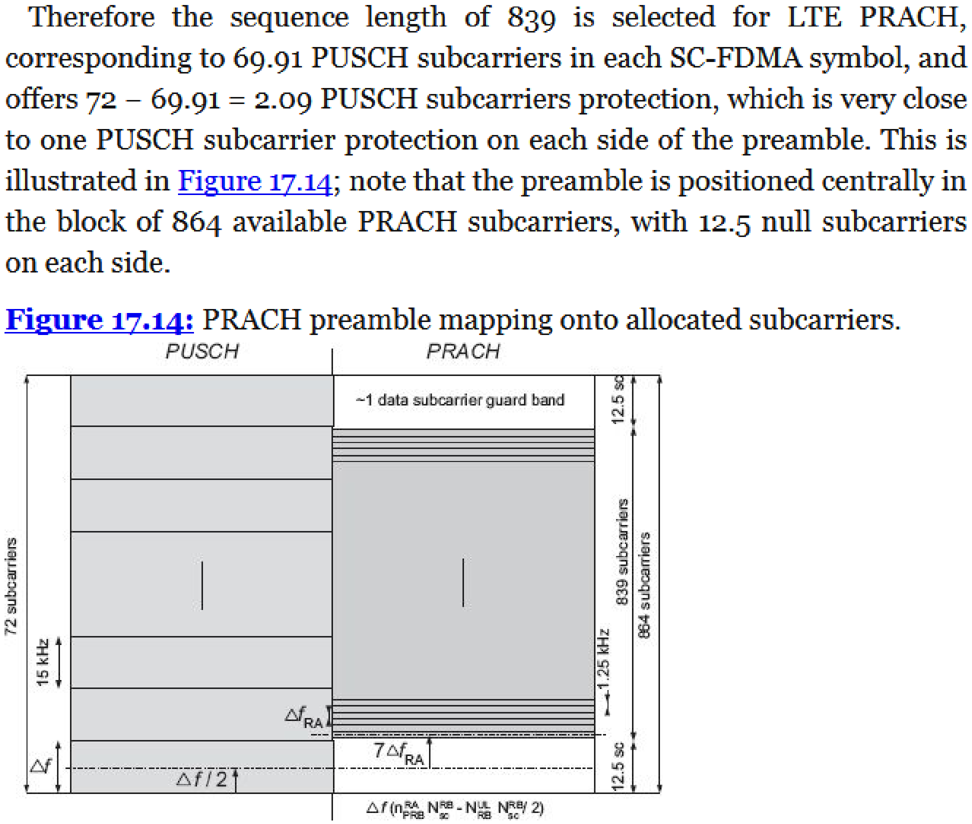
where $0\leq t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

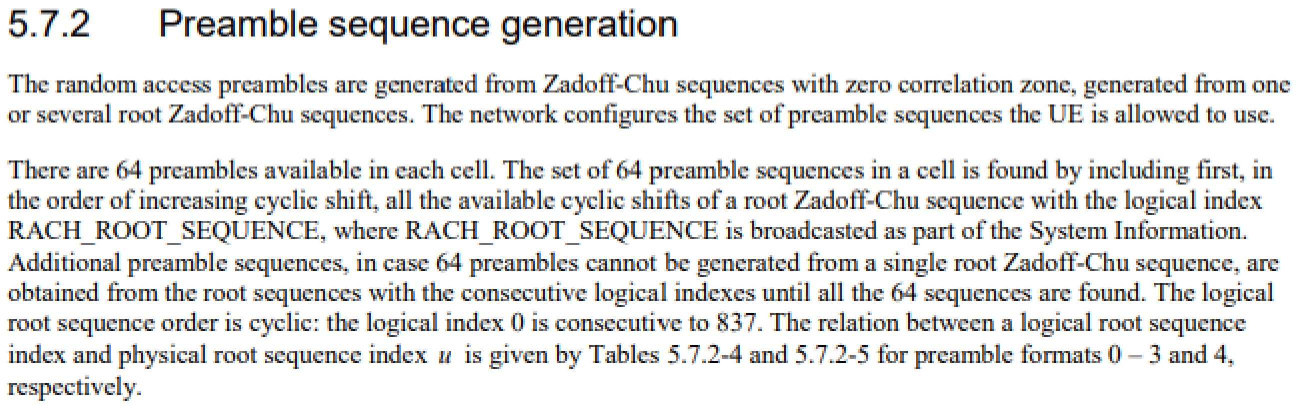
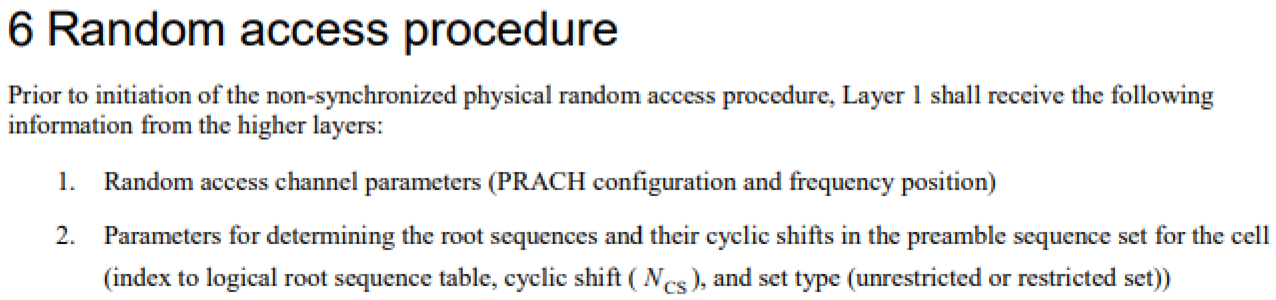


Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 9
“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Honda’s Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

US Patent No. 10,833,908: Claim 9

“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

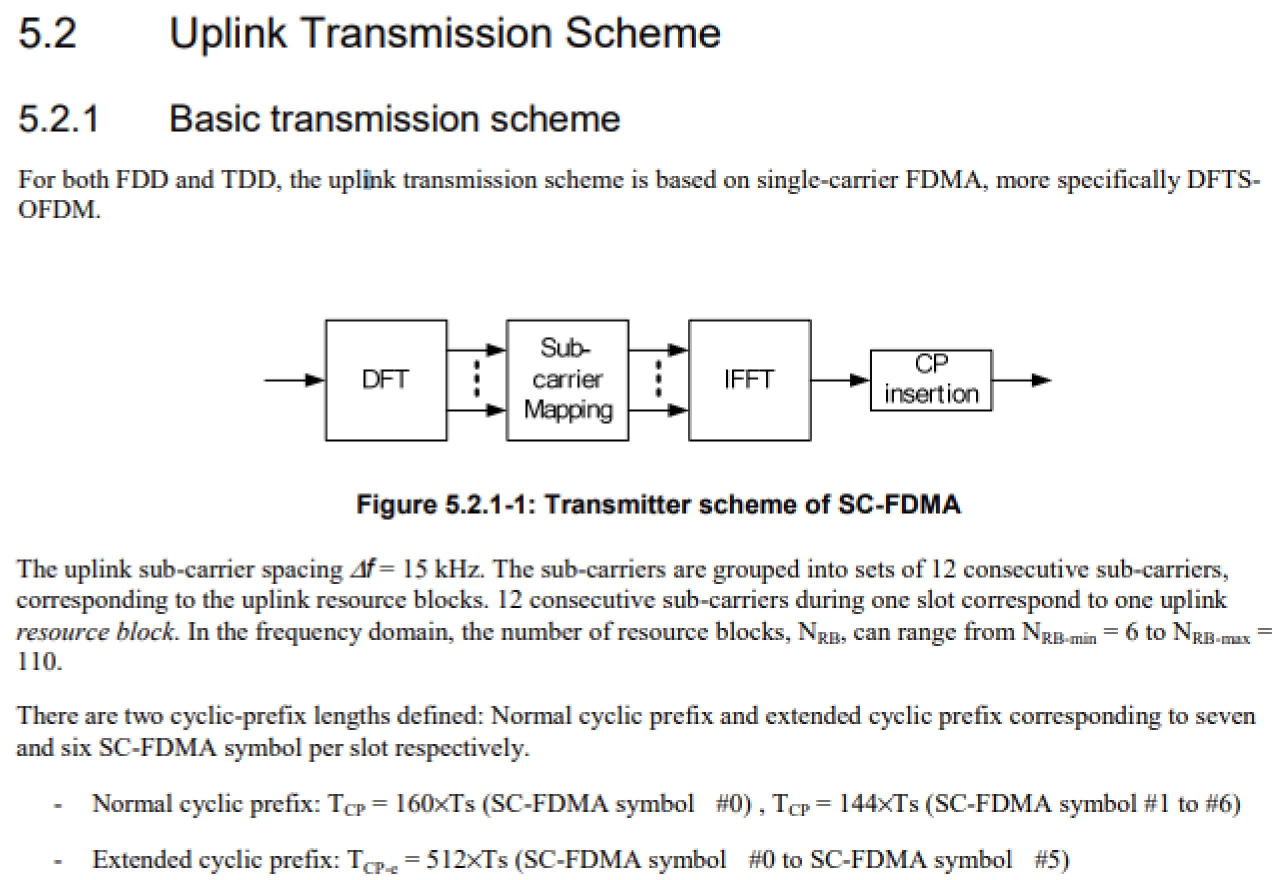
```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

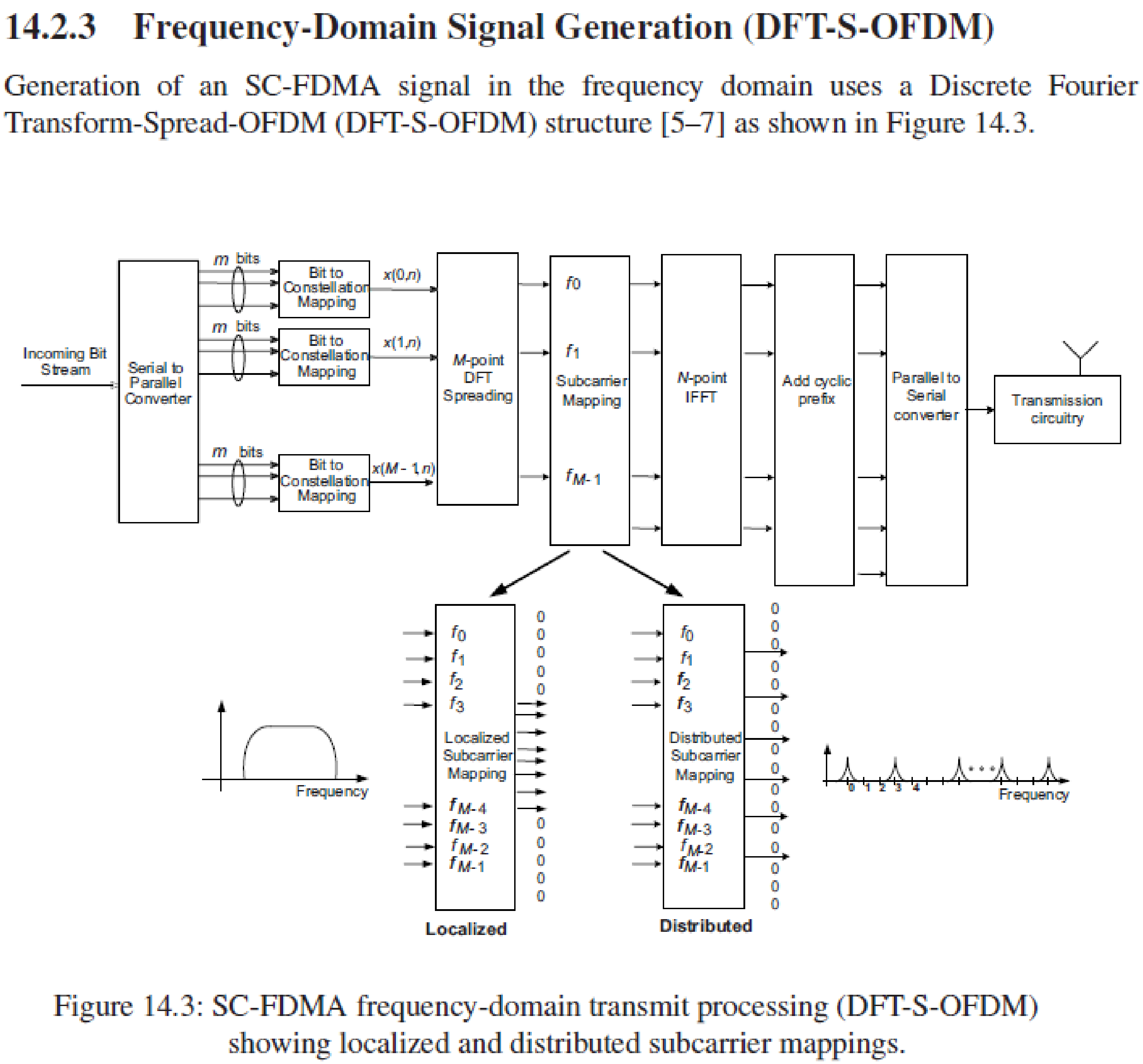
See e.g., 36.331 V8.21.0 at pp. 126-127.

US Patent No. 10,833,908: Claim 10

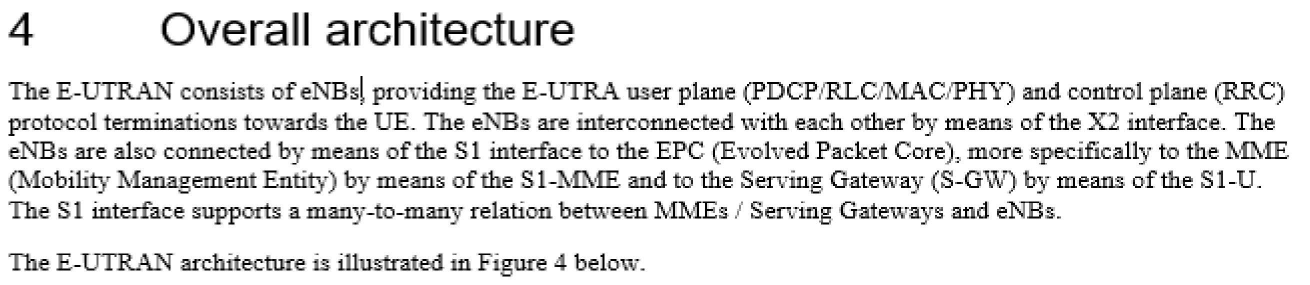
"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 1. Honda's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Honda's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

	 **14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)** Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3. Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, Honda's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* Honda's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Honda offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

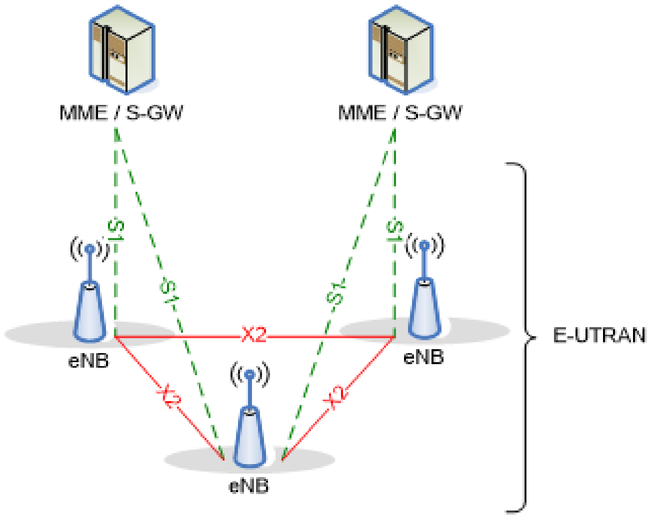


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

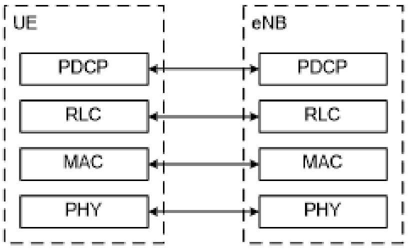
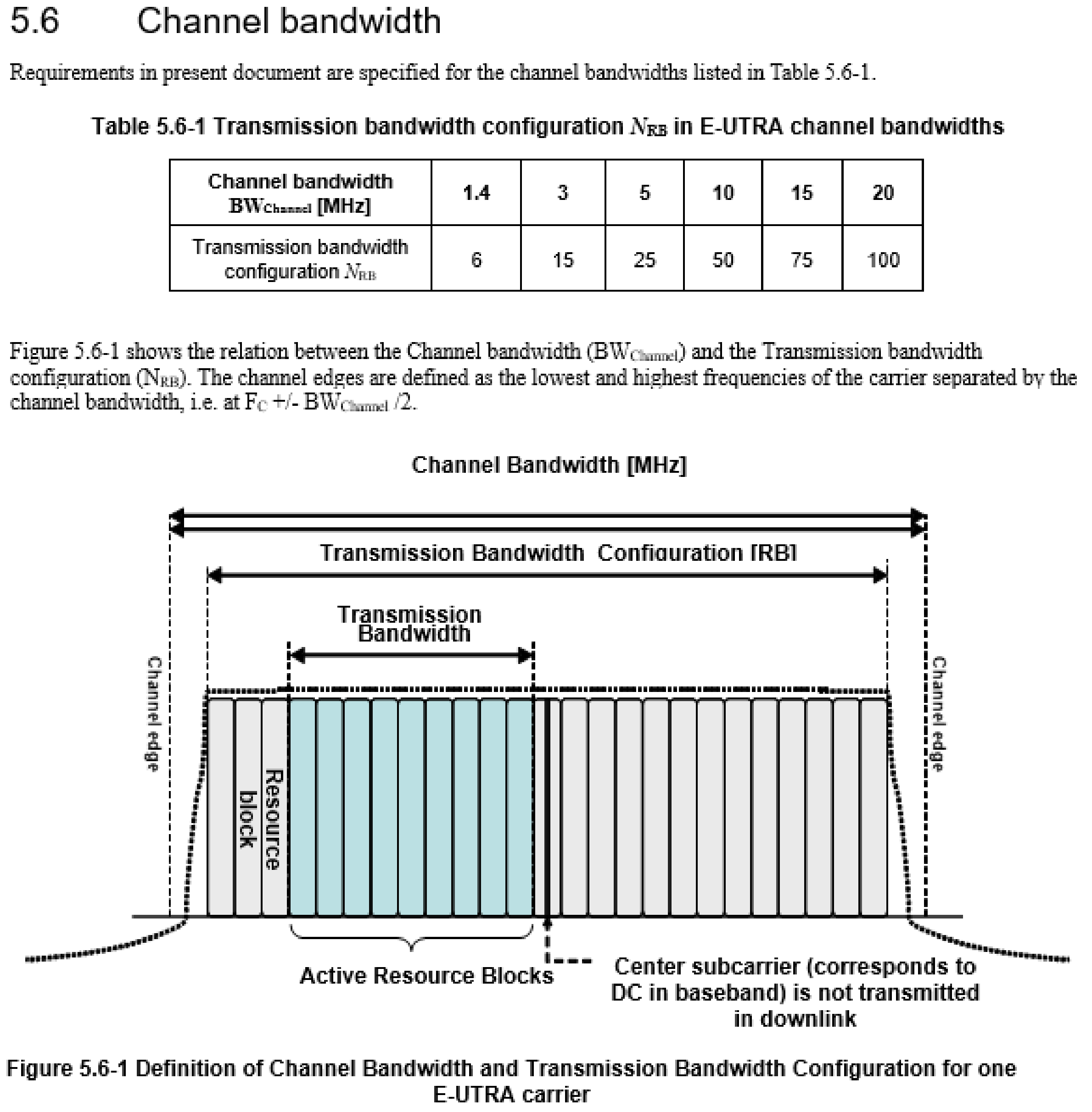


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Honda's Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

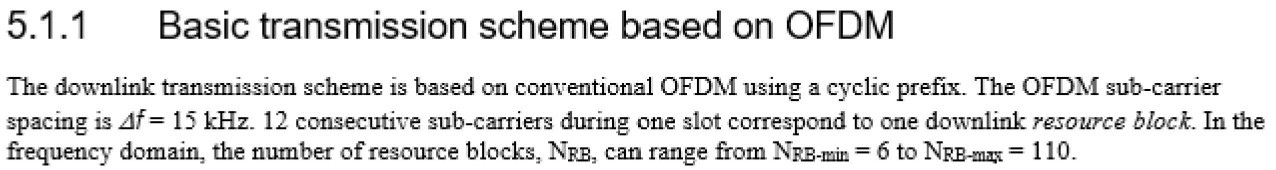
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

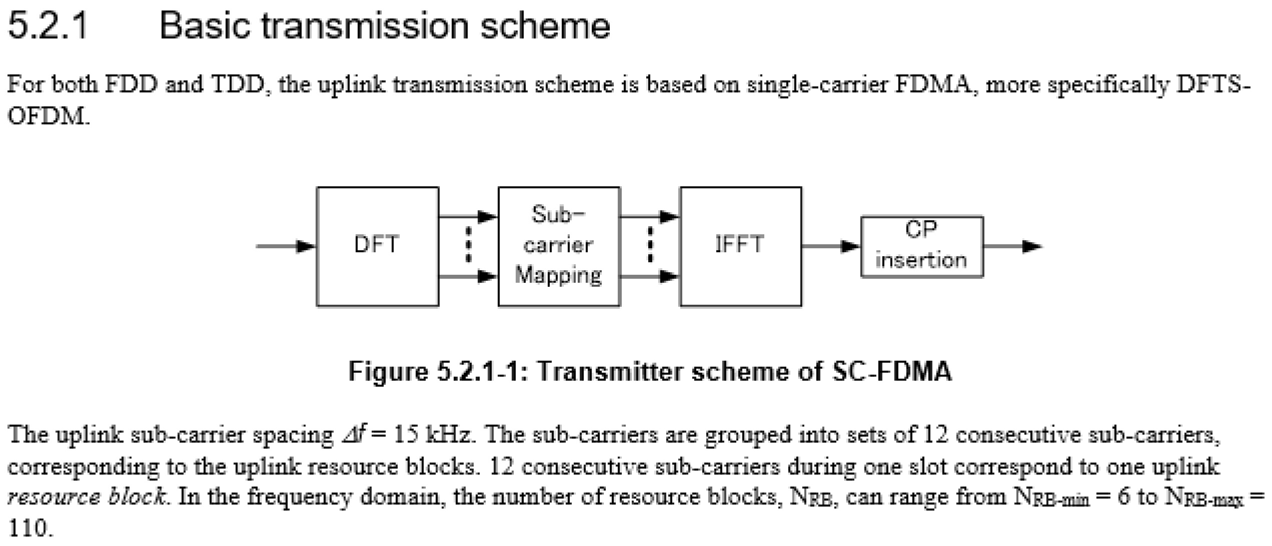
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

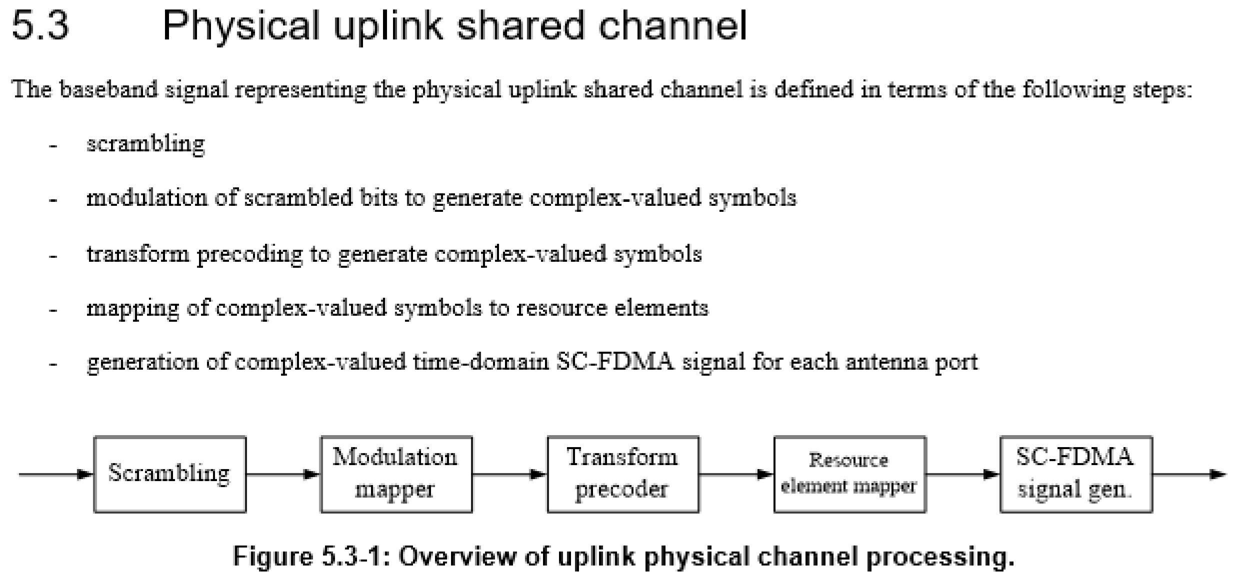
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

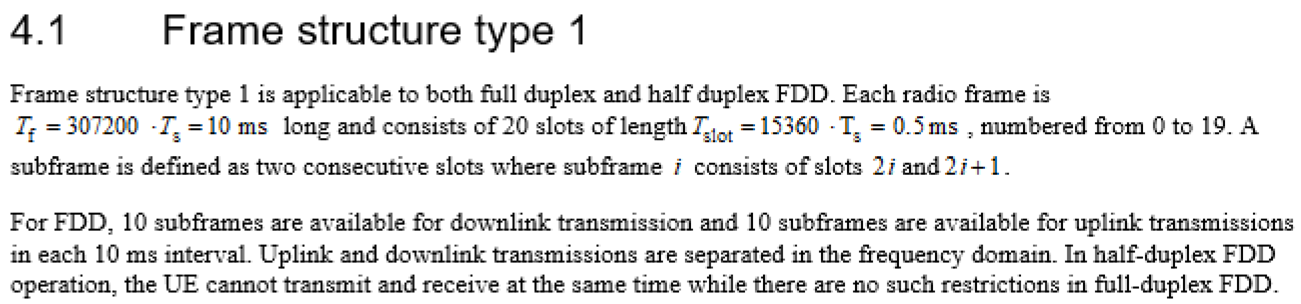
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

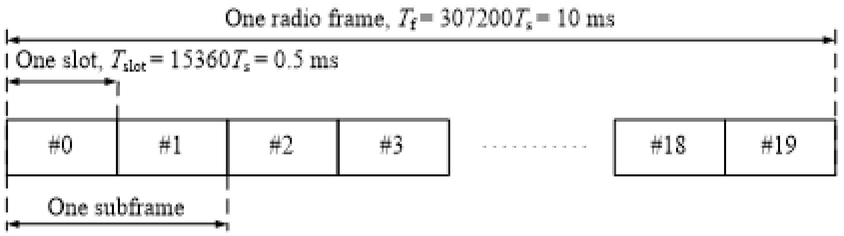
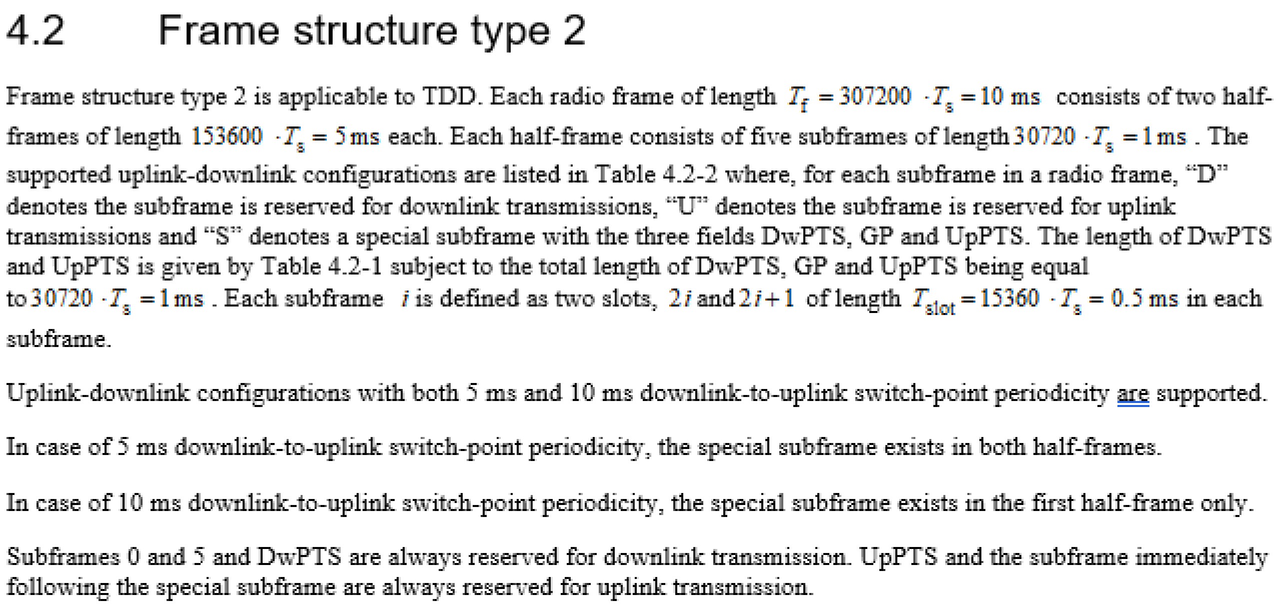


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

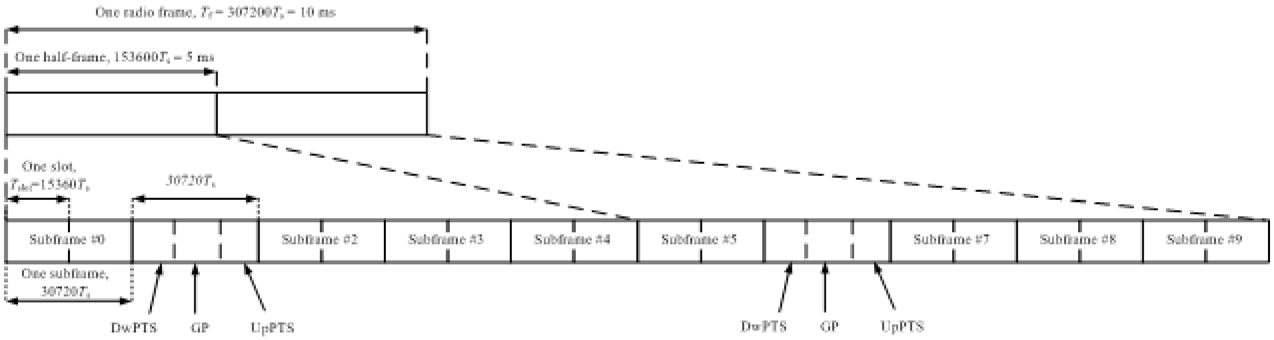
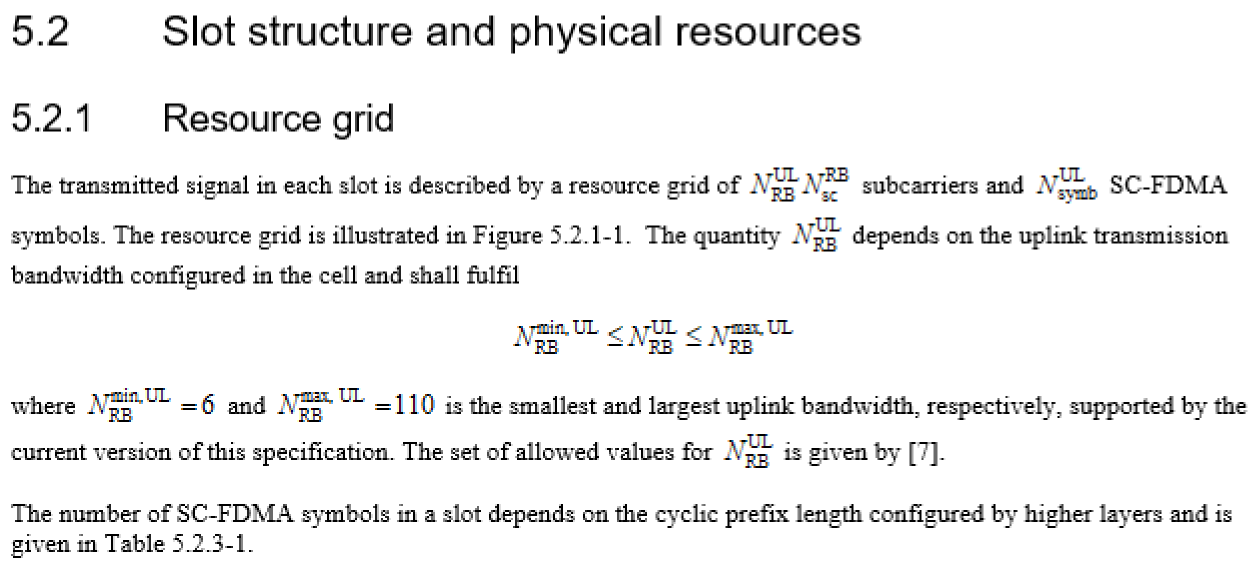


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

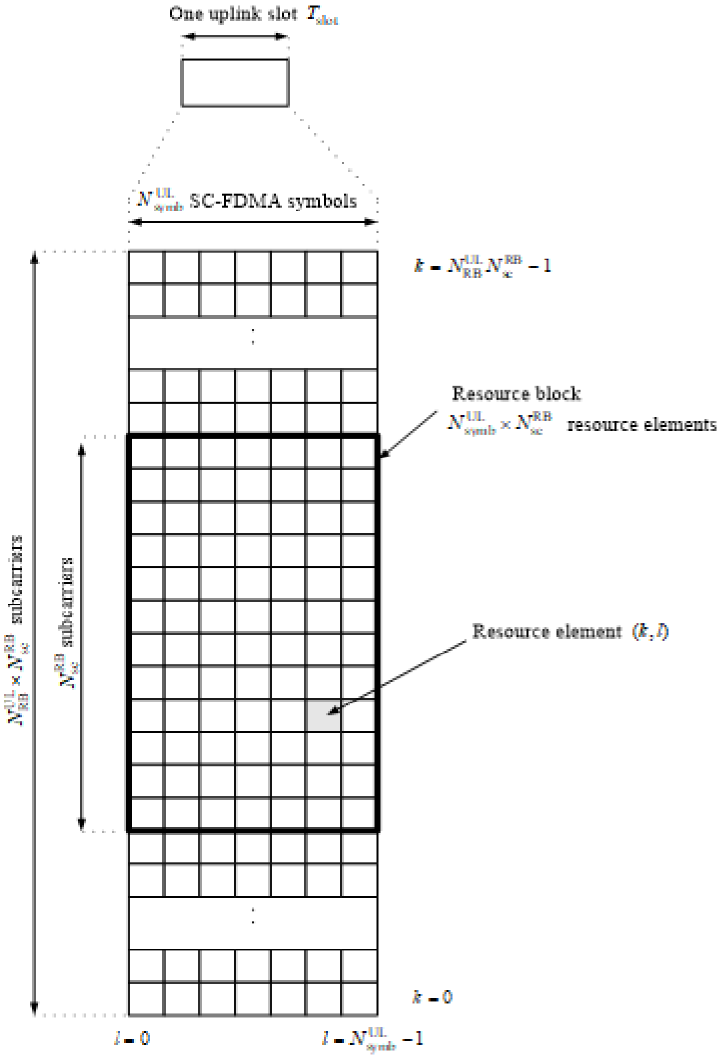
$$N_{\mathrm{RB}}^{\min,\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$$

where $N_{\mathrm{RB}}^{\min,\mathrm{UL}} = 6$ and $N_{\mathrm{RB}}^{\max,\mathrm{UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

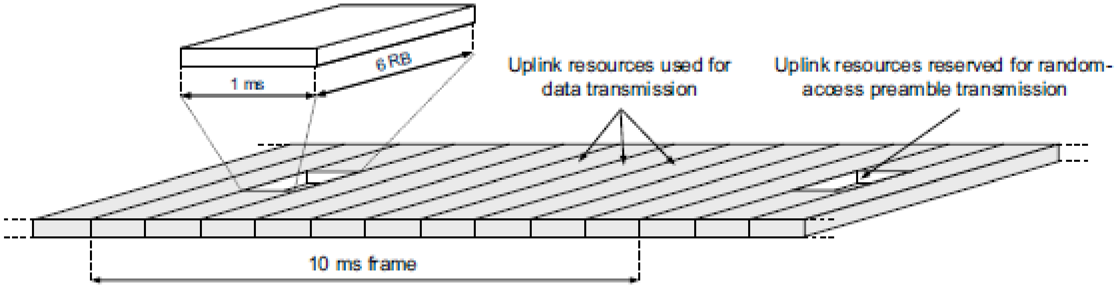
The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

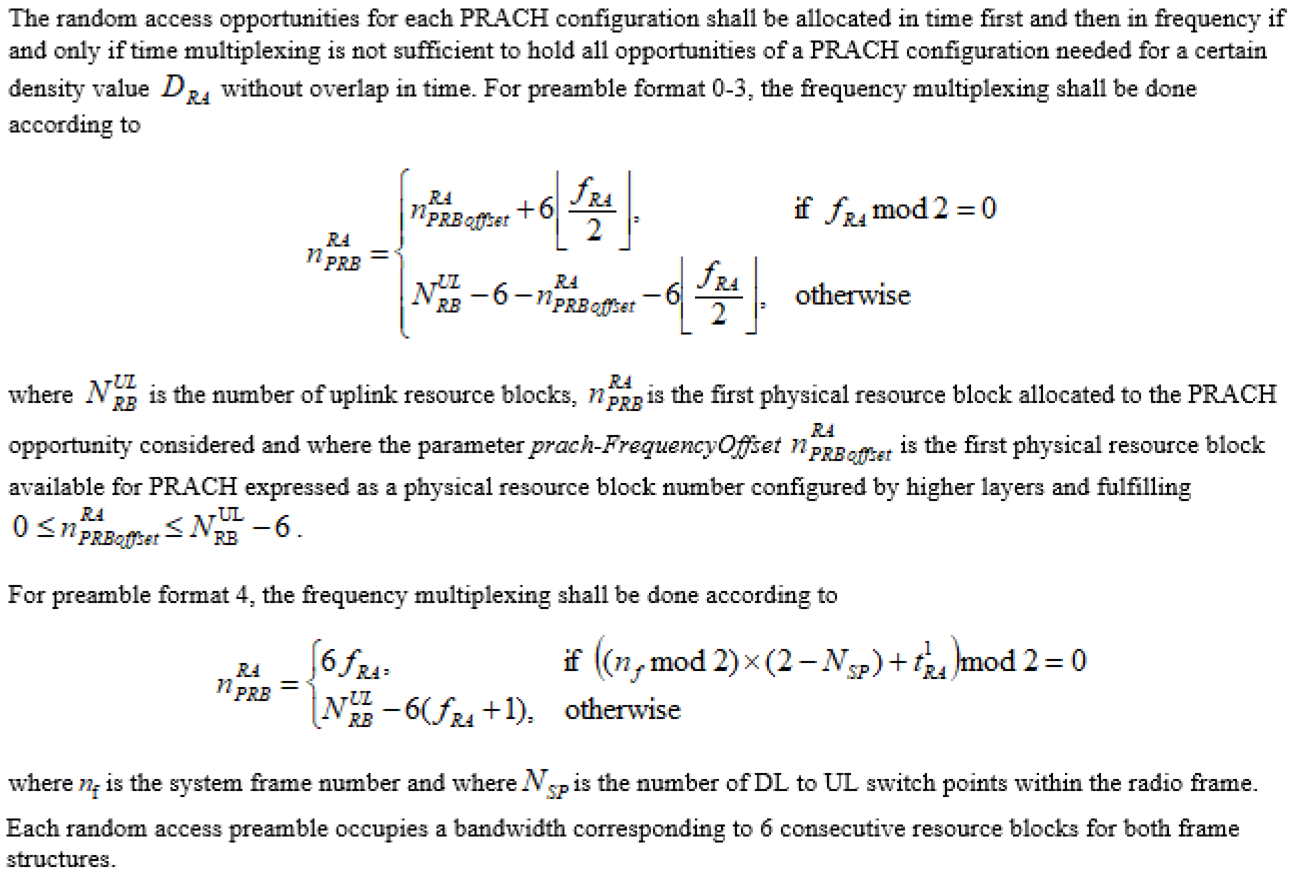
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)

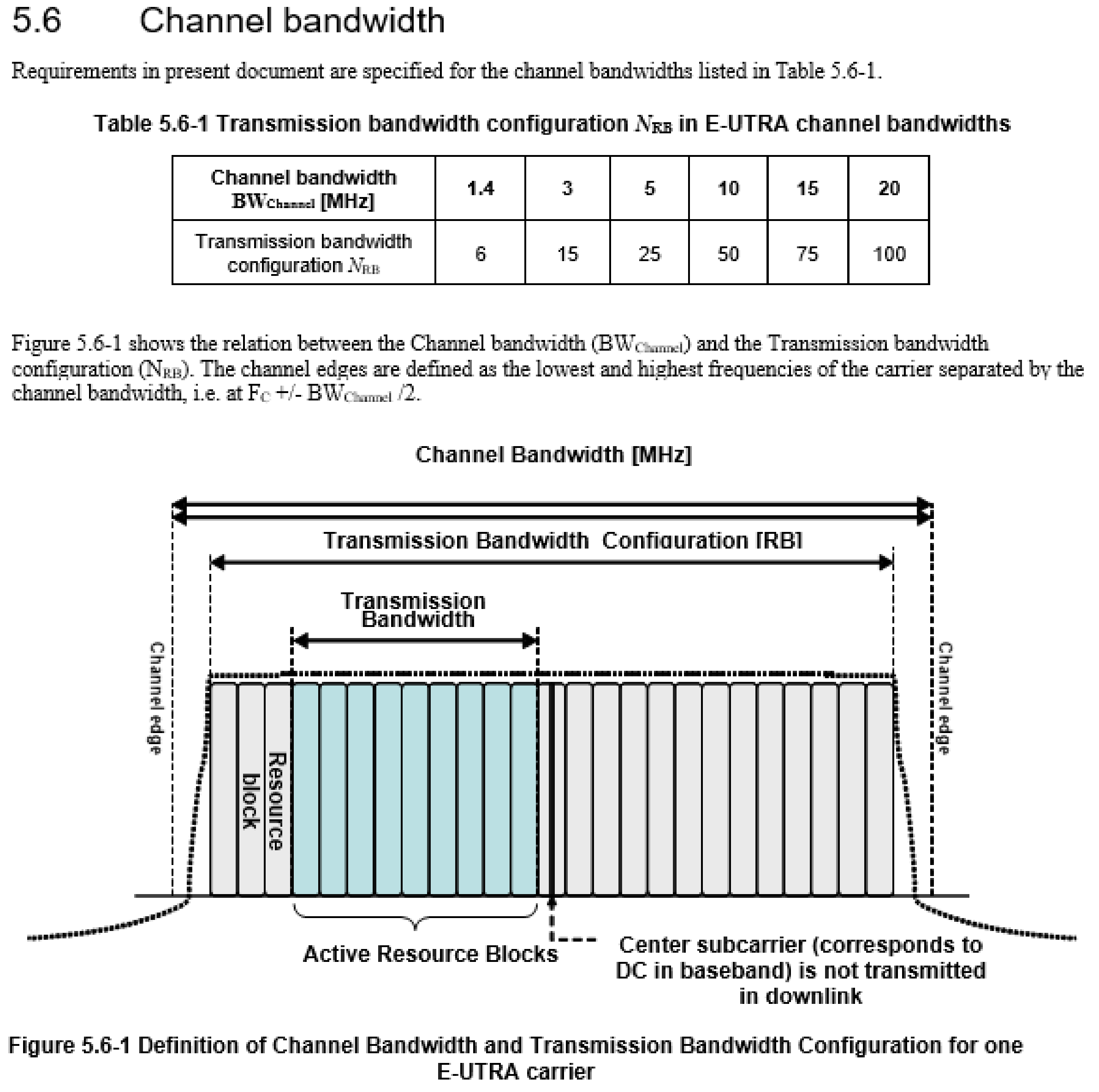
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	Honda's Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA}=\begin{cases} n_{PRBoffset}^{RA}+6\left\lfloor \frac{f_{RA}}{2}\right\rfloor, & \text{if } f_{RA} \bmod 2=0 \\ N_{RB}^{UL}-6-n_{PRBoffset}^{RA}-6\left\lfloor \frac{f_{RA}}{2}\right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}}-6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA}=\begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2=0 \\ N_{RB}^{UL}-6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

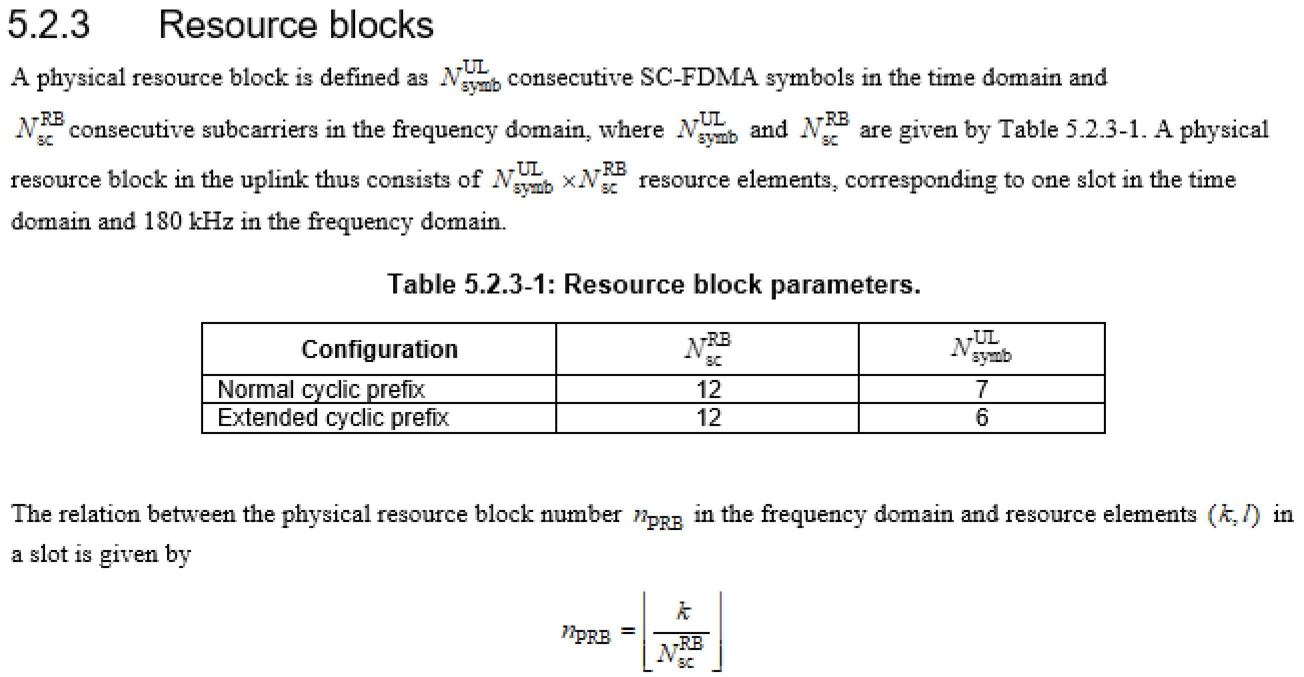
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

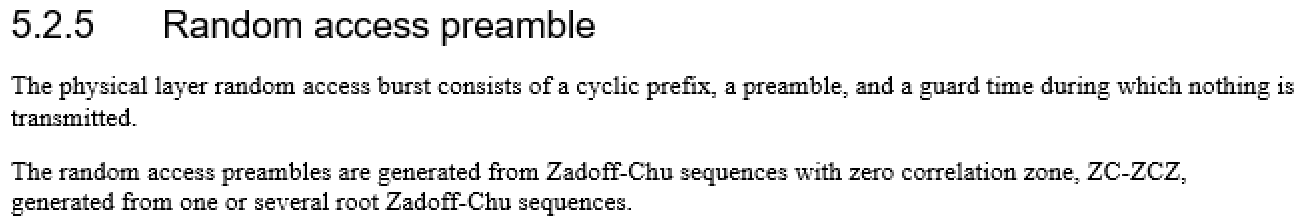
Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\mathrm{PRB}} = \left\lfloor \frac{k}{N_{\mathrm{sc}}^{\mathrm{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

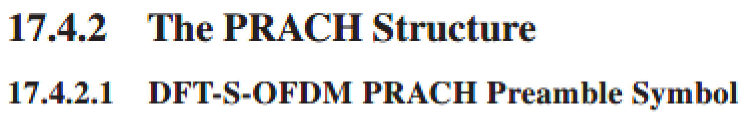


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

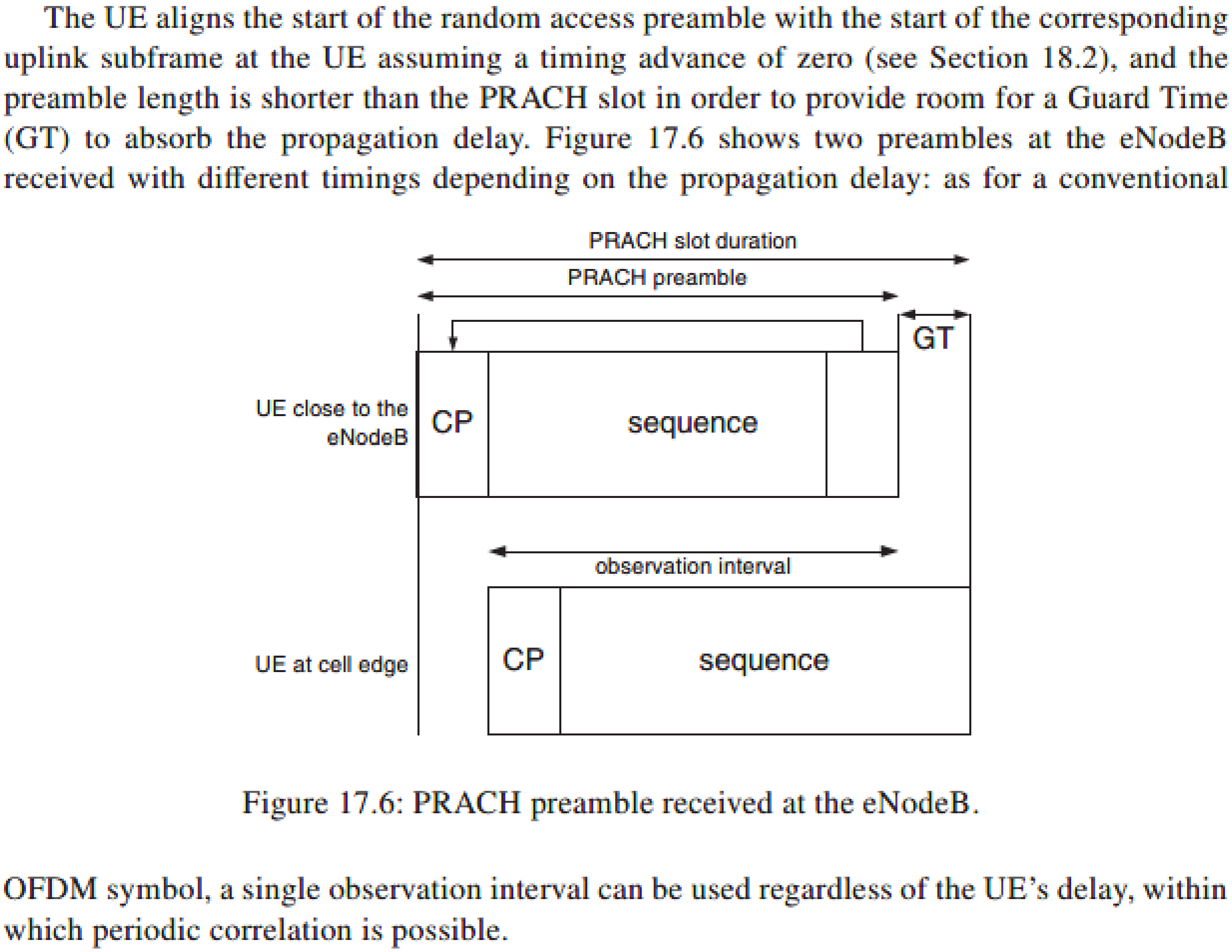


17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional

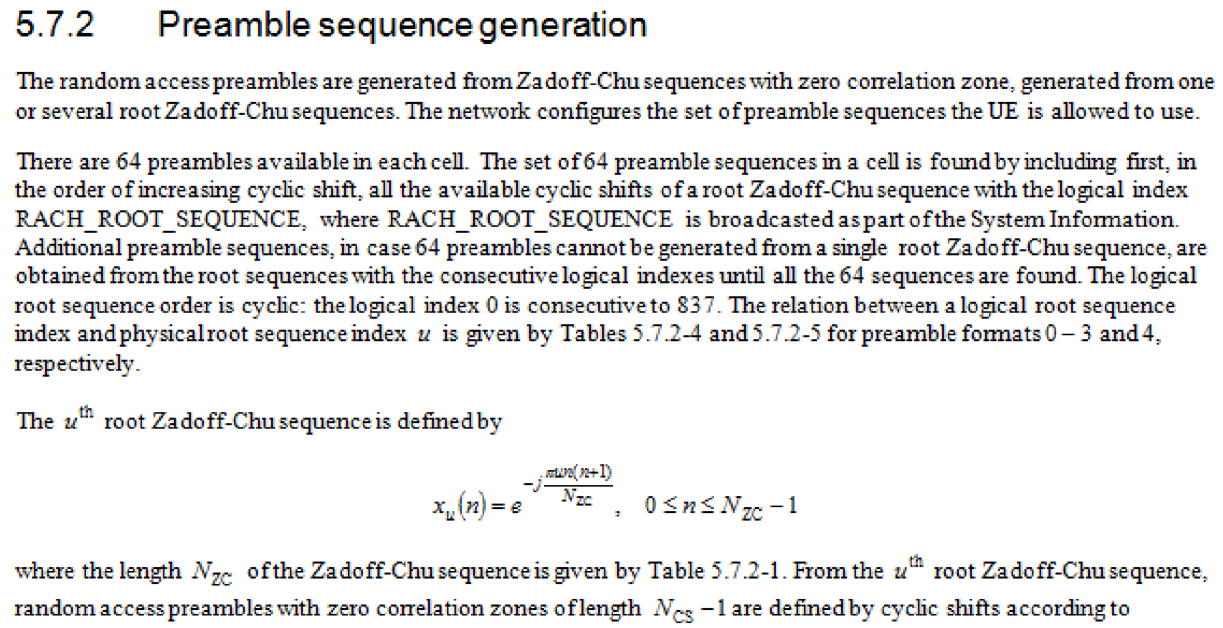
Figure 17.6: PRACH preamble received at the eNodeB.

OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378.

The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

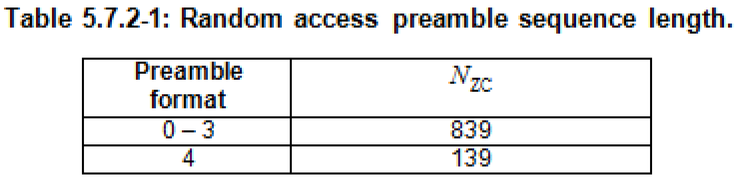
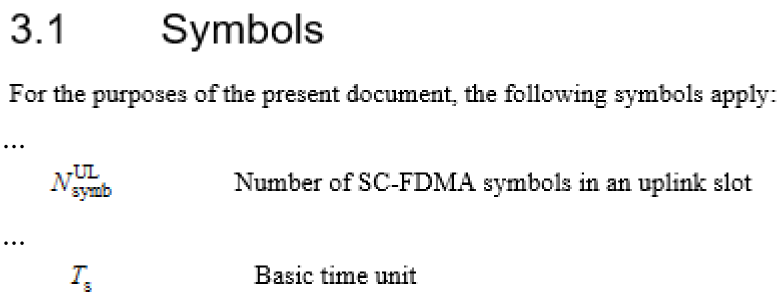
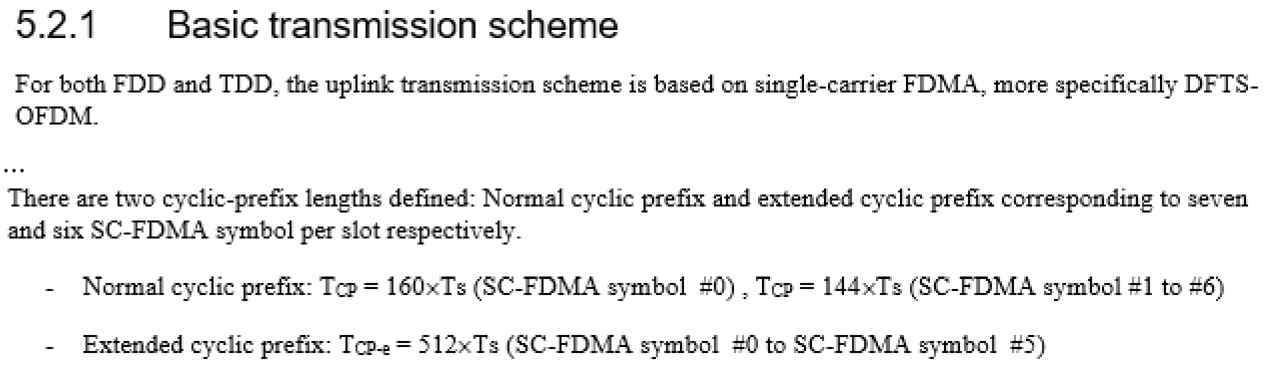


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Honda’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)

"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

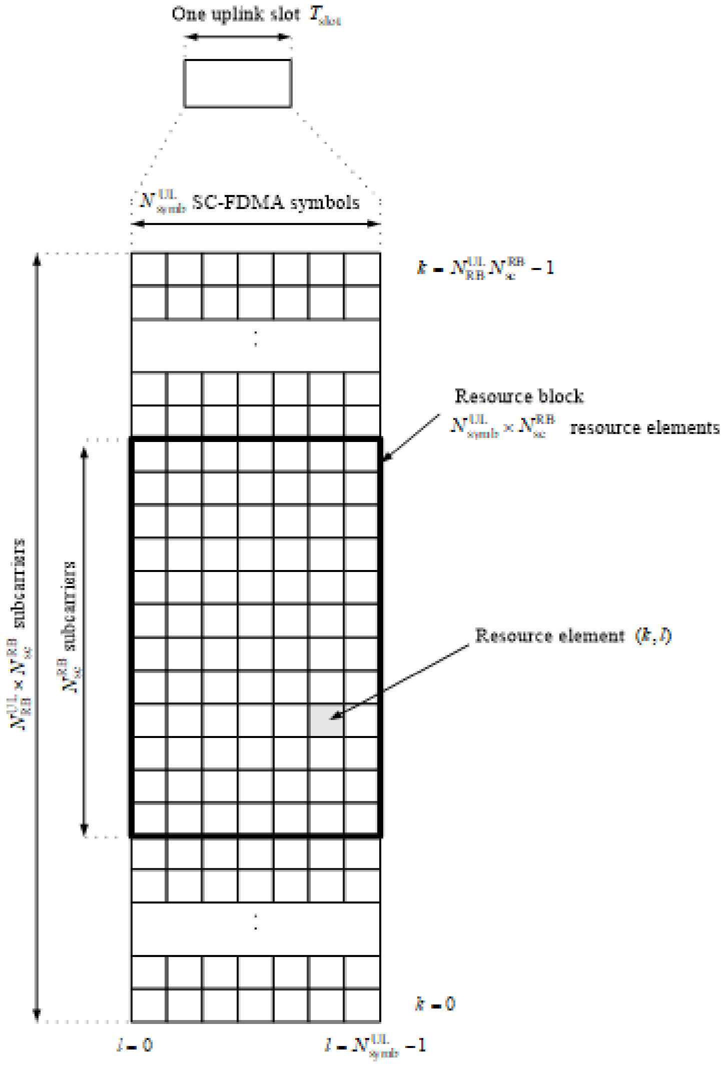
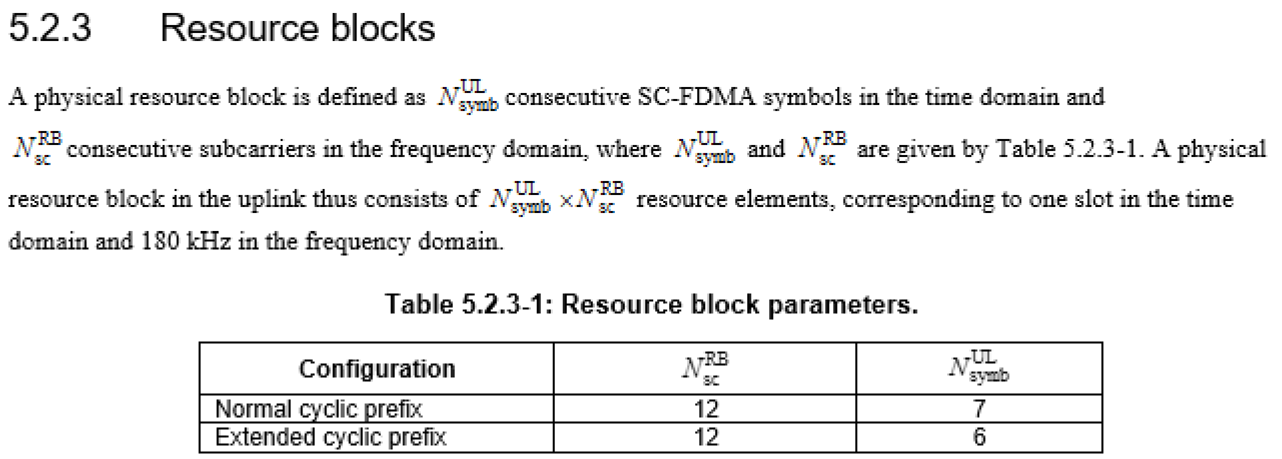


Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

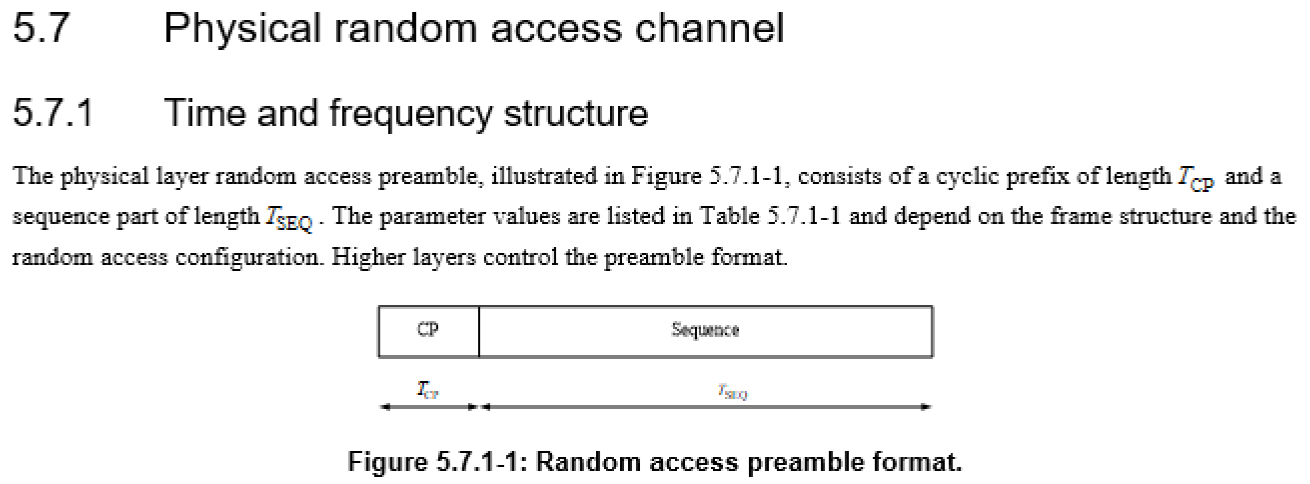
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

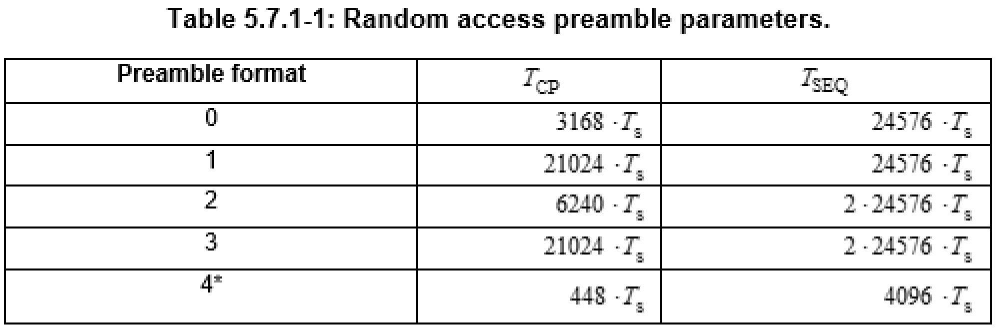
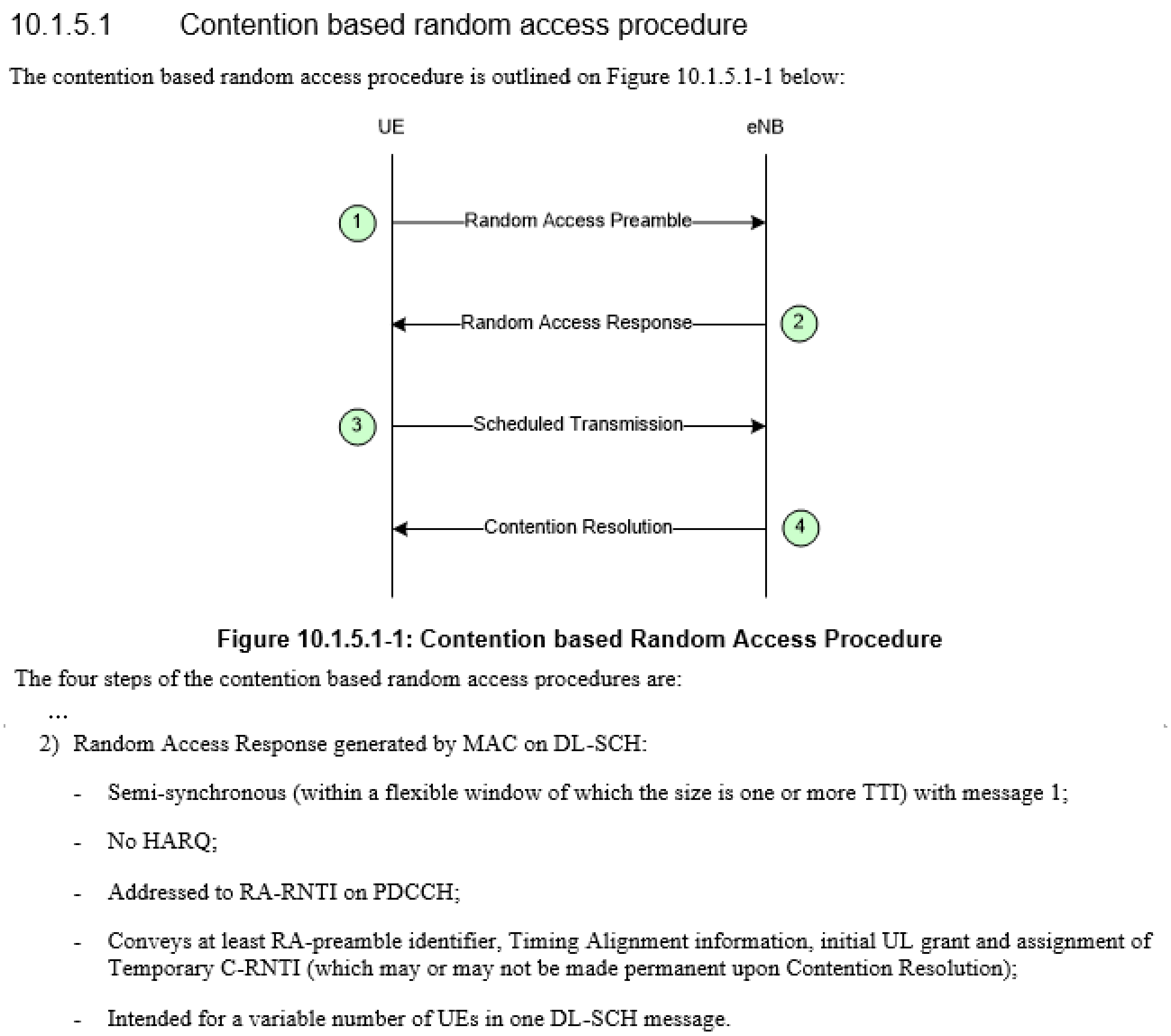


Table 5.7.1-1: Random access preamble parameters.

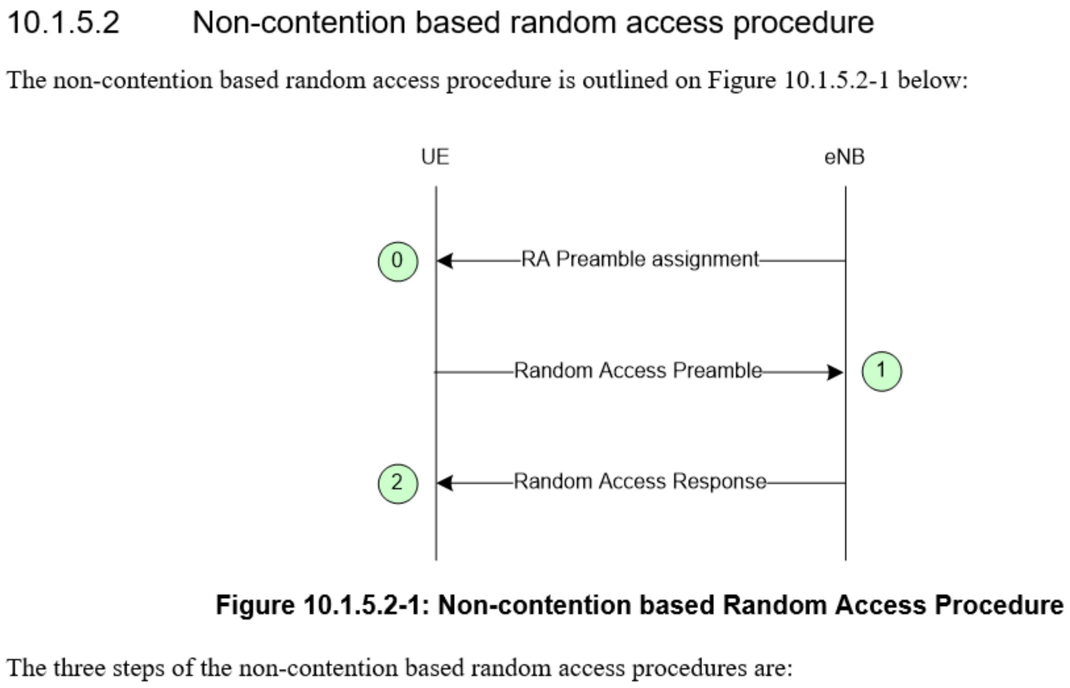
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

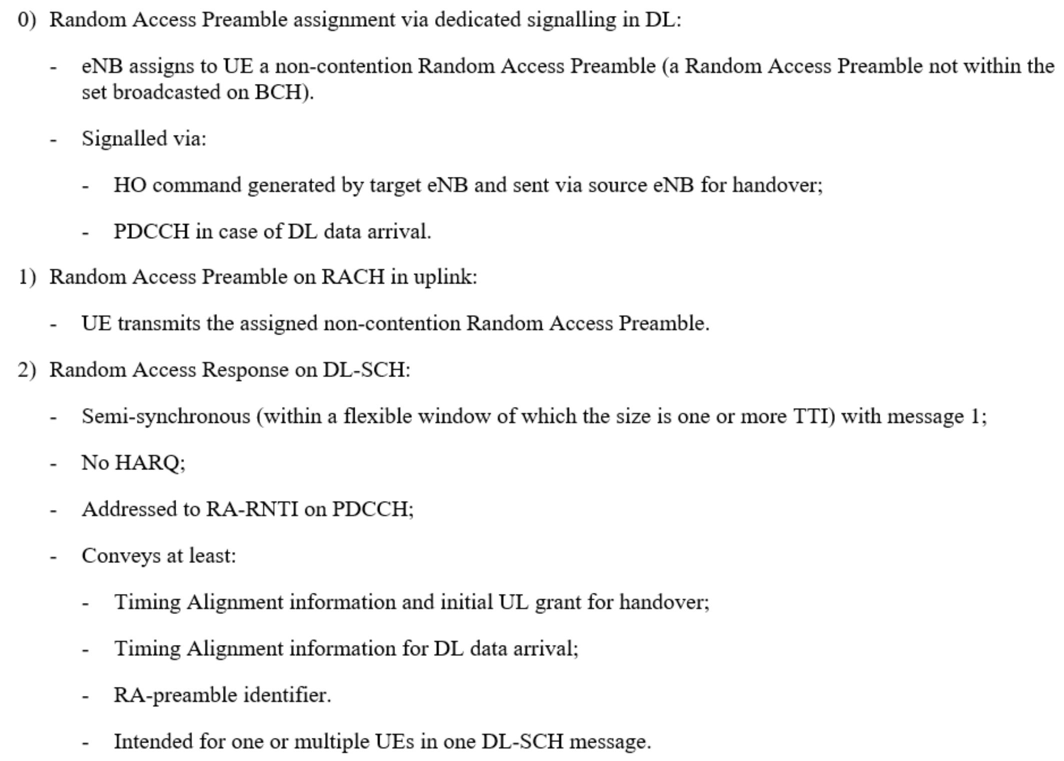
US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

receiving, from the base station, a response message. ;	Honda's Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

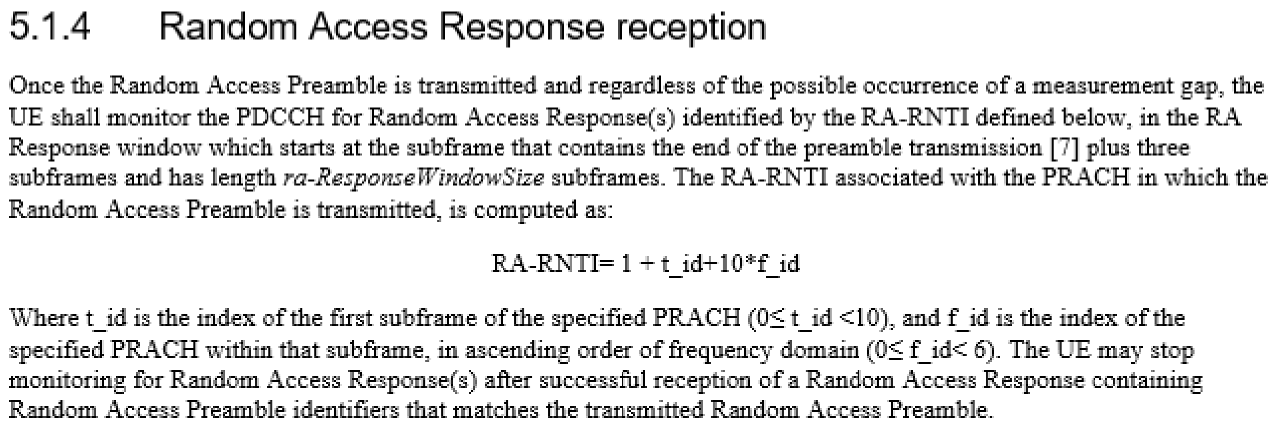
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



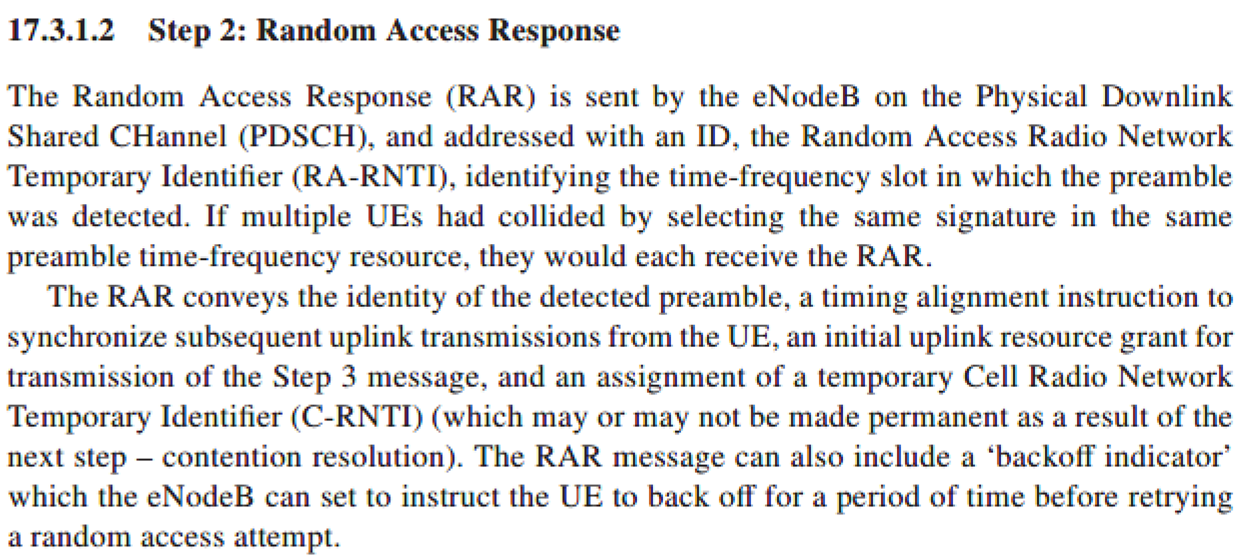
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

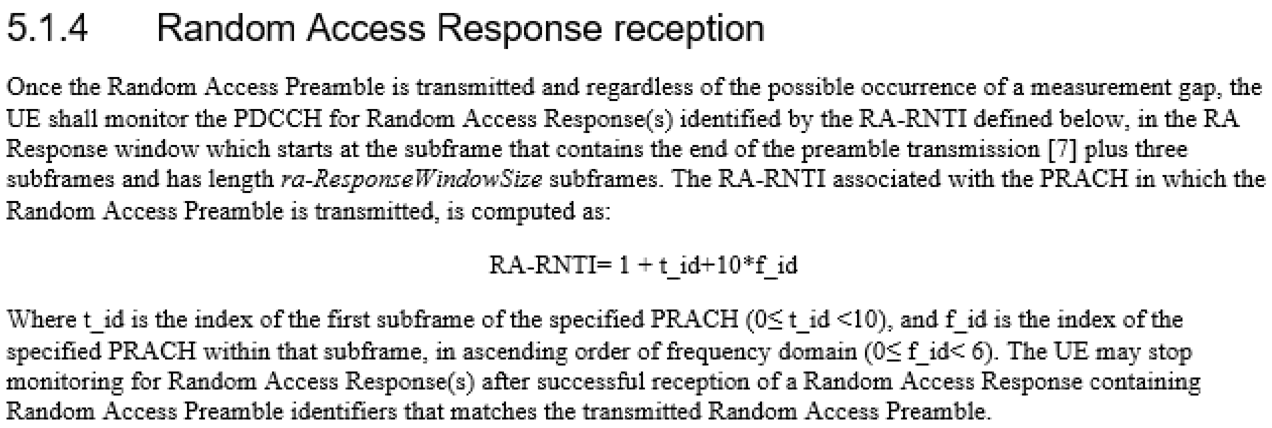
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

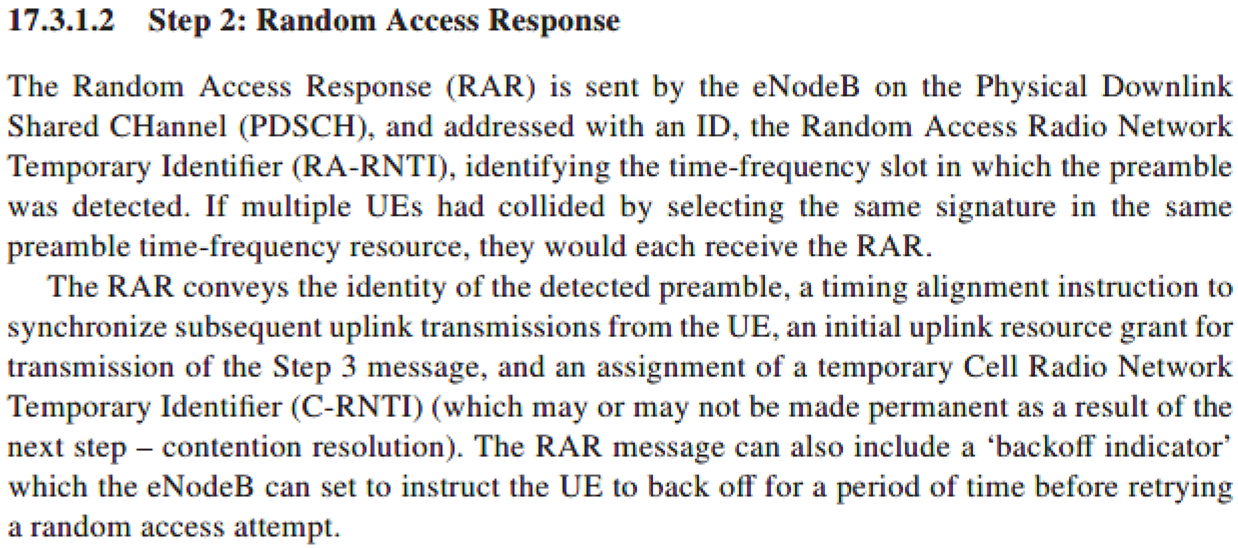
US Patent No. 10,833,908: Claim 12(a)
"The method claim 11, further comprising:"

12. The method claim 11, further comprising:	*See* Claim 11.

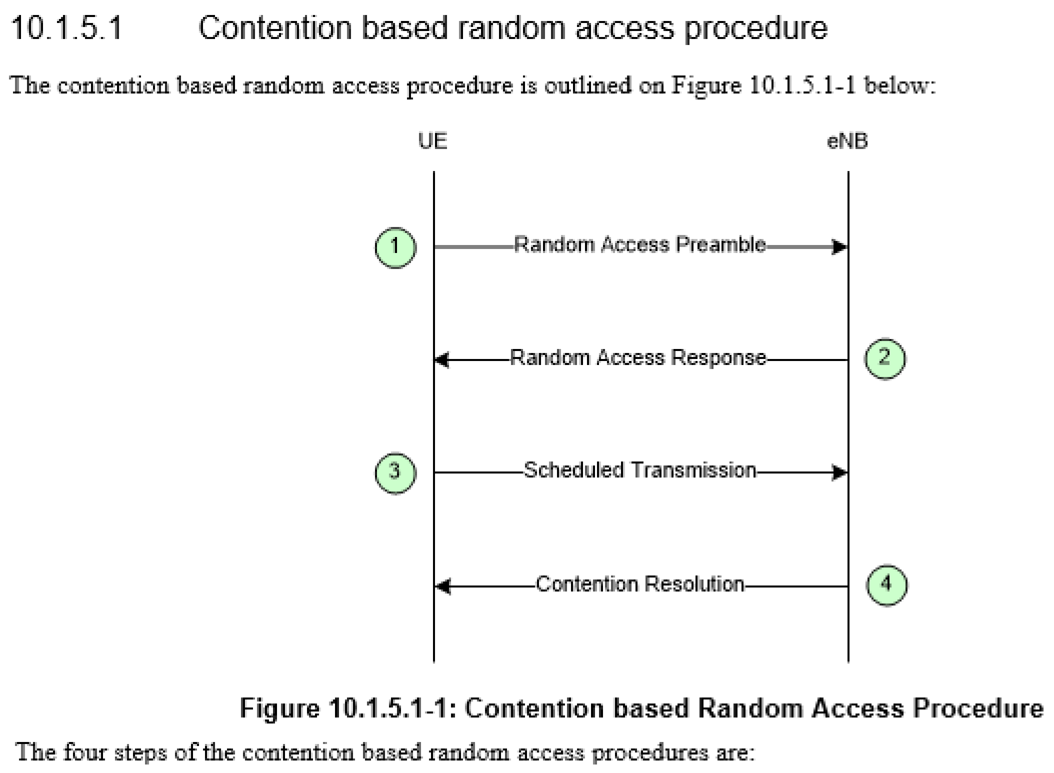
US Patent No. 10,833,908: Claim 12(b)
"determining if the response message identifies the sequence associated with the base station in the random access signal; and"

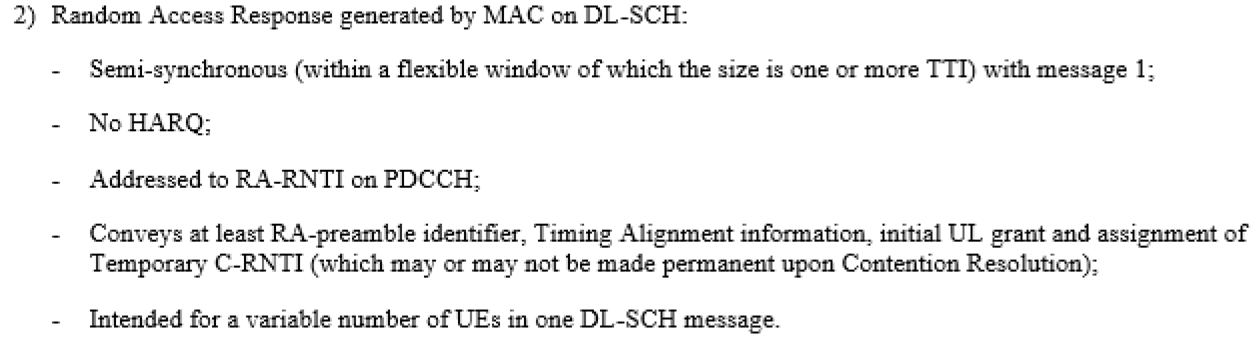
determining if the response message identifies the sequence associated with the base station in the random access signal; and	Honda's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $RA\text{-}RNTI = 1 + t\_id + 10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Honda's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

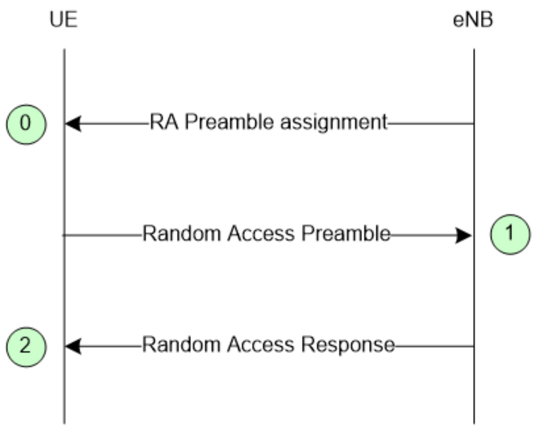
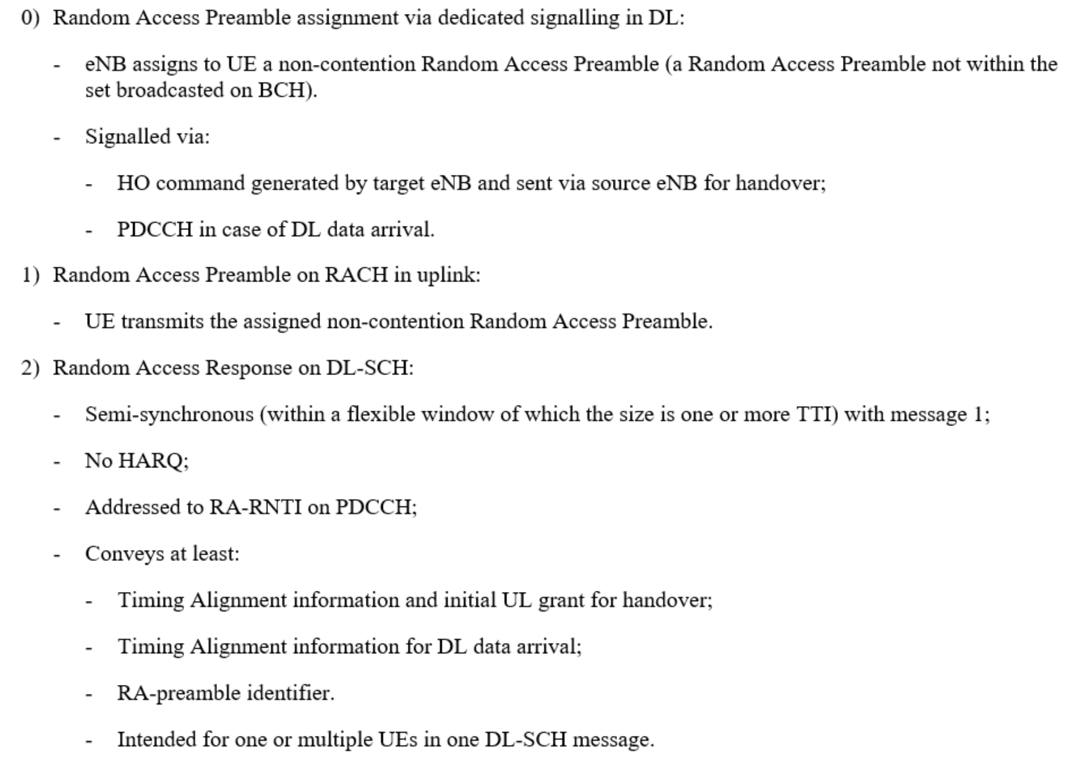


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

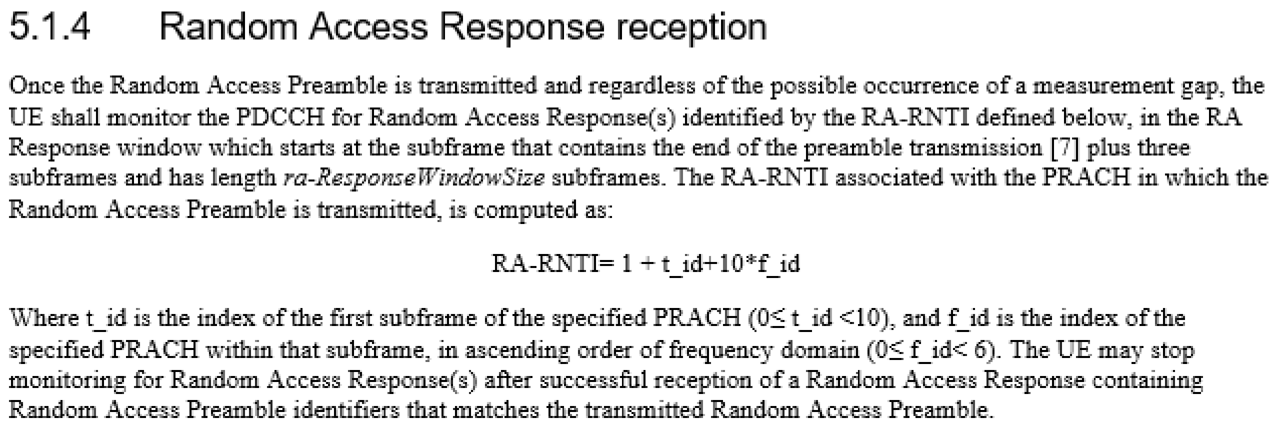
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



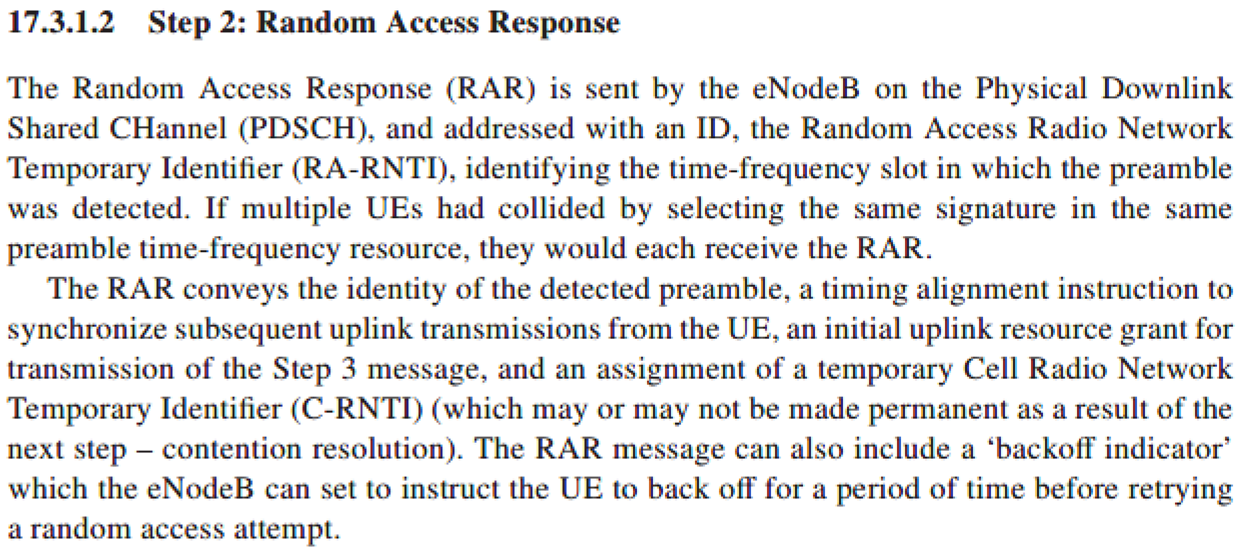
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

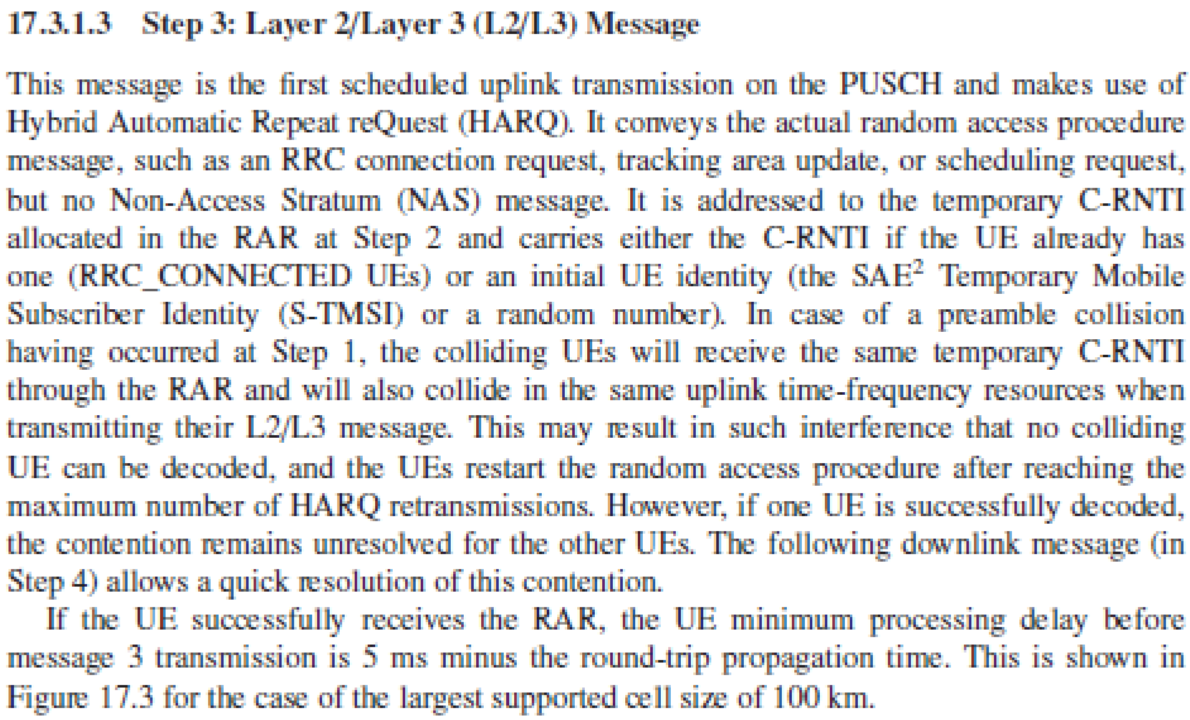
$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message

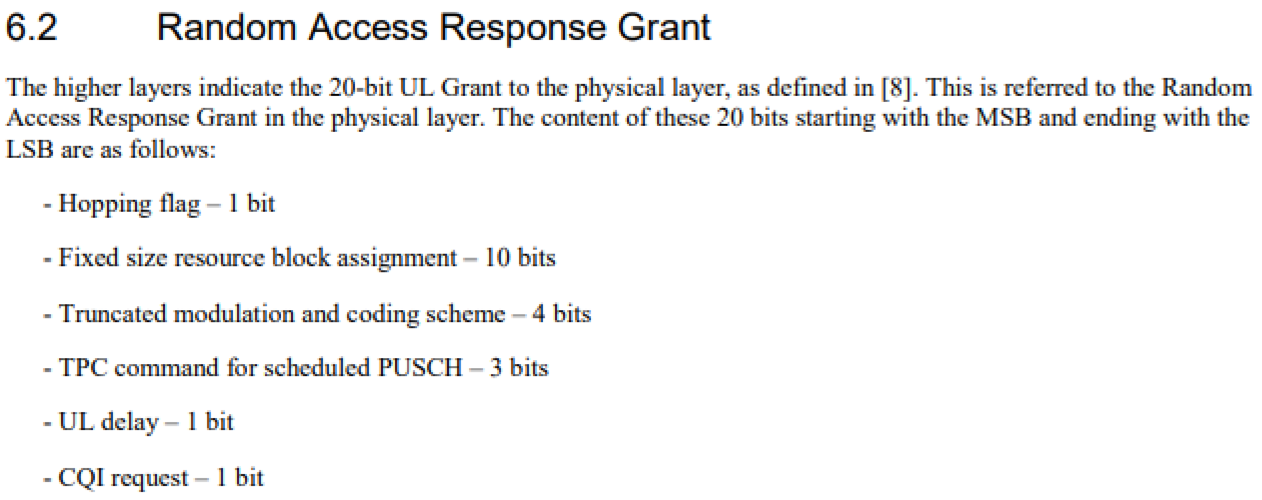
This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention.

If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km.

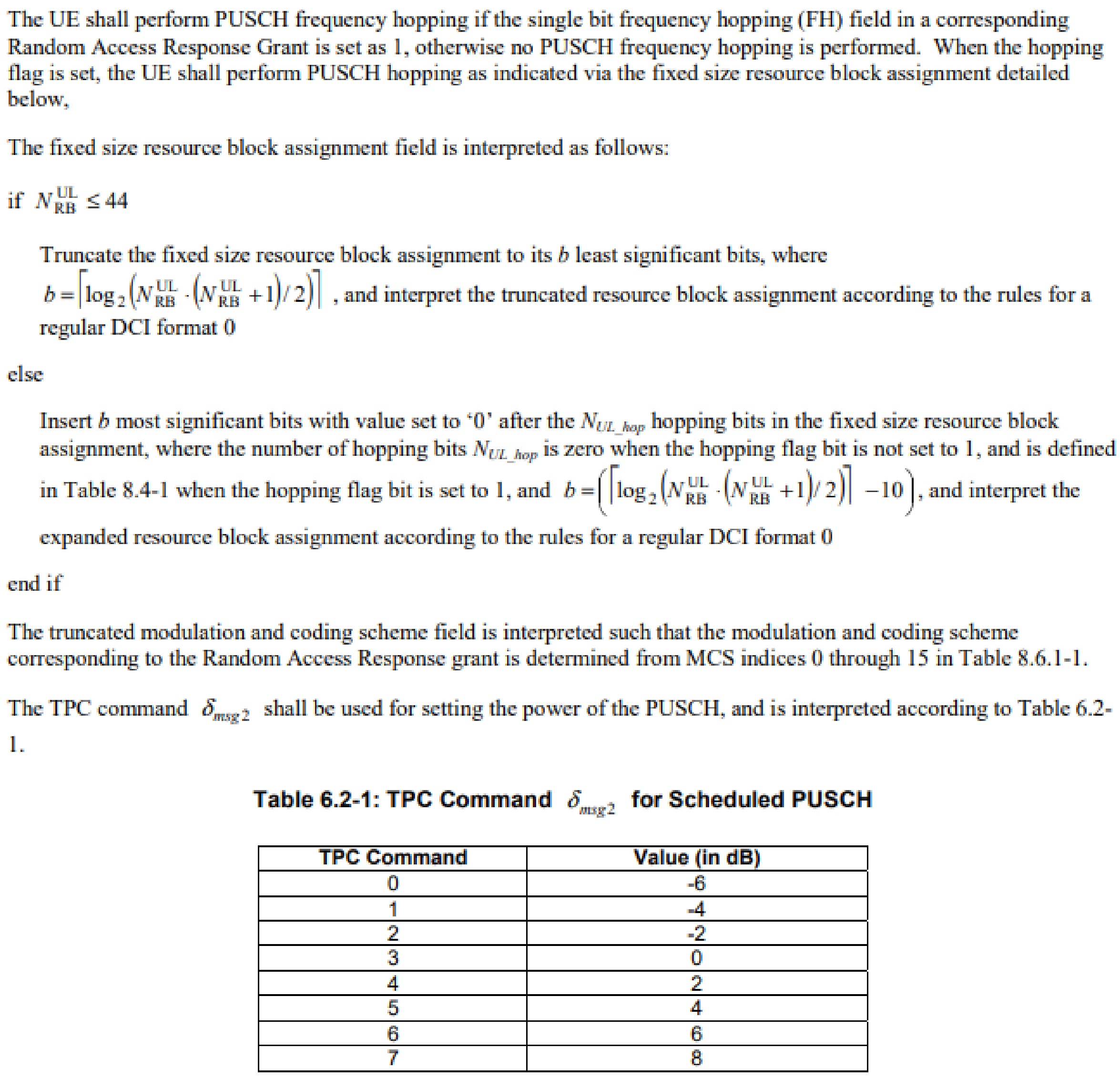
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

See also Claim 2.

US Patent No. 10,833,908: Claim 13(a)
“The method of claim 12, wherein the response message includes power adjustment information and”

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by Honda’s Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)
“The method of claim 12, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

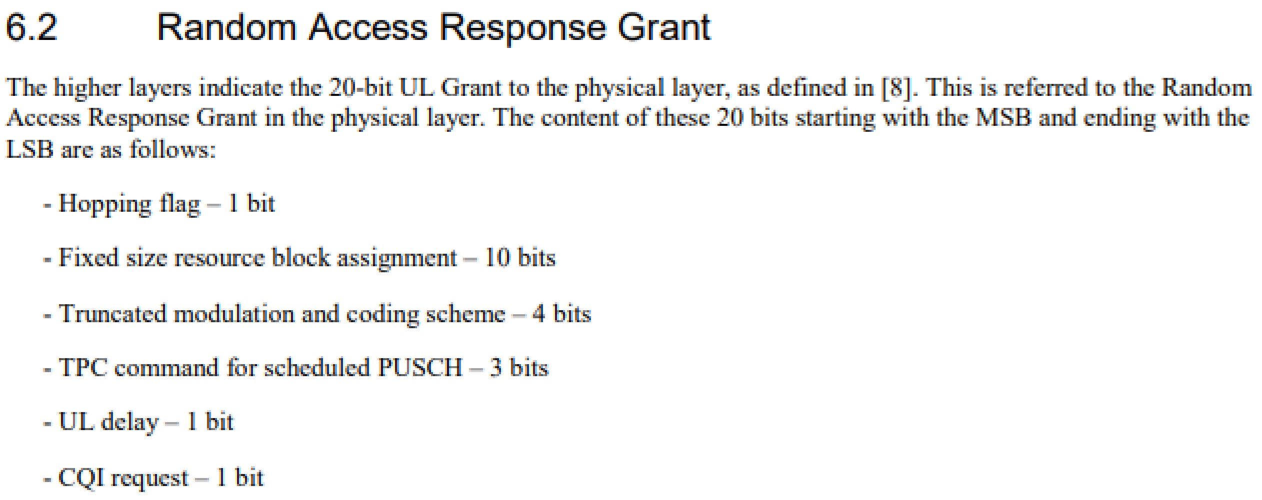
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

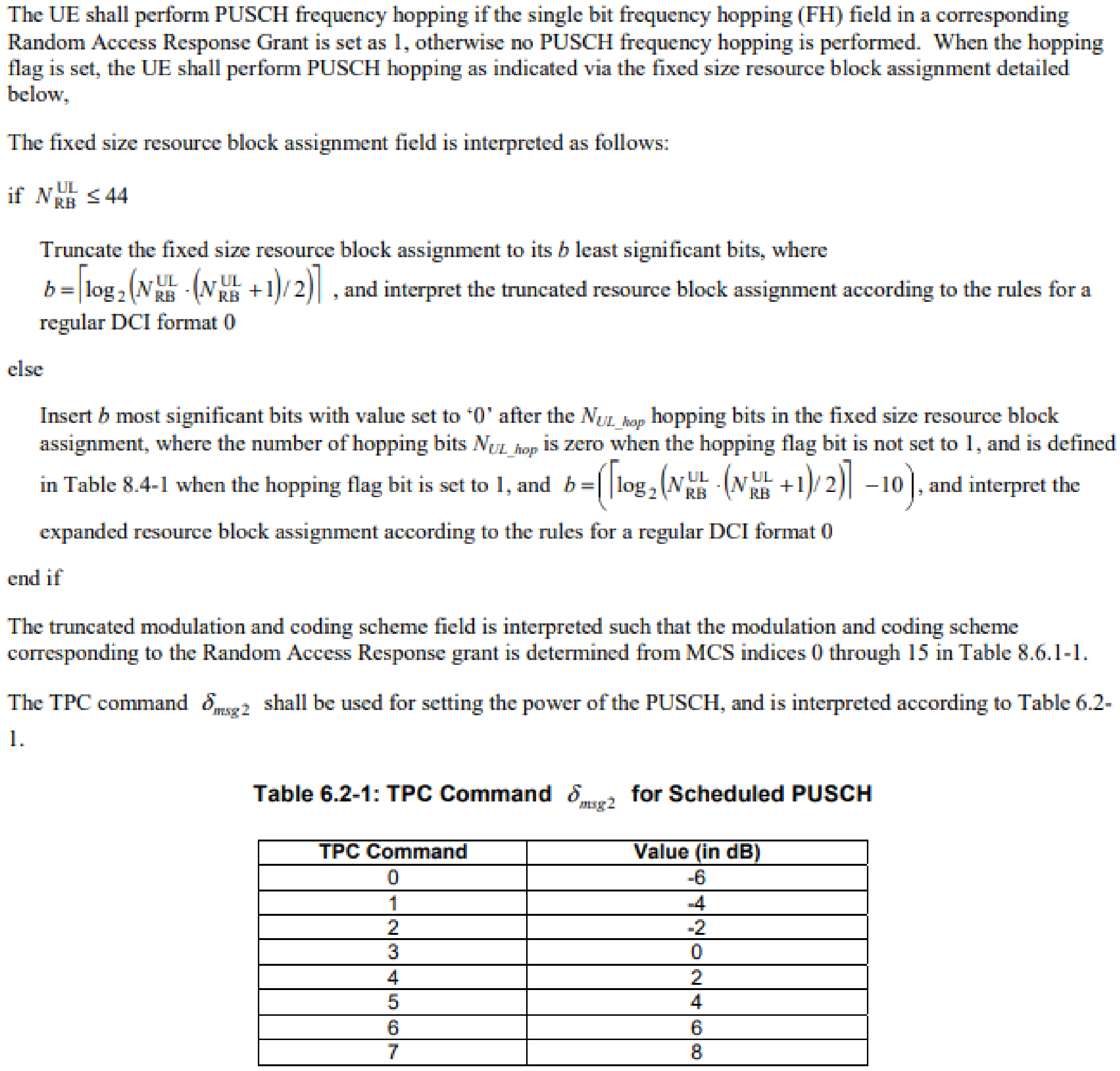
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the second uplink signal is transmitted according to the power adjustment information.	Honda's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

<table>
<tr>
<td>14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.</td>
<td>

The portion of the frequency band used for transmission of the random access signal by Honda's Accused Instrumentalities does not include control channels. *E.g.,*

See Claim 11.

The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.

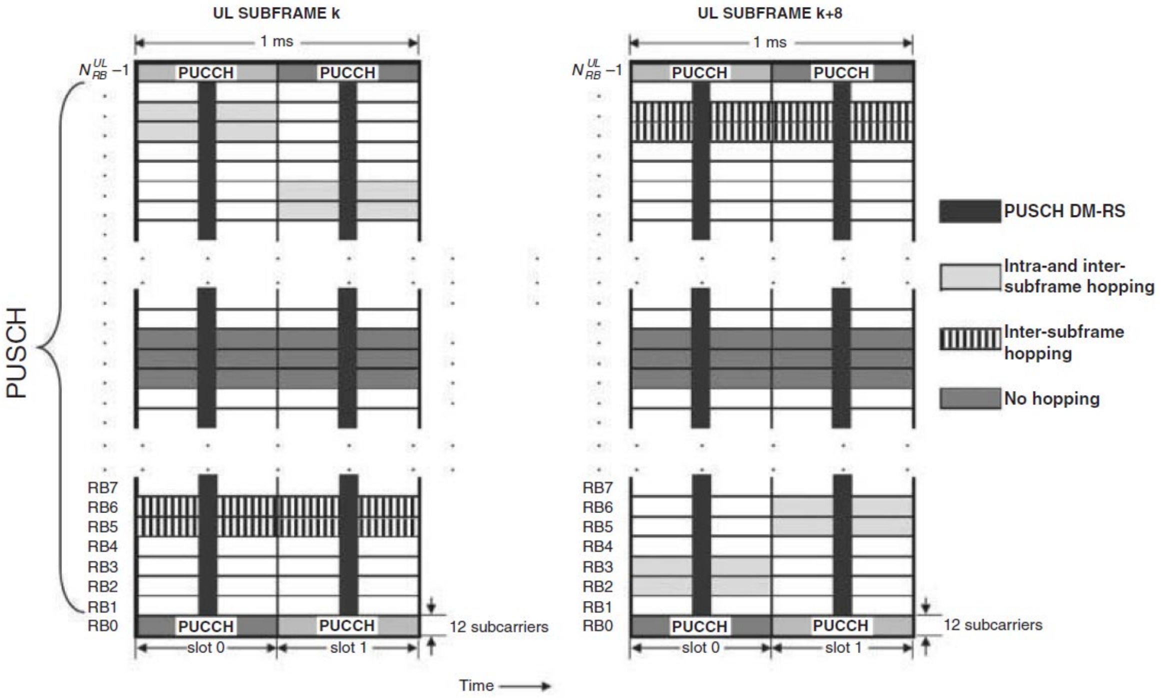


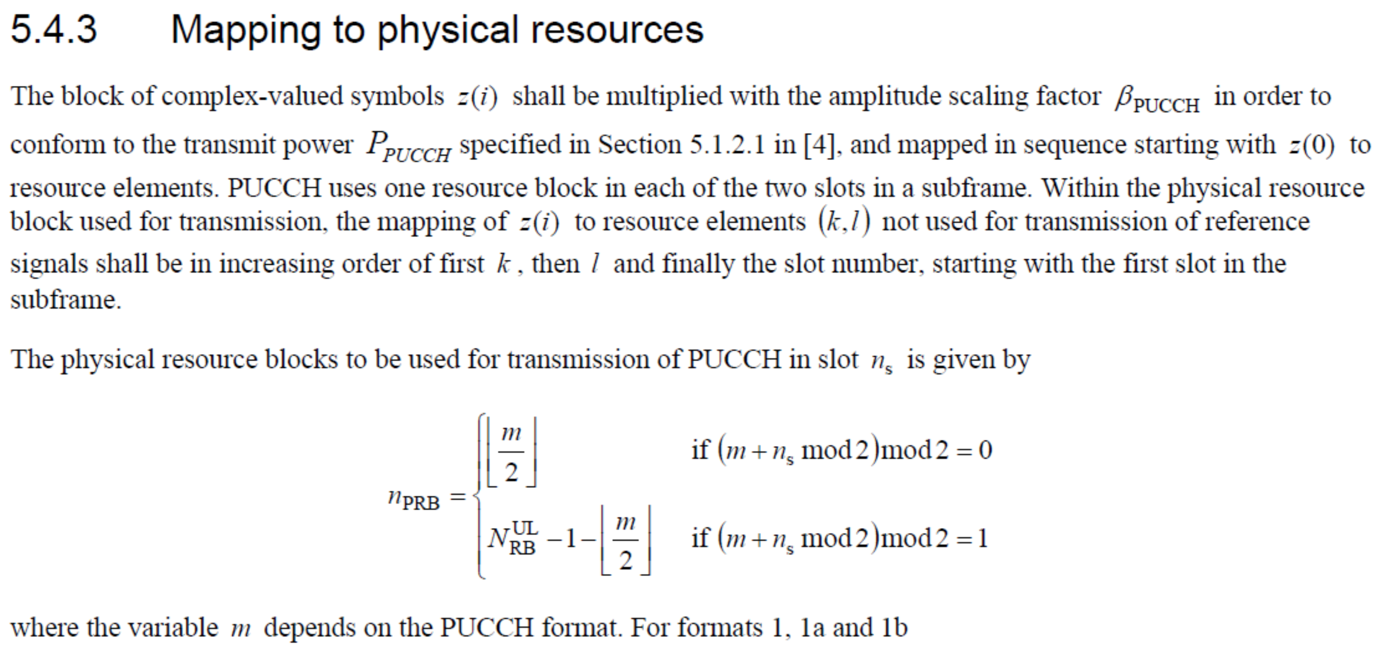
Figure 16.3: Uplink physical data channel processing.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

</td>
</tr>
</table>

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

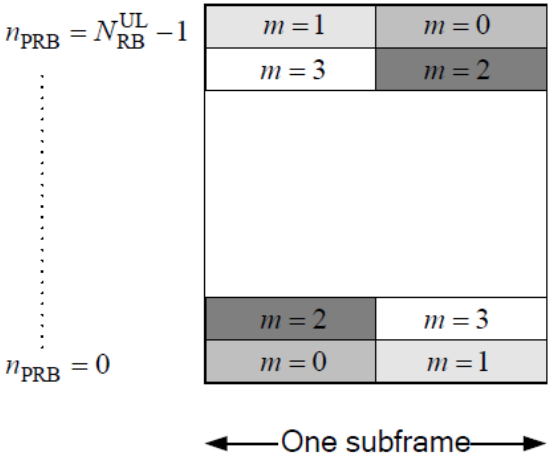


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\mathrm{RA}}_{\mathrm{PRBoffset}}$. For FDD, the parameter directly determines

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

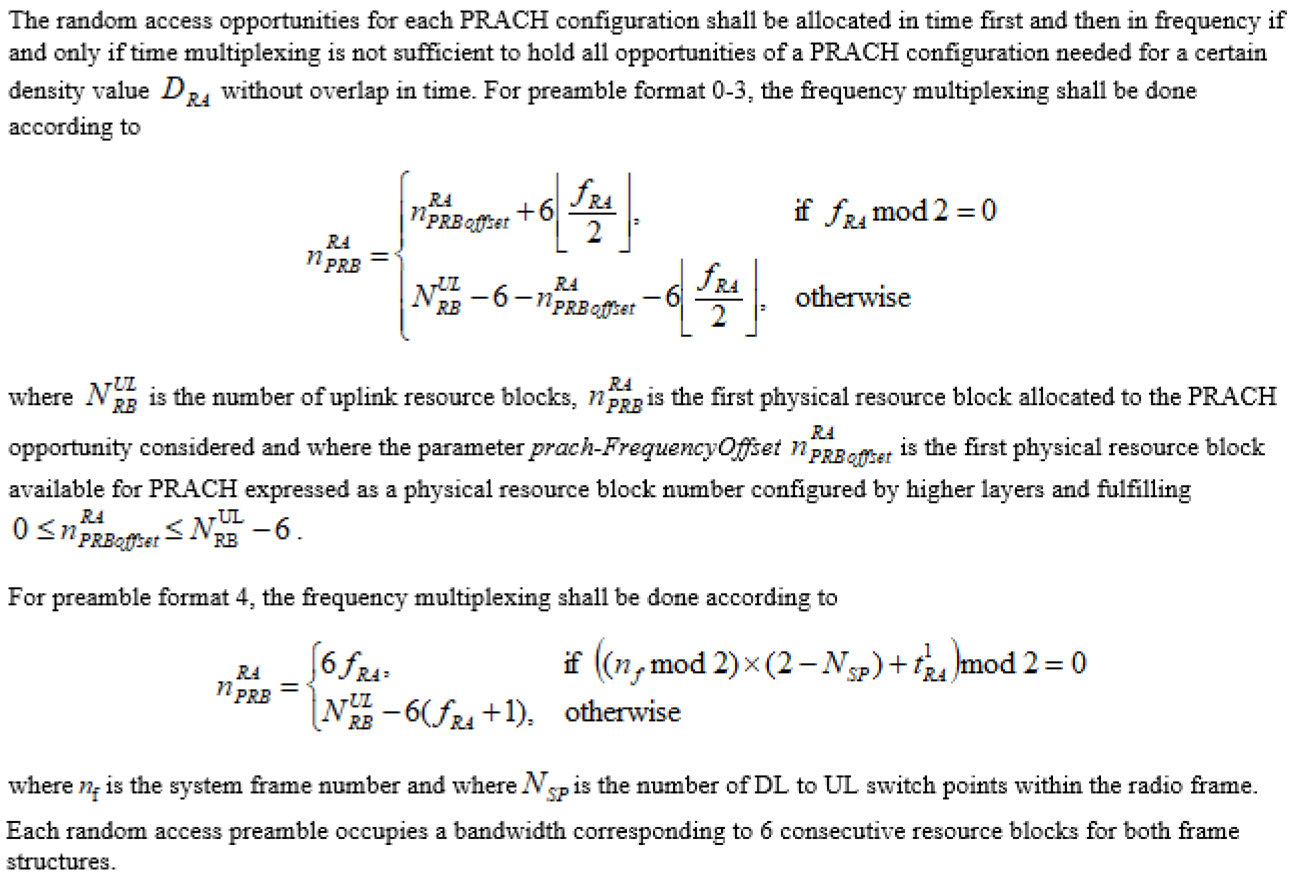
...

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\,offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

...

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.

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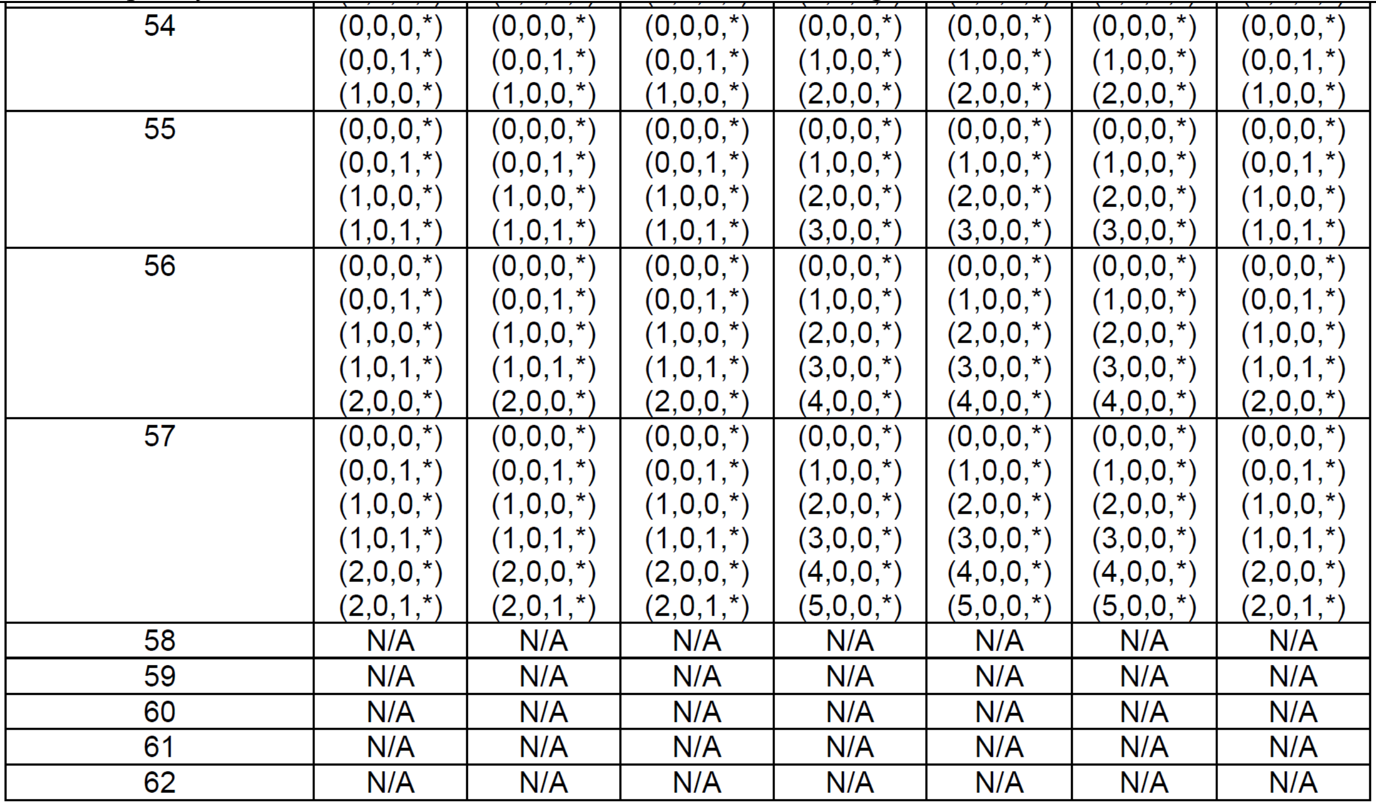
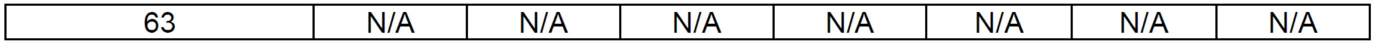
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

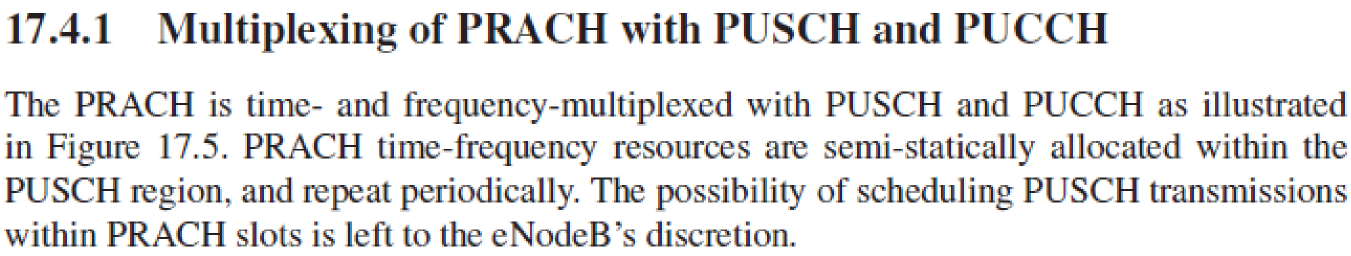


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A



63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

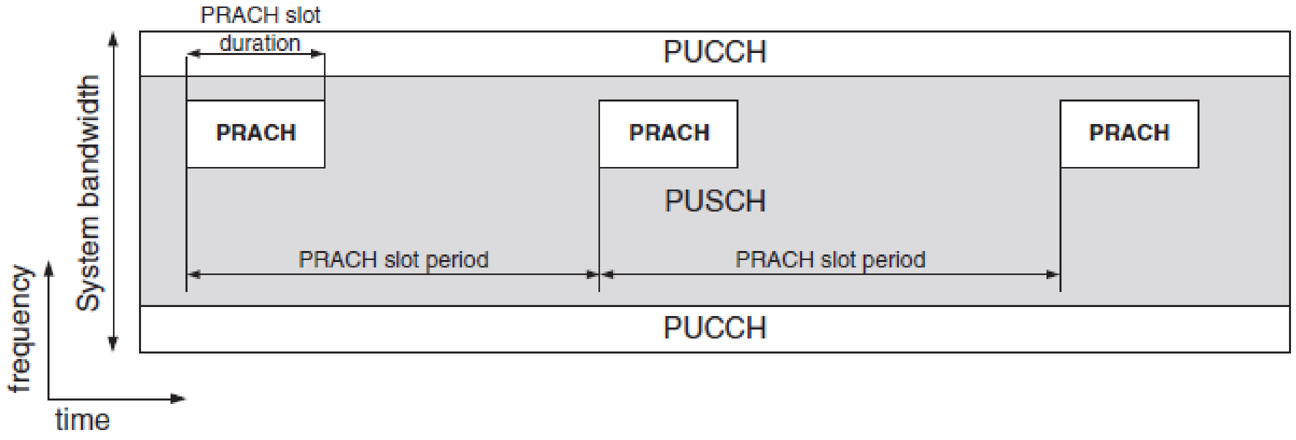
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

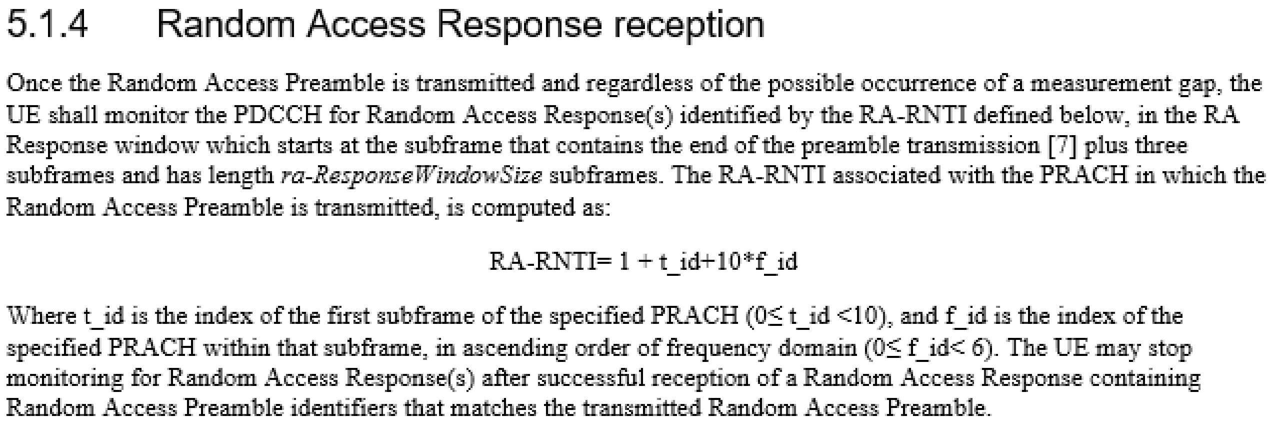
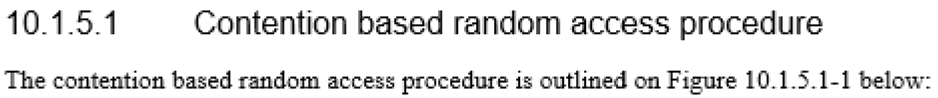
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 14
“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Honda's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

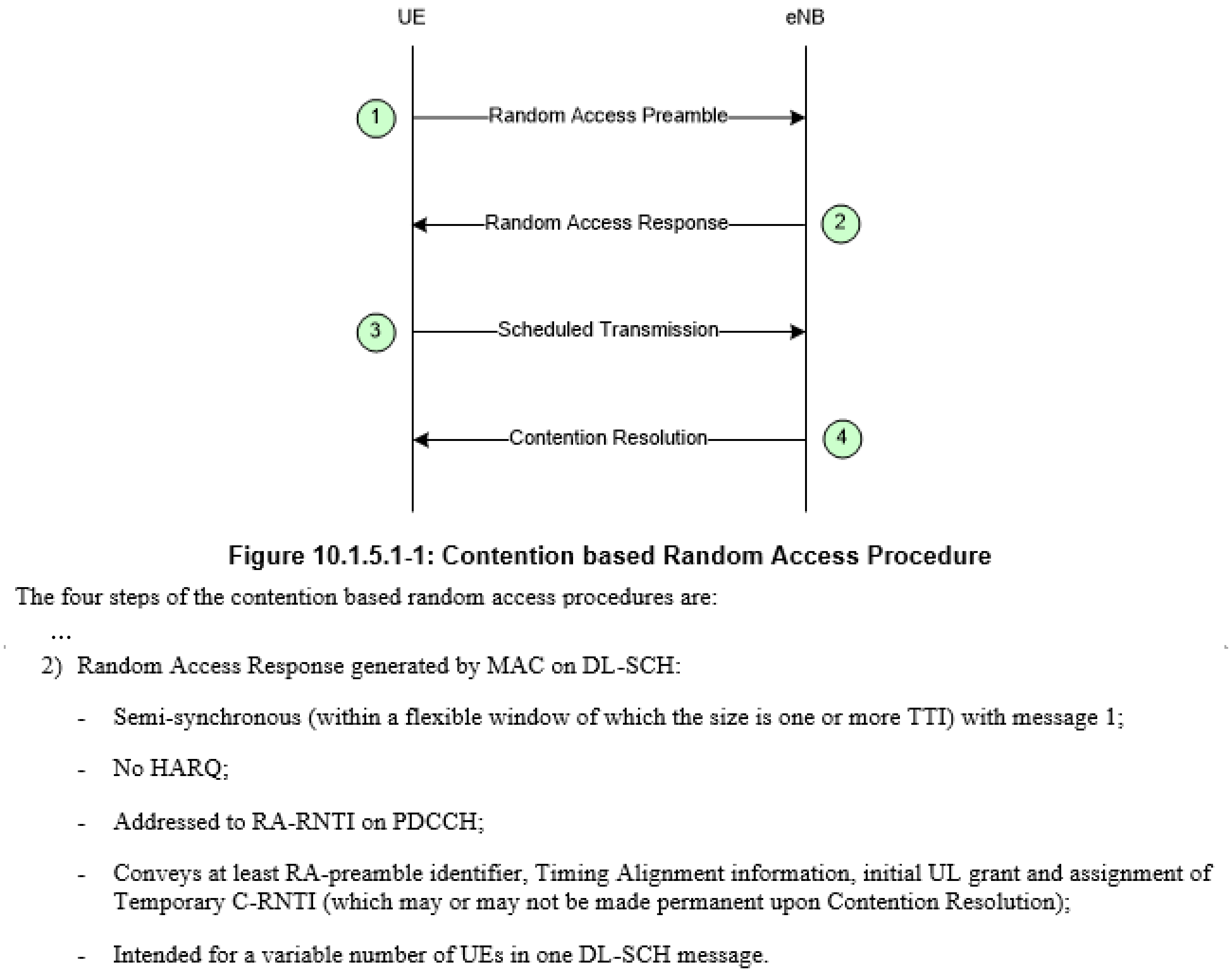


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

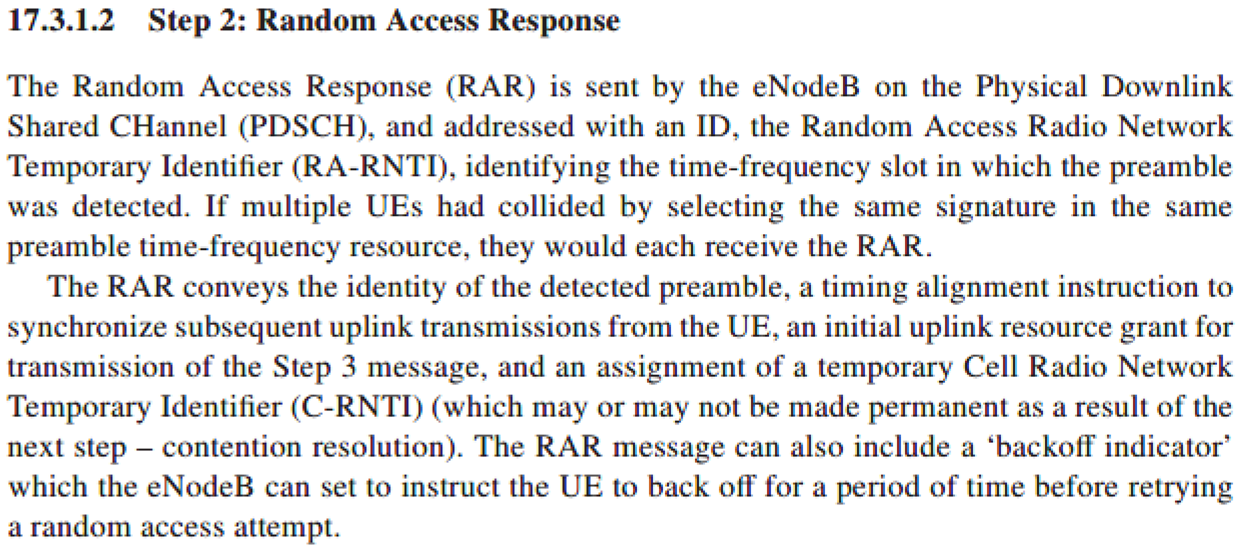
...

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15
“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 16
“The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.”

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Honda’s Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

<table>
<tr>
<td>17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.</td>
<td>

See Claim 1.

The frequency band used with Honda’s Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,*

For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.

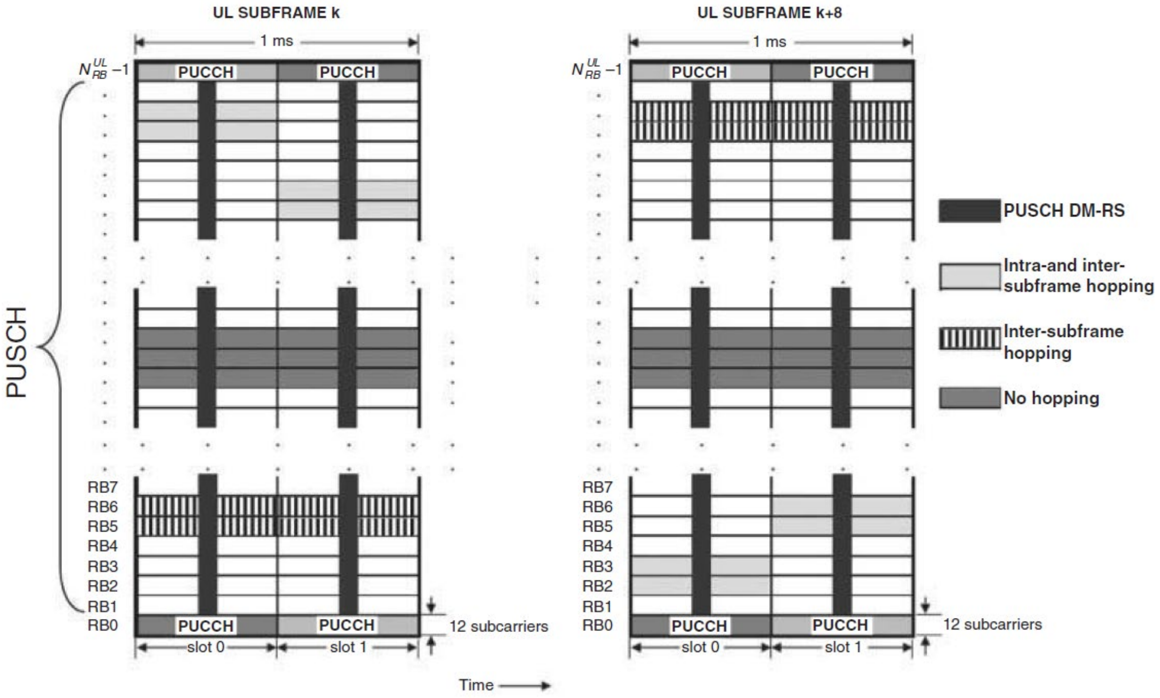


Figure 16.3: Uplink physical data channel processing.

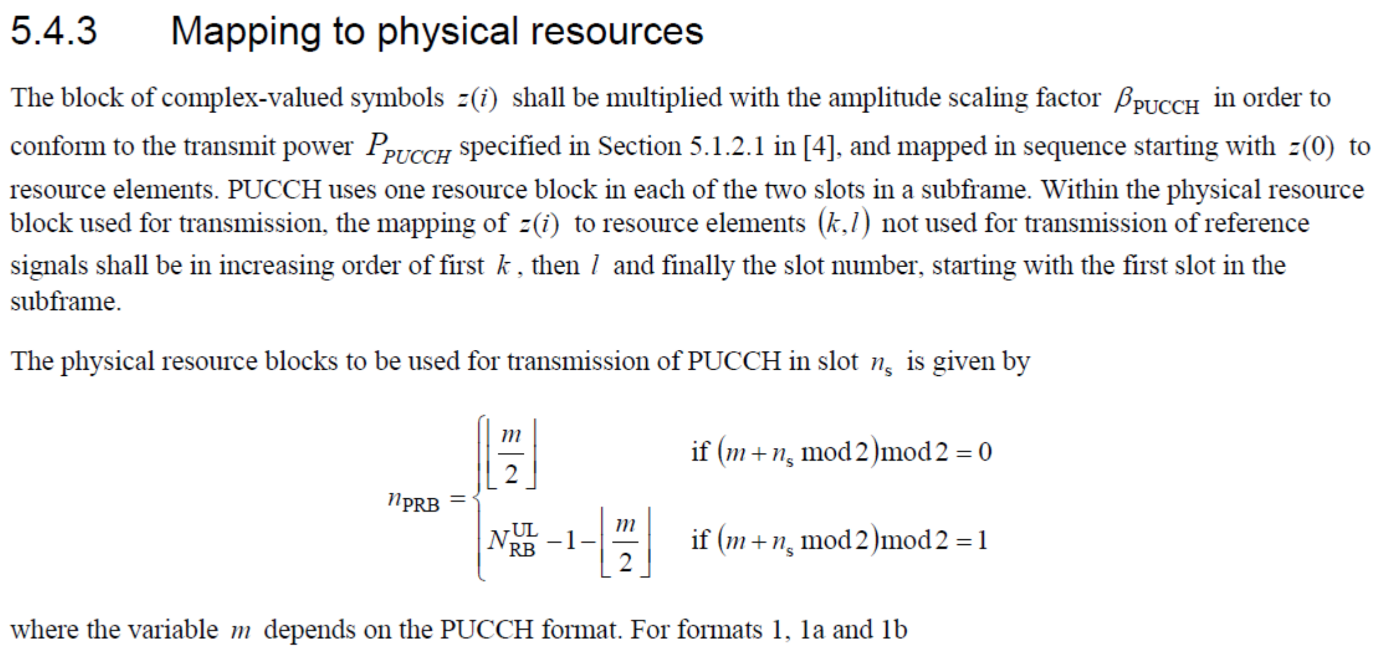
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

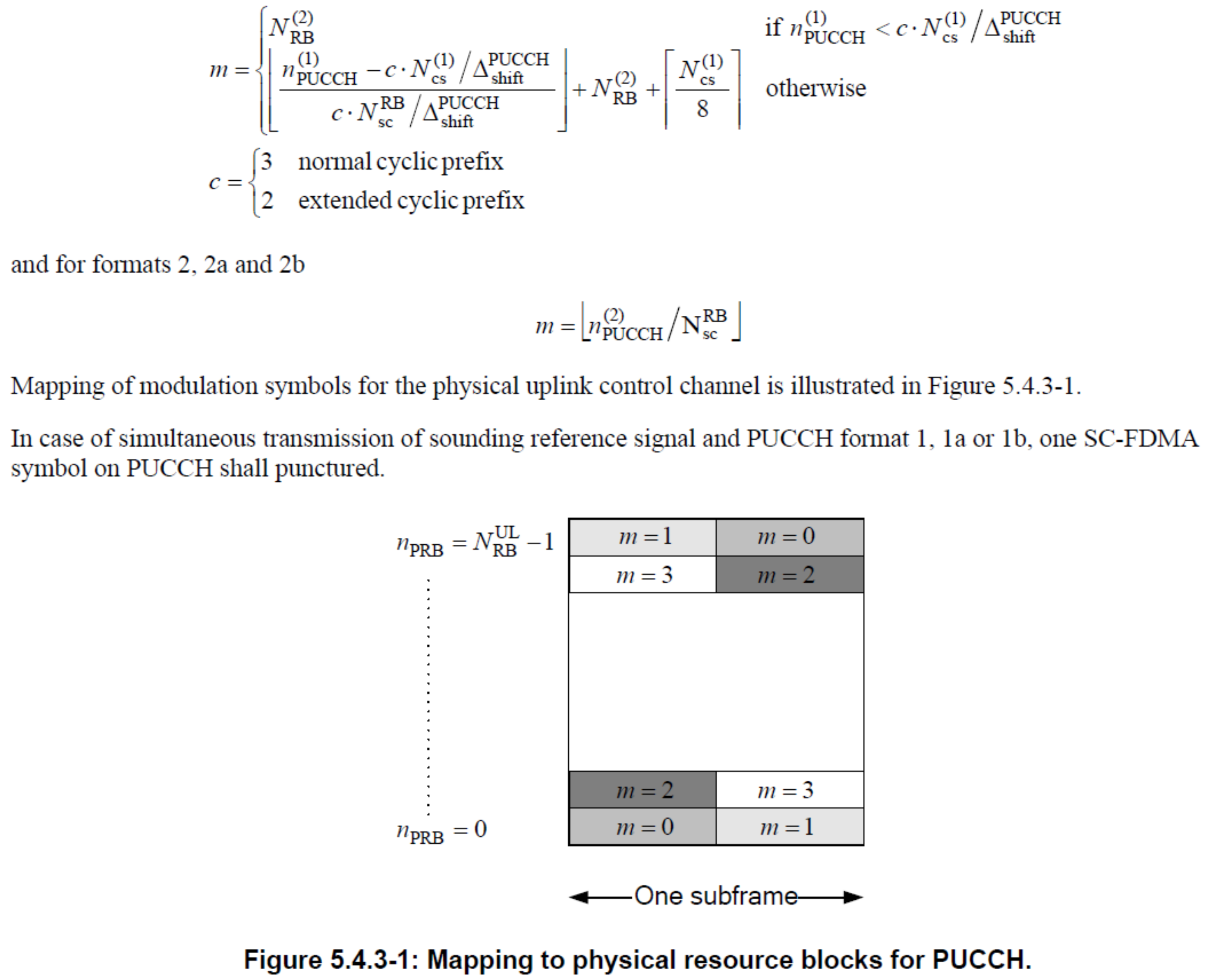
The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_s \bmod 2\right) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_s \bmod 2\right) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c\cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c\cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c\cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

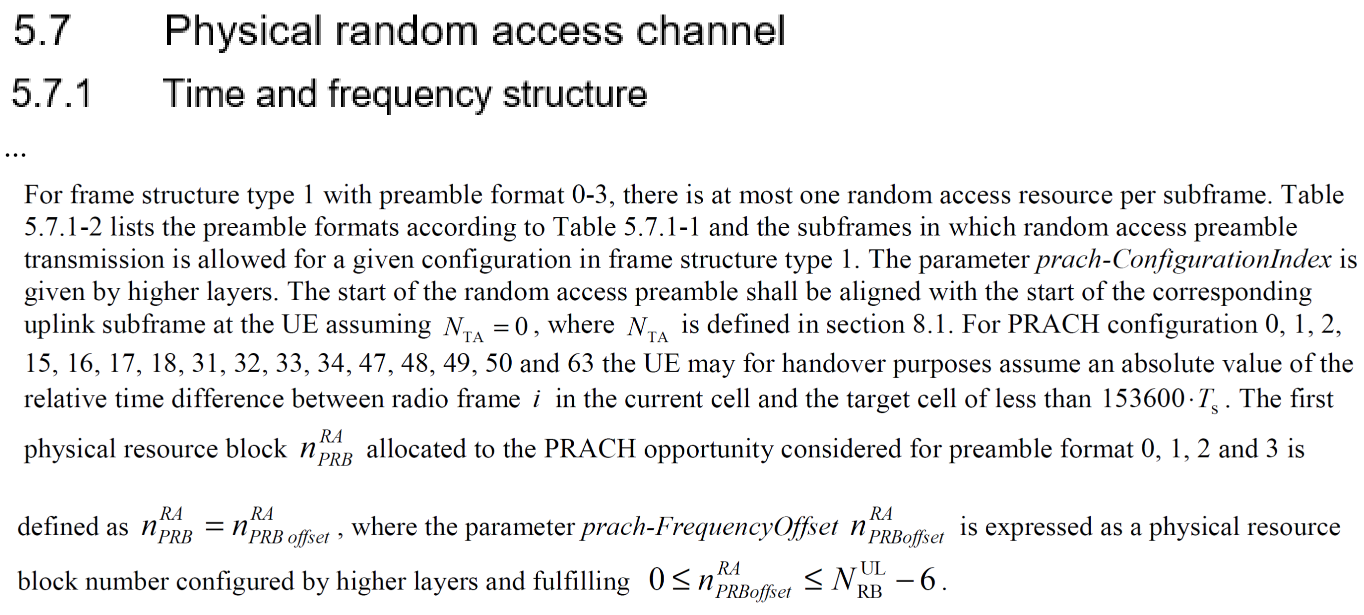
In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

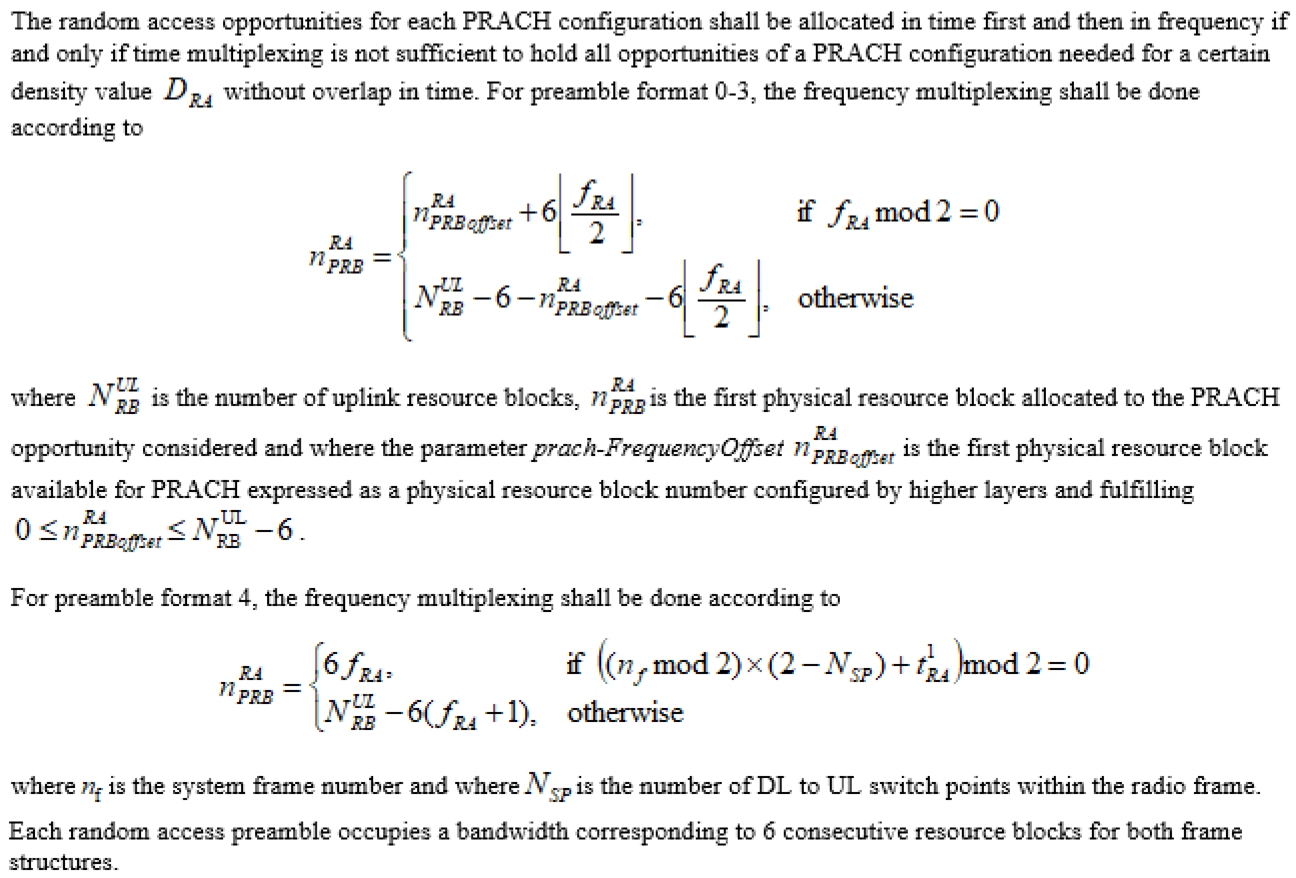
…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA}=\begin{cases} n_{PRBoffset}^{RA}+6\left\lfloor \frac{f_{RA}}{2}\right\rfloor, & \text{if } f_{RA} \bmod 2=0\\ N_{RB}^{UL}-6-n_{PRBoffset}^{RA}-6\left\lfloor \frac{f_{RA}}{2}\right\rfloor, & \text{otherwise}\end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}}-6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA}=\begin{cases}6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2=0\\ N_{RB}^{UL}-6(f_{RA}+1), & \text{otherwise}\end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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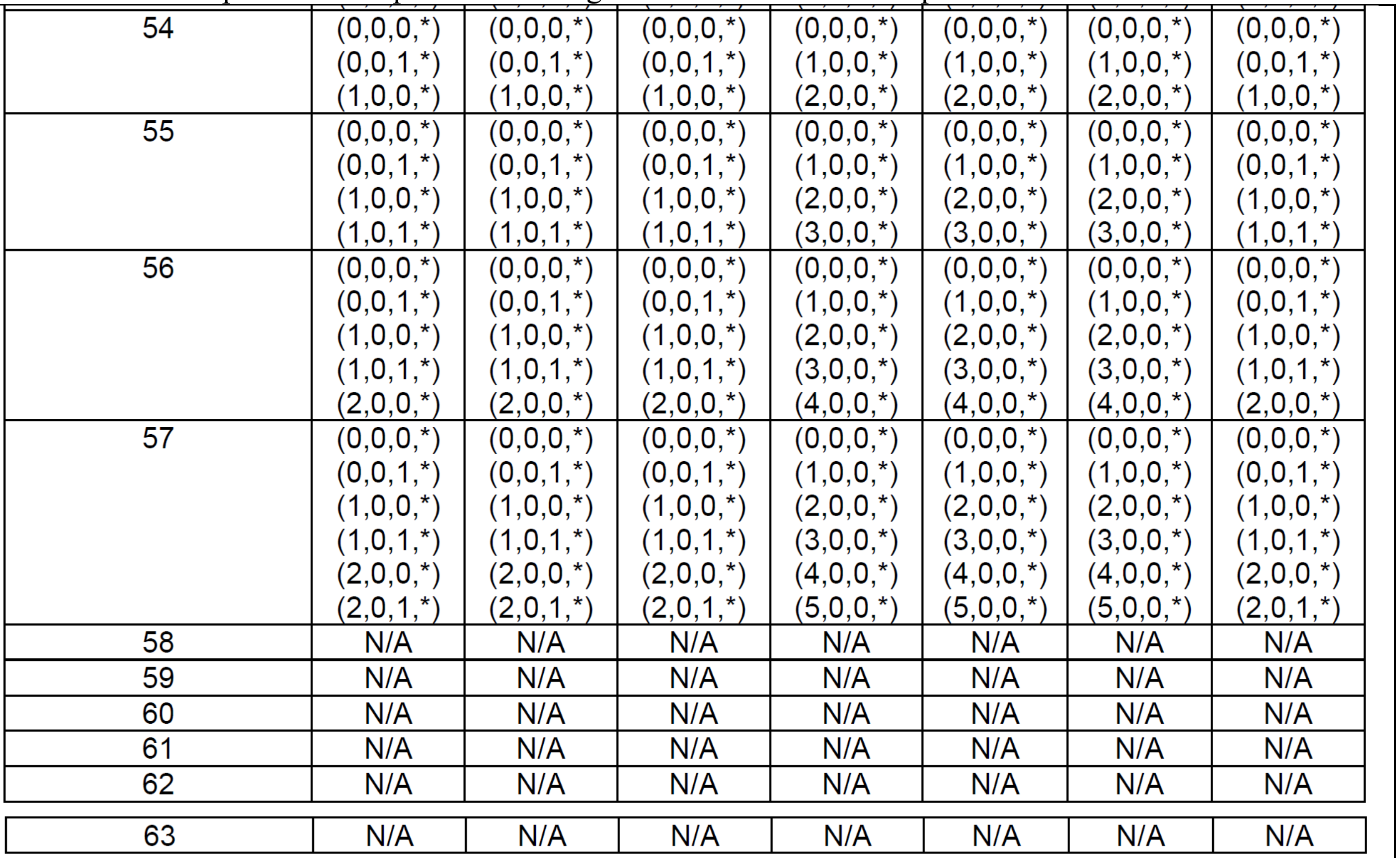
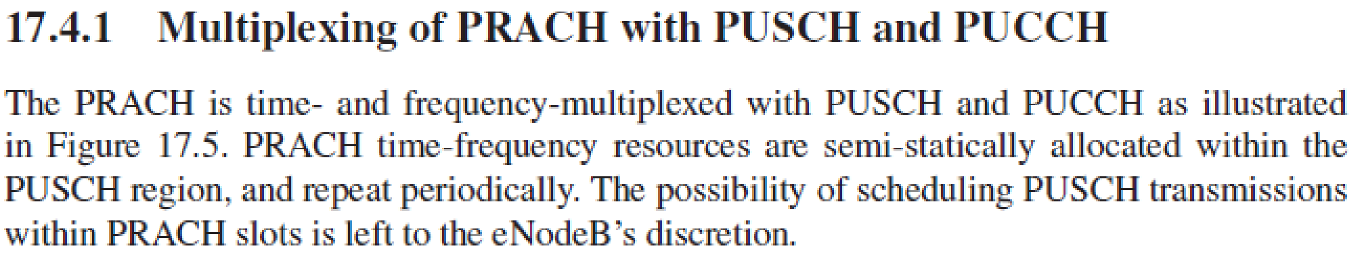
US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

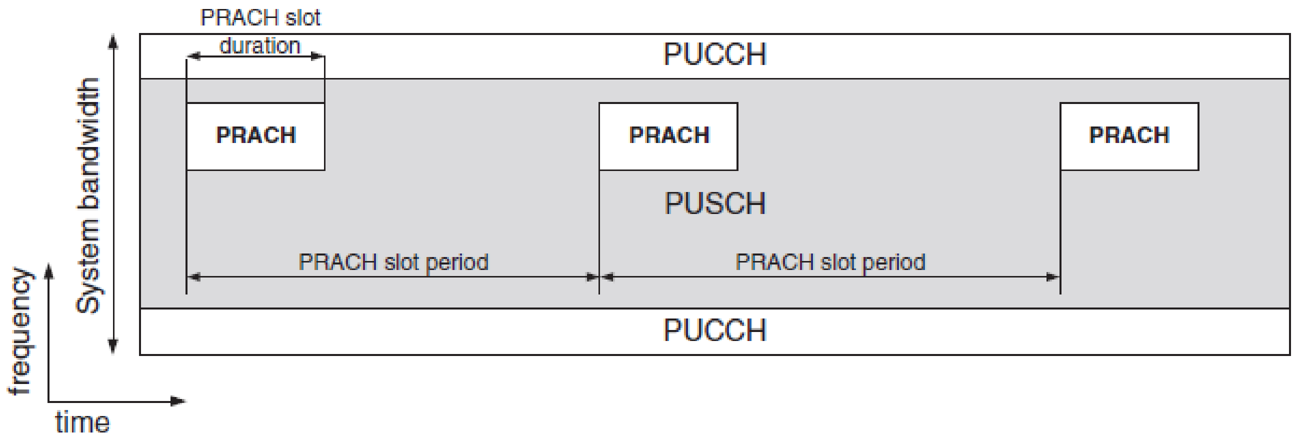
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



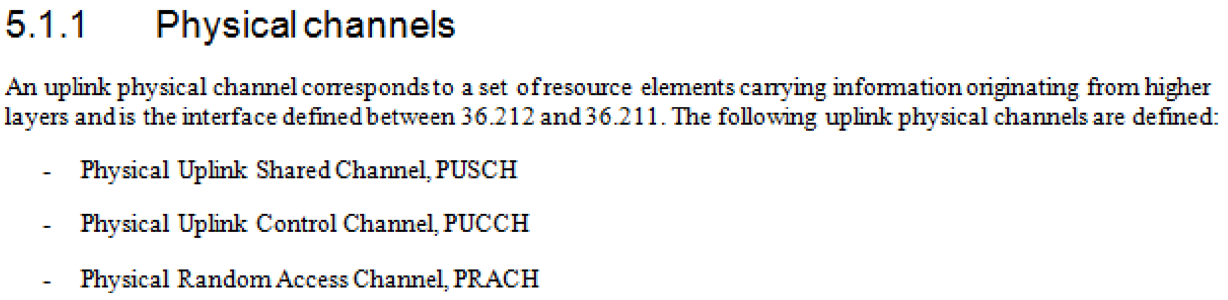
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

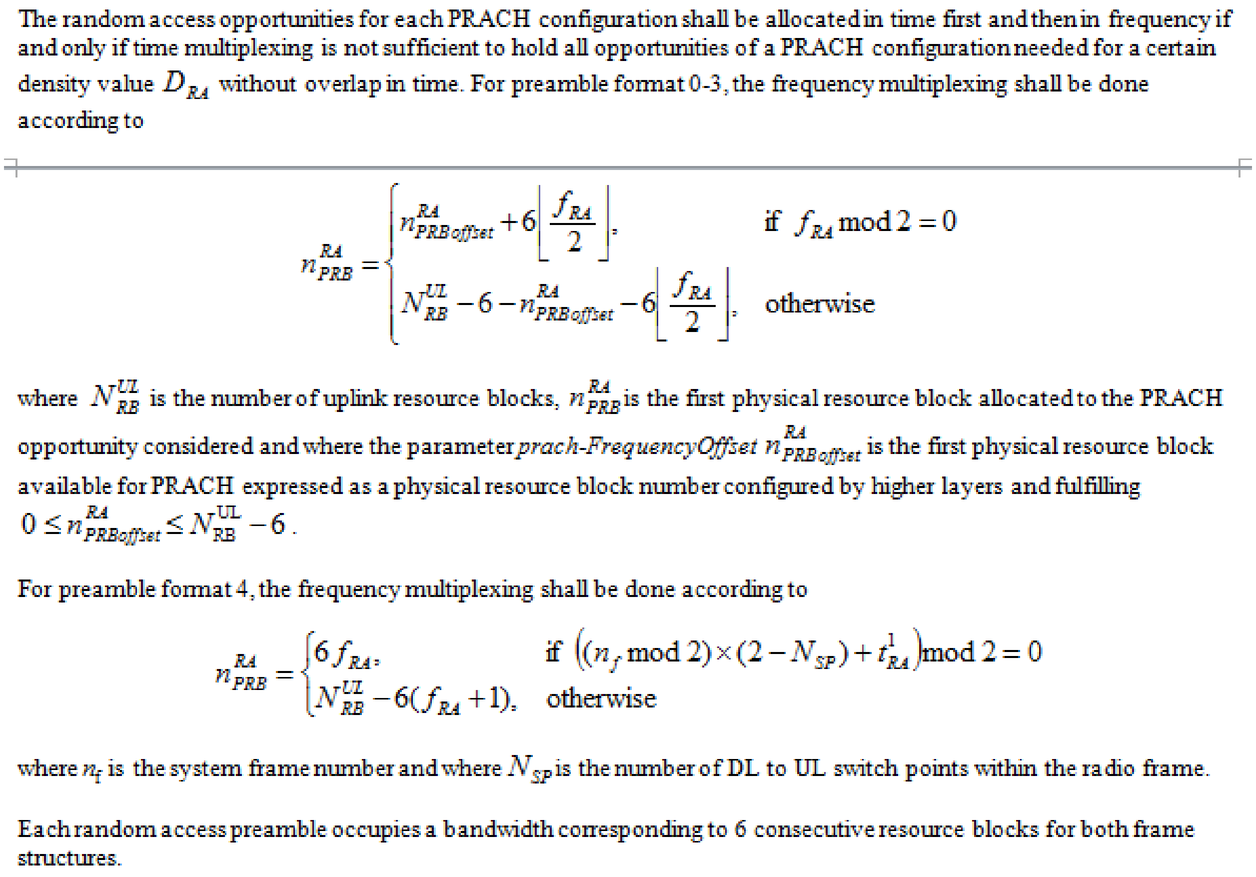
US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Honda’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

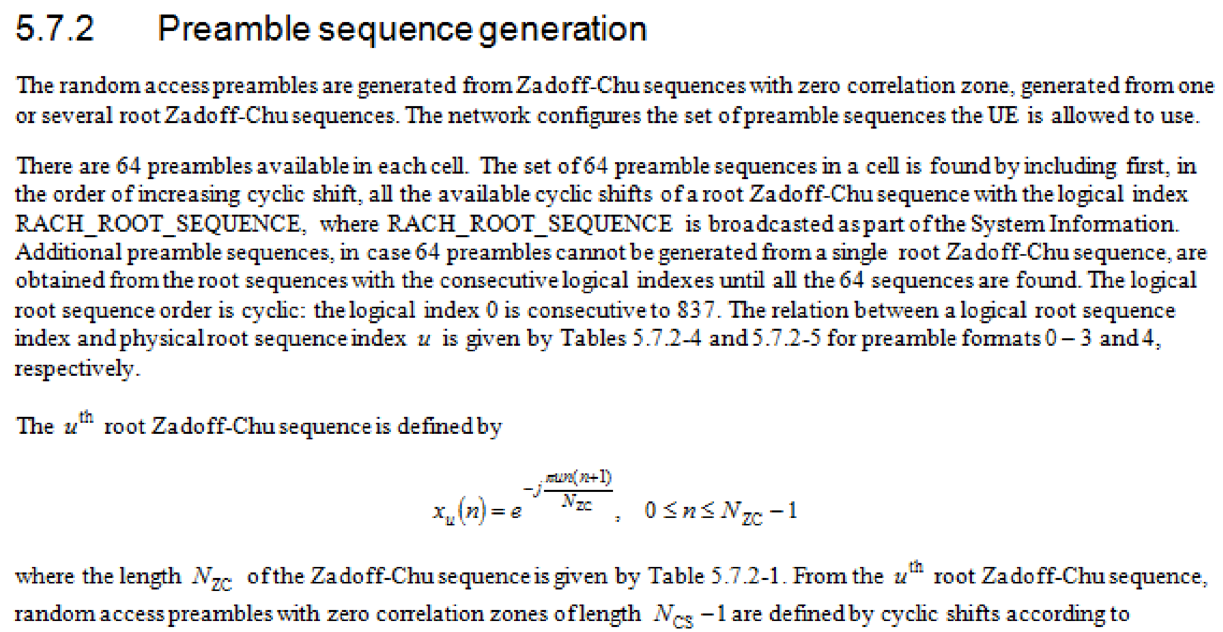
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

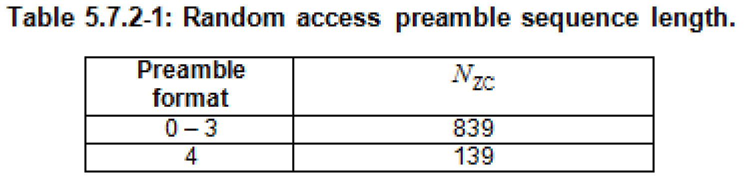
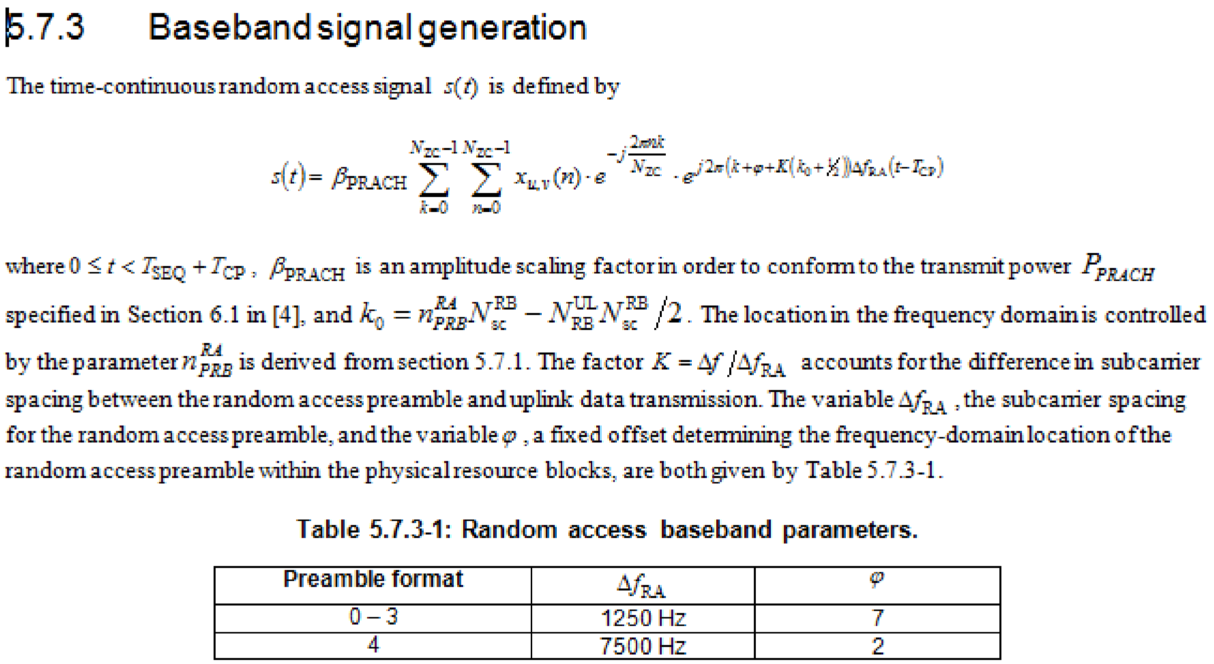


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\text{RA}}\left(t-T_{\text{CP}}\right)}$$

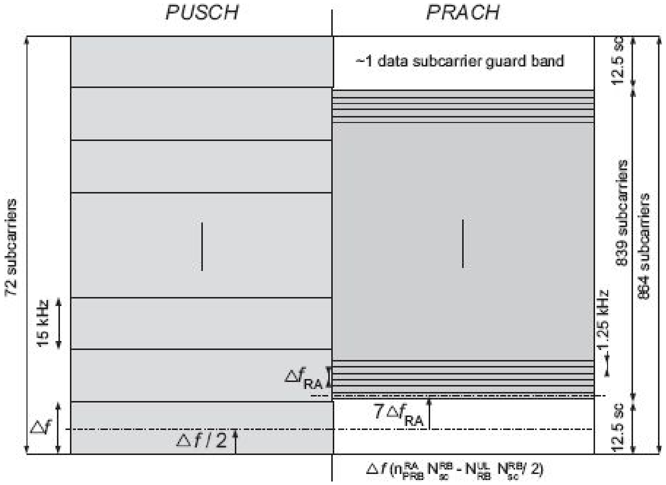
where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

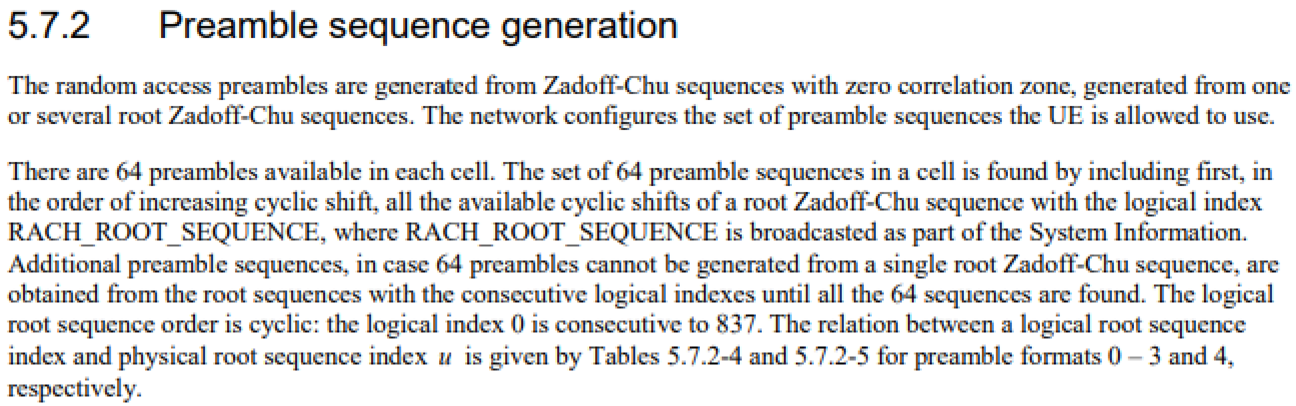
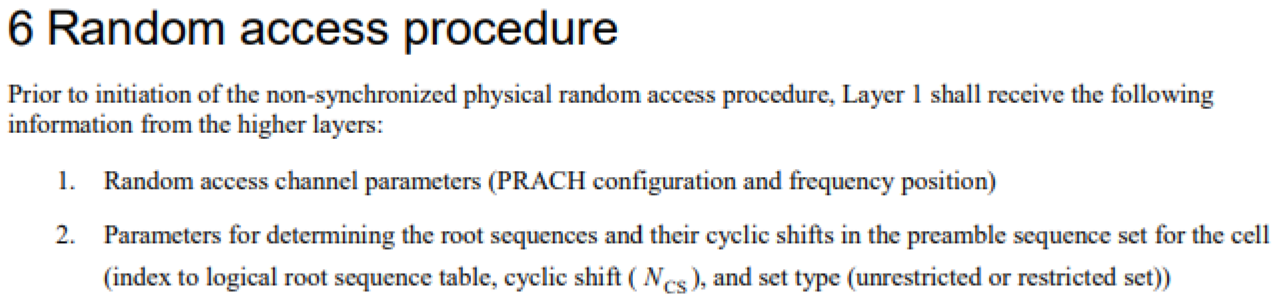
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 19
"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Honda's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

“The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

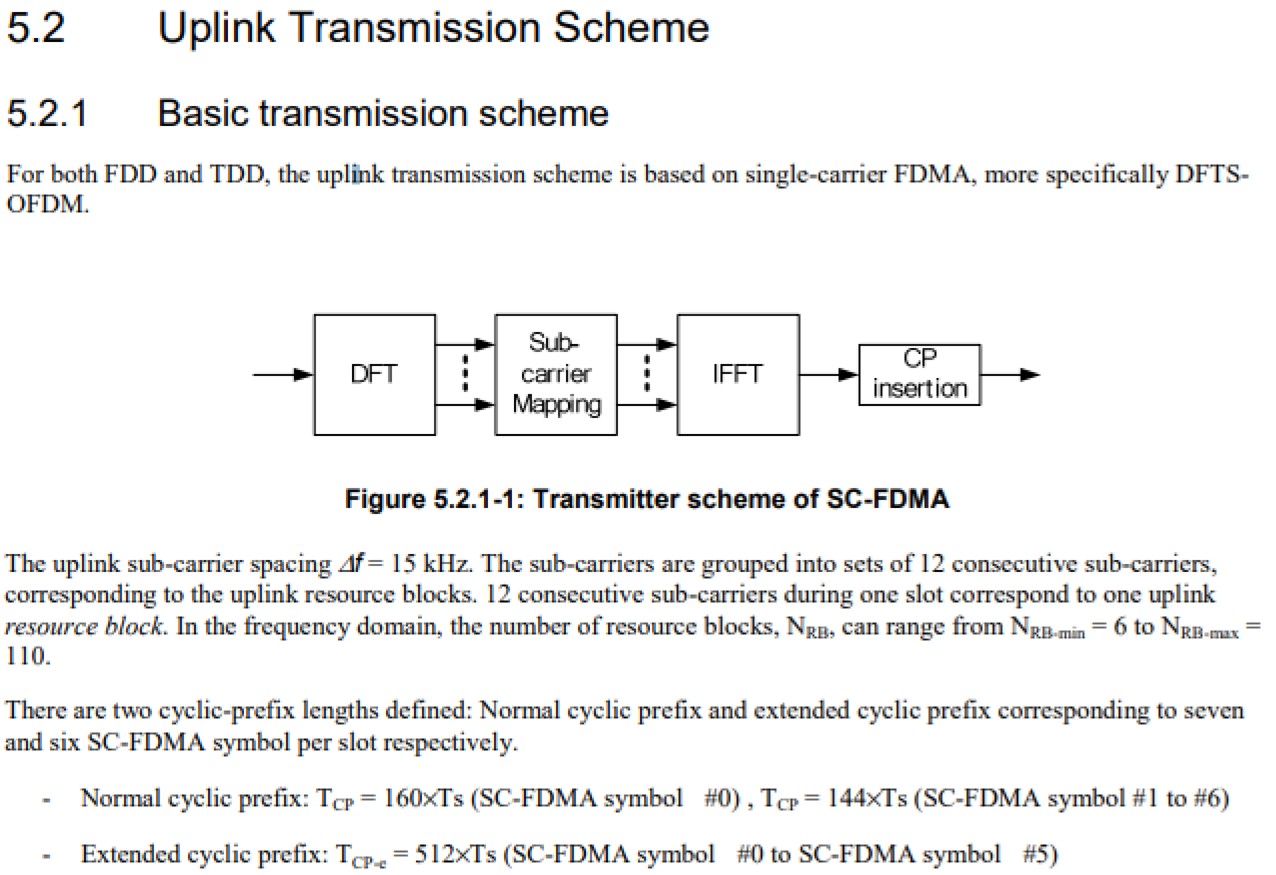
US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

<table>
<tr>
<td>20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.</td>
<td>

See Claim 11.

Honda's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,*

Honda's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:



5.2 Uplink Transmission Scheme

5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

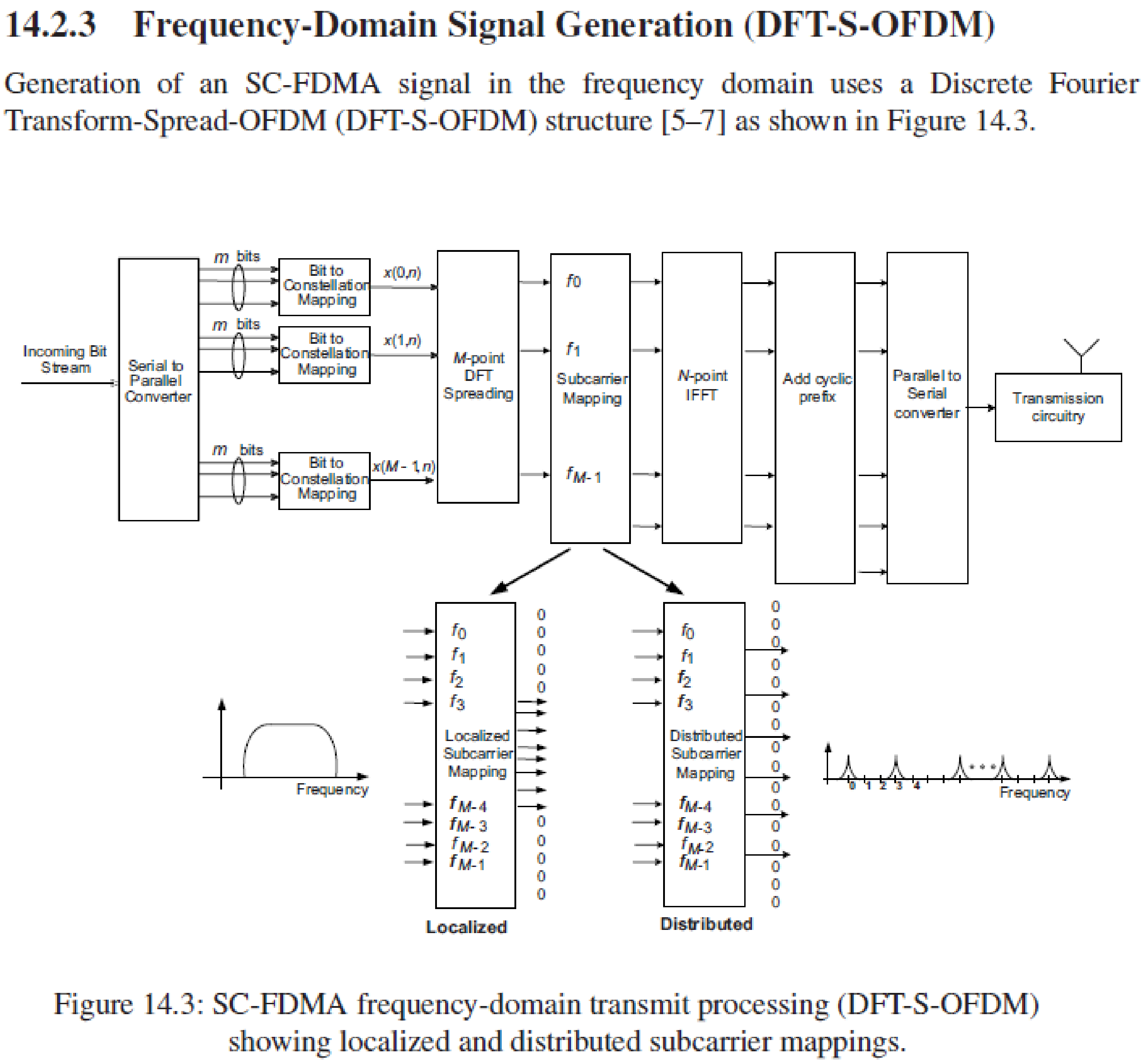
There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5)

</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

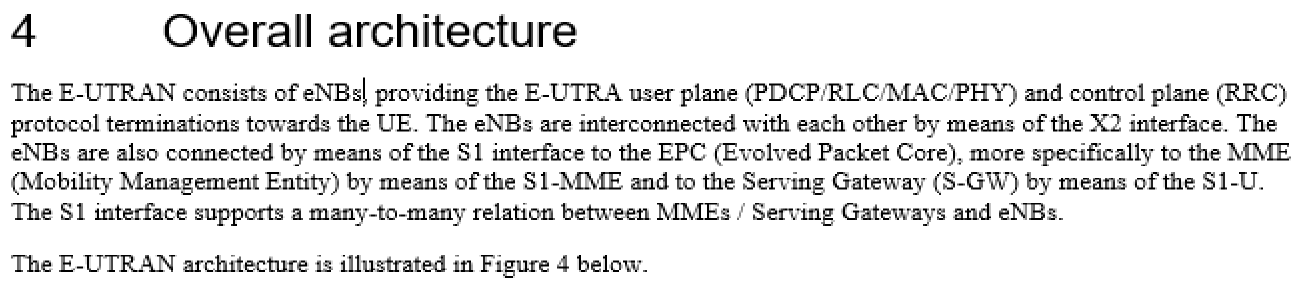
Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

21. A mobile station comprising:	To the extent the preamble is considered a limitation, Honda's Accused Instrumentalities meet the preamble of claim 21 of the '908 patent. *E.g.,* Honda's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Honda offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

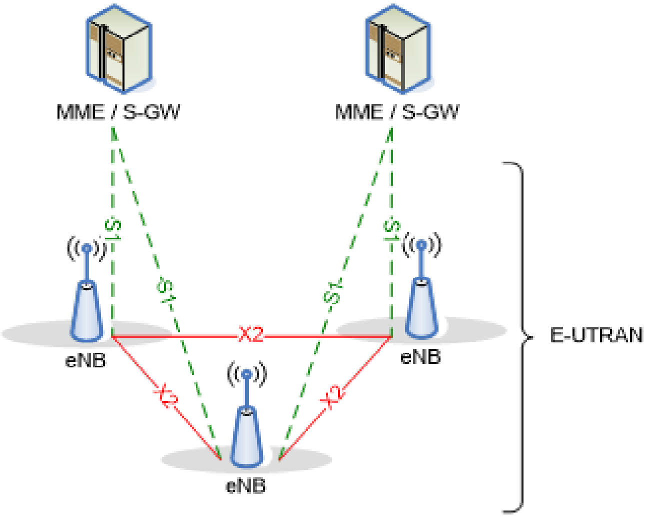


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

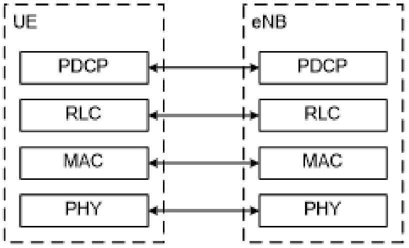


Figure 4.3.1-1: User-plane protocol stack

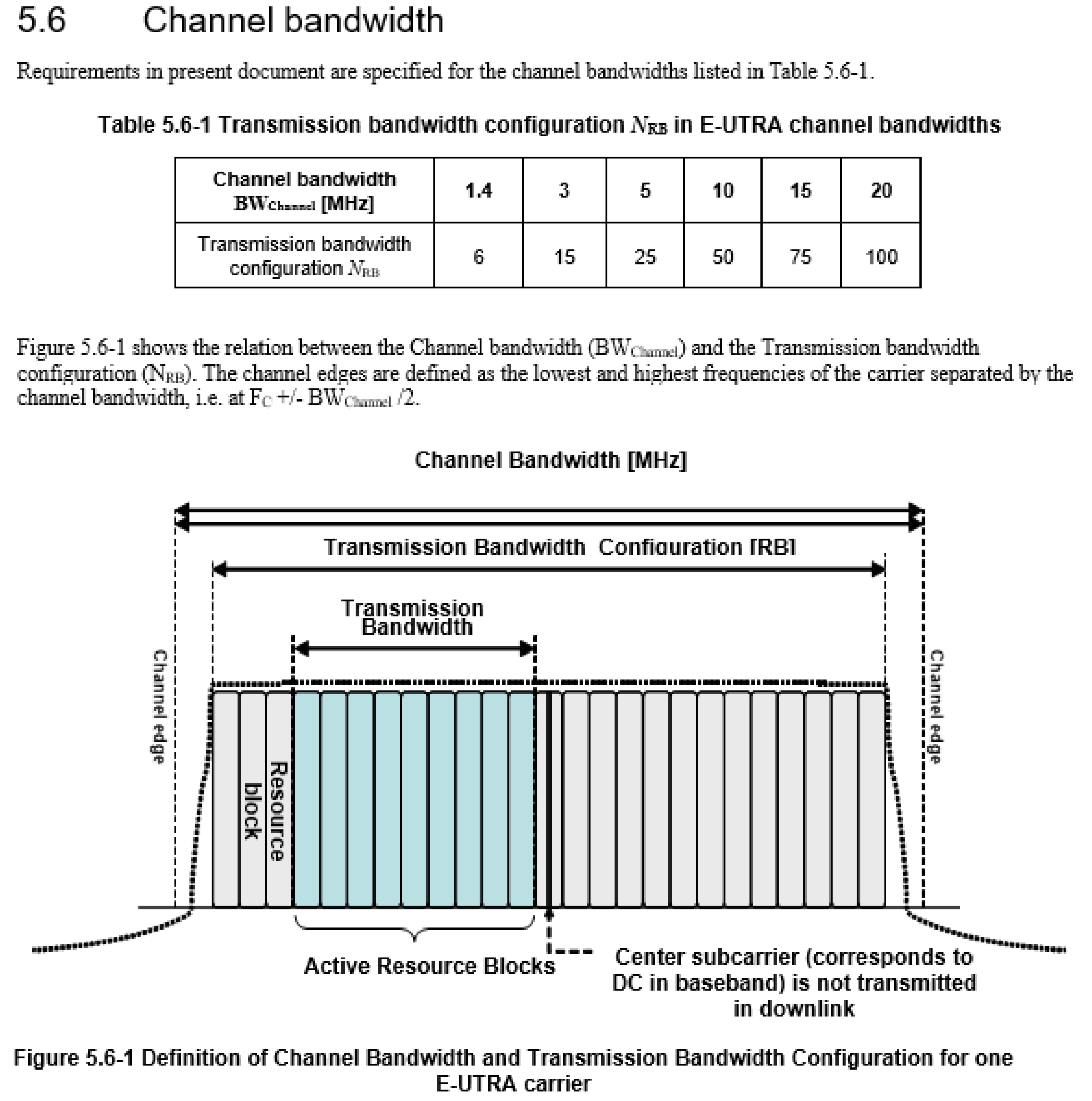
See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	Honda's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The Honda Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

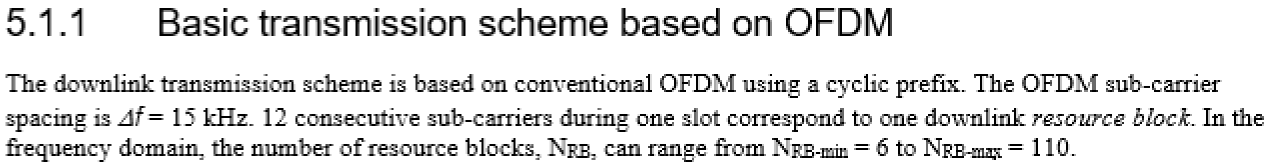
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

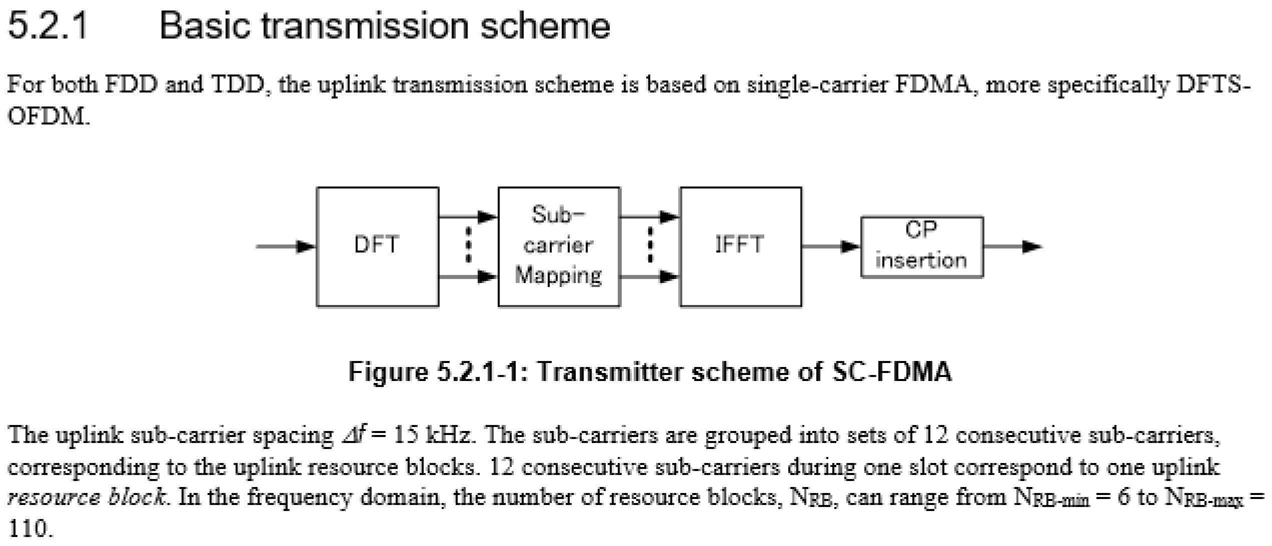
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

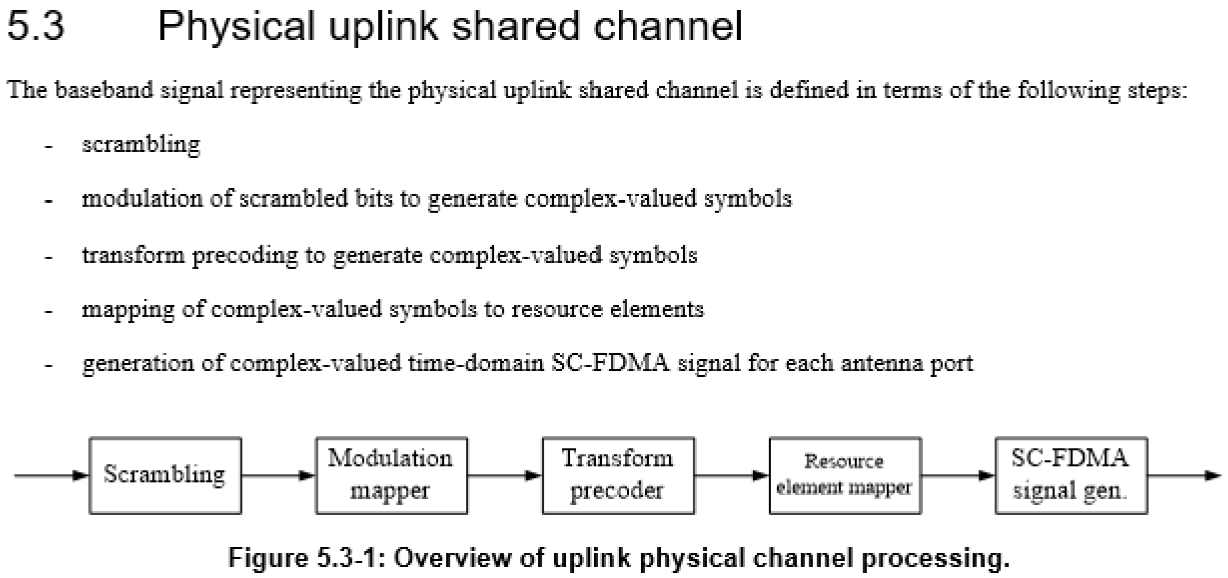
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

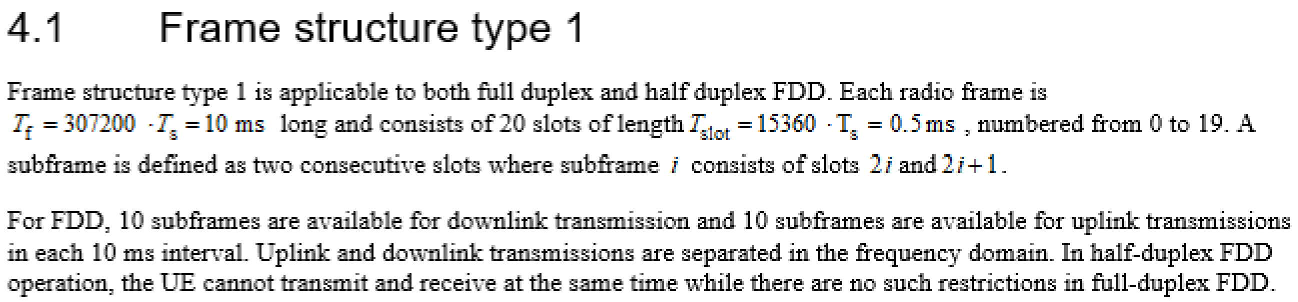
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\ \text{ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\ \text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

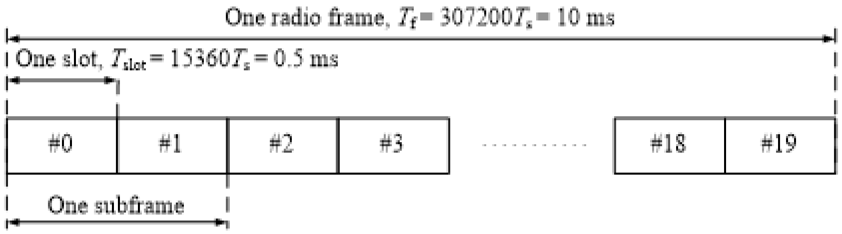
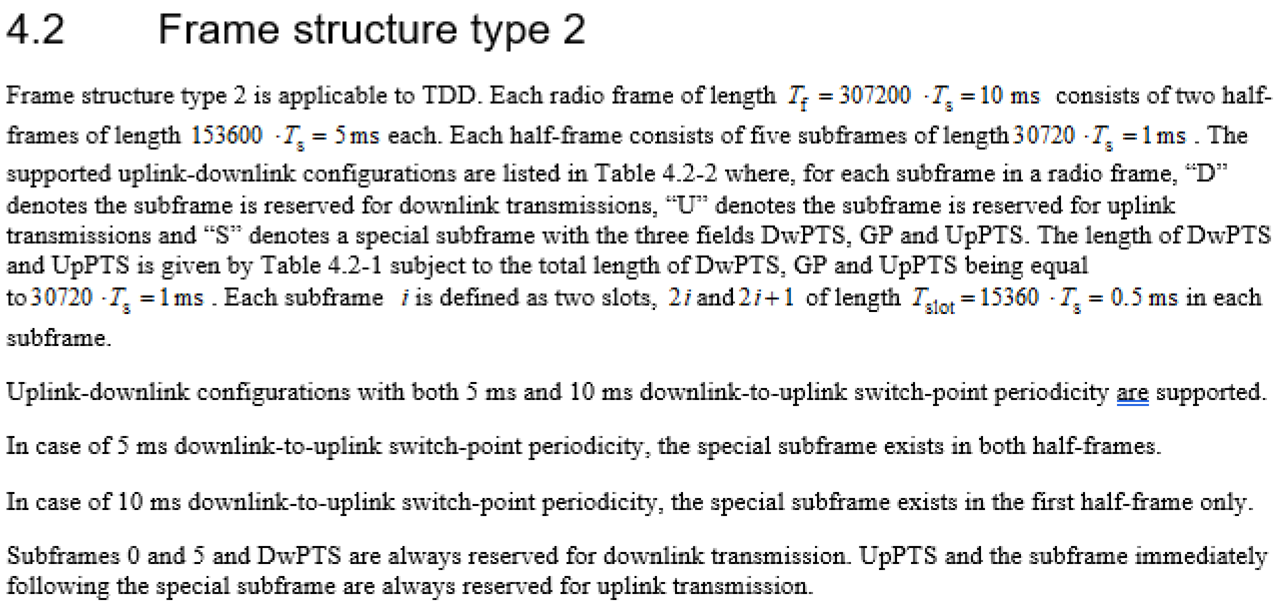


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

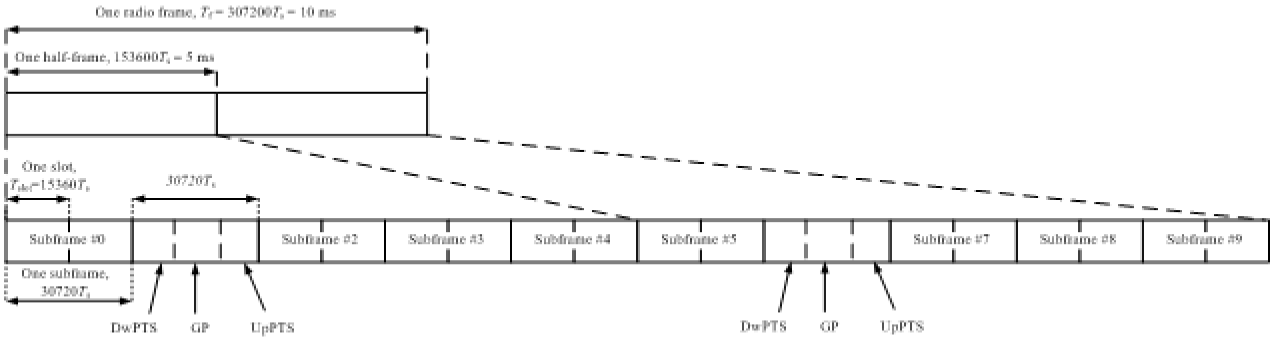


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).

5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \leq N_{\mathrm{RB}}^{\mathrm{UL}} \leq N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

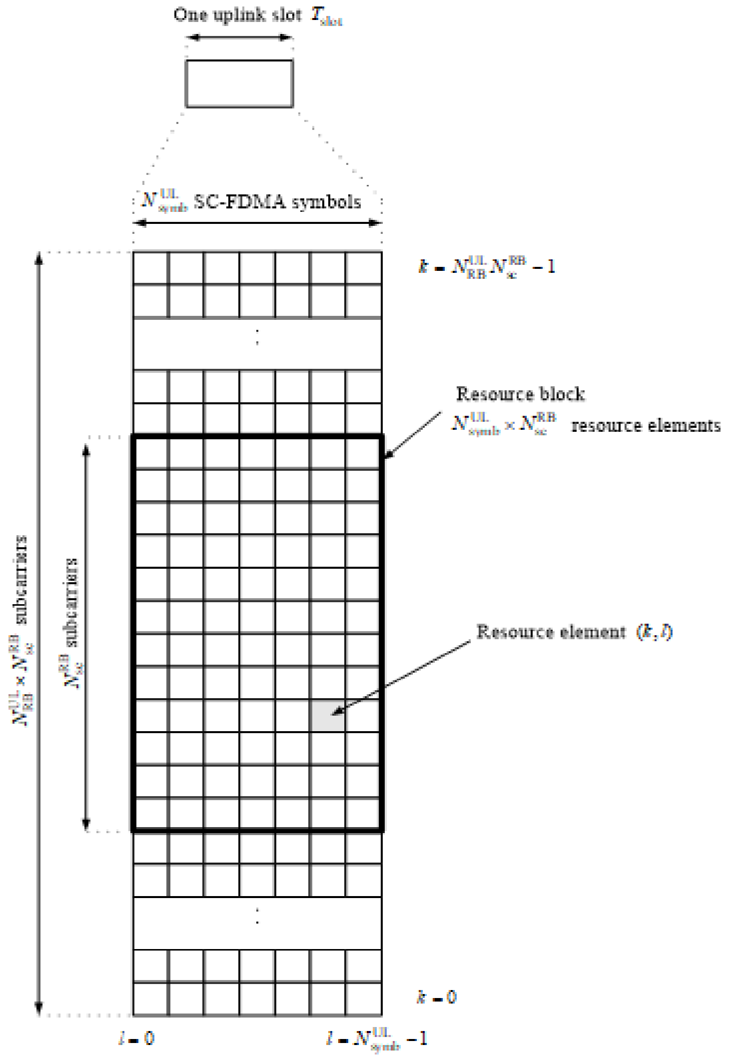
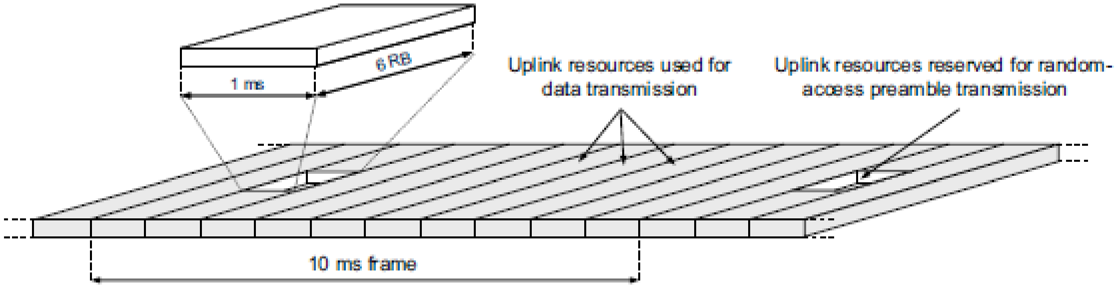


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

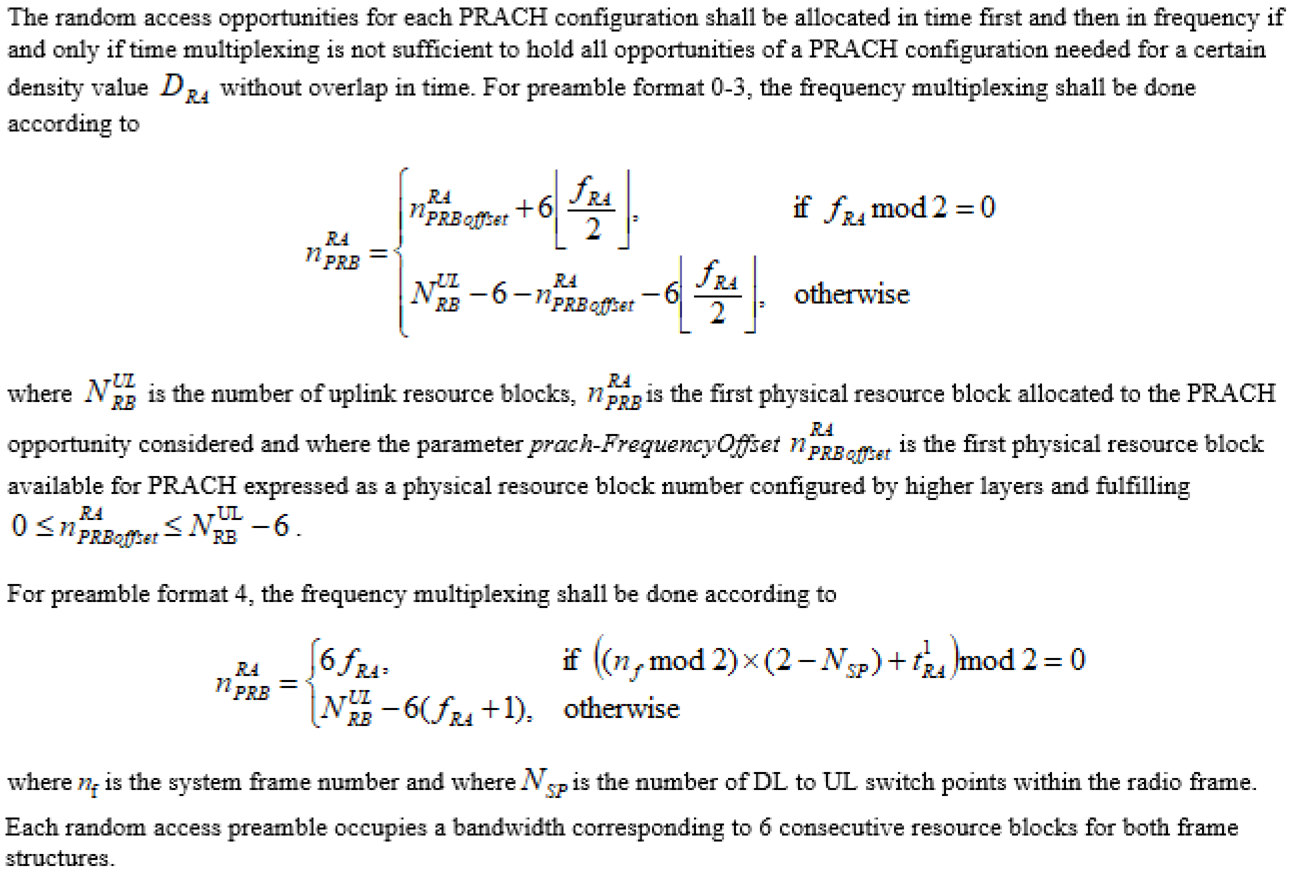
US Patent No. 10,833,908: Claim 21(c)

“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	Honda’s Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

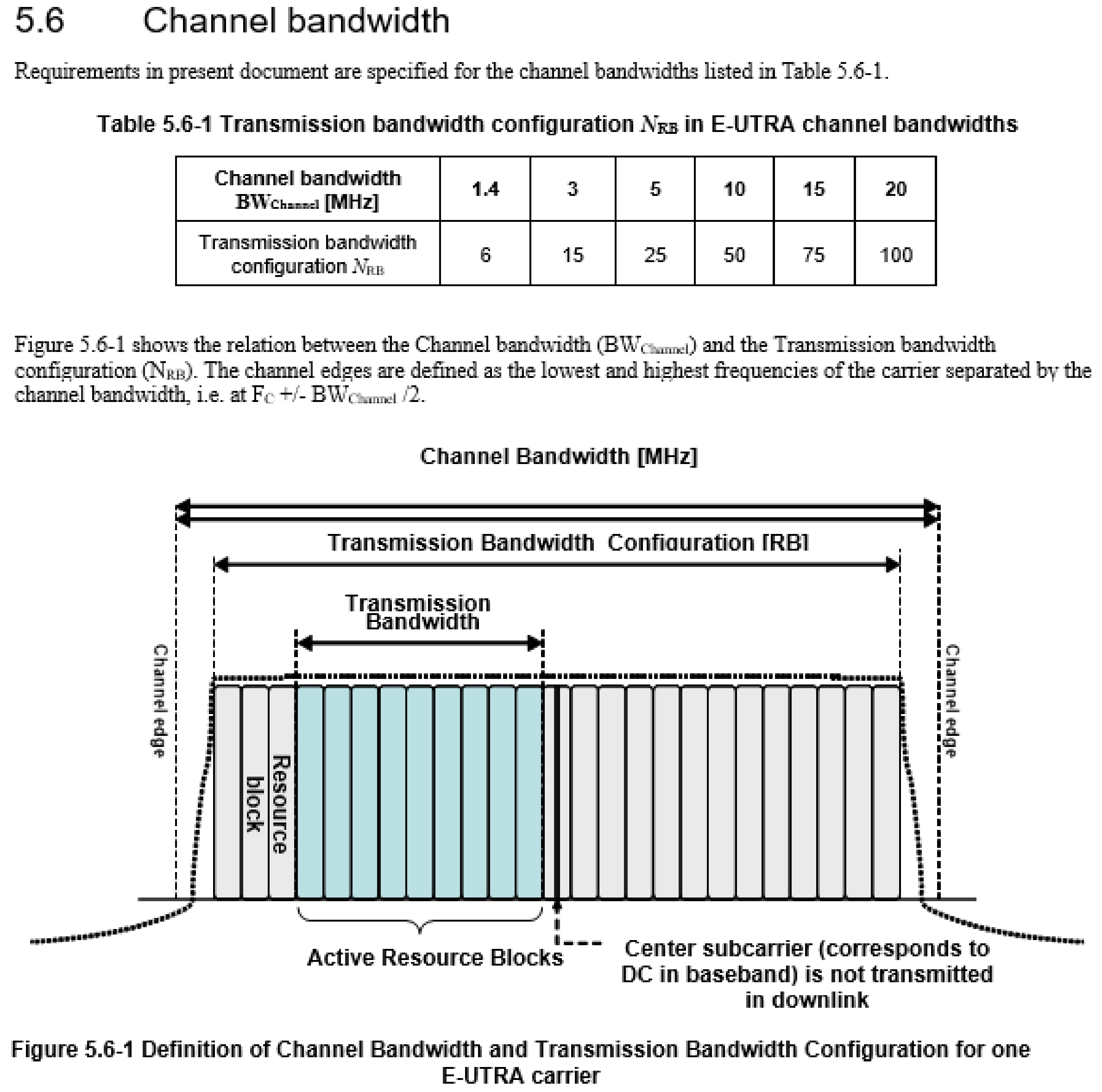
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

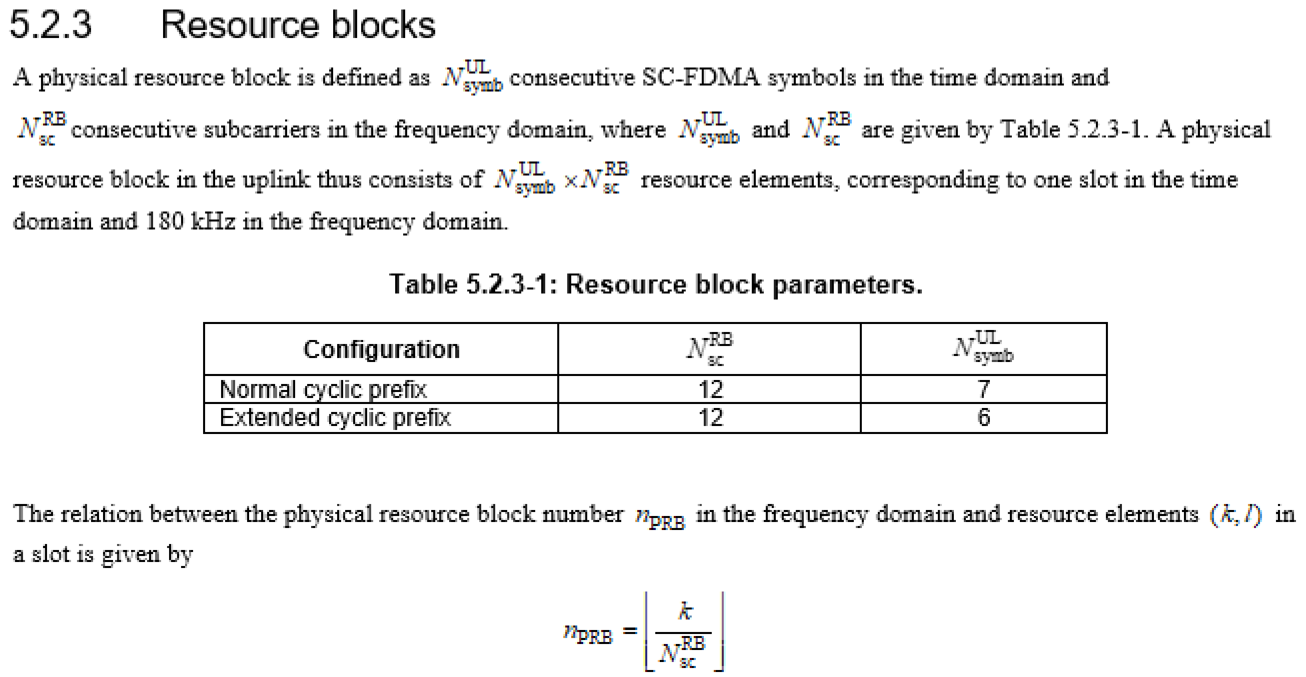
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

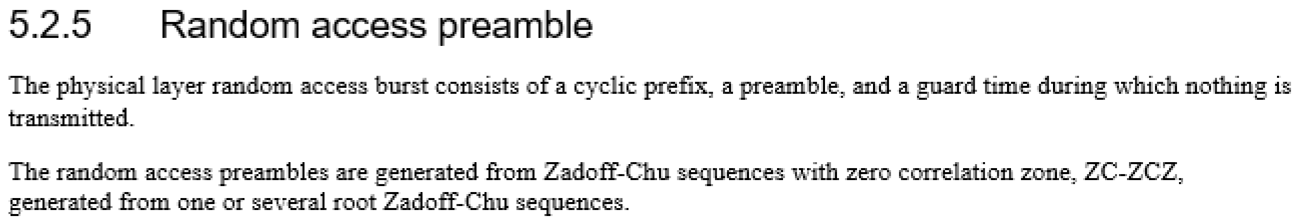
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

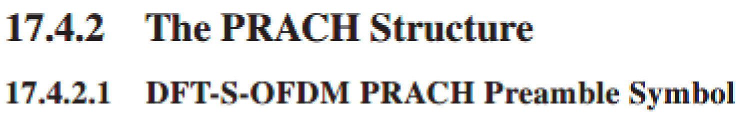


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

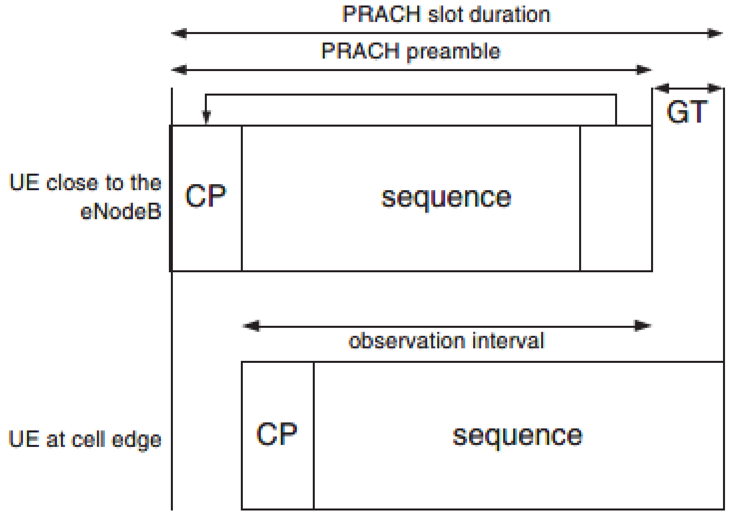


17.4.2 The PRACH Structure

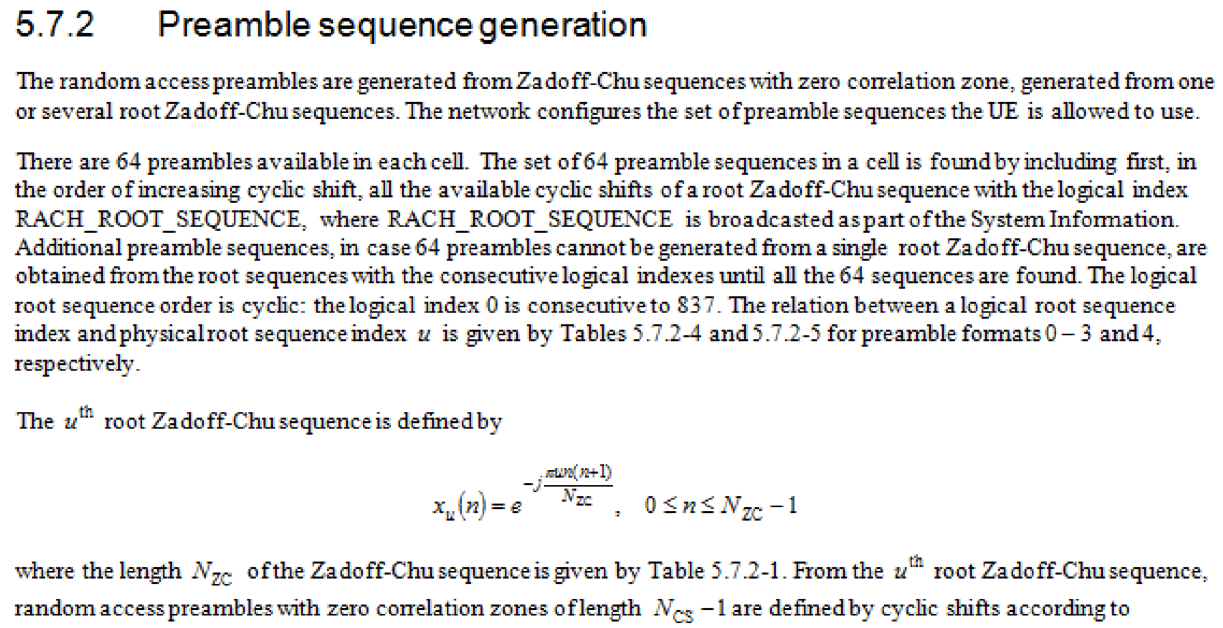
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

...

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

	The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional  Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE's delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

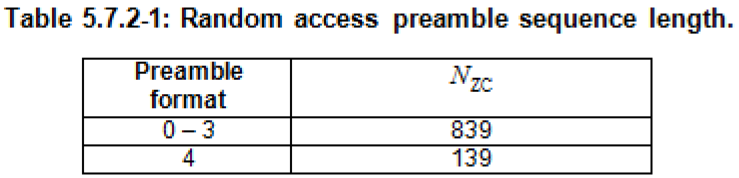
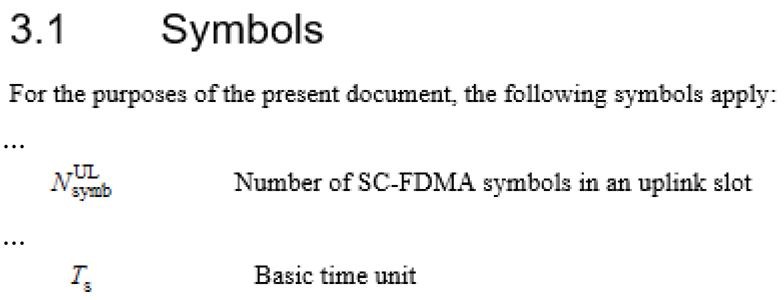
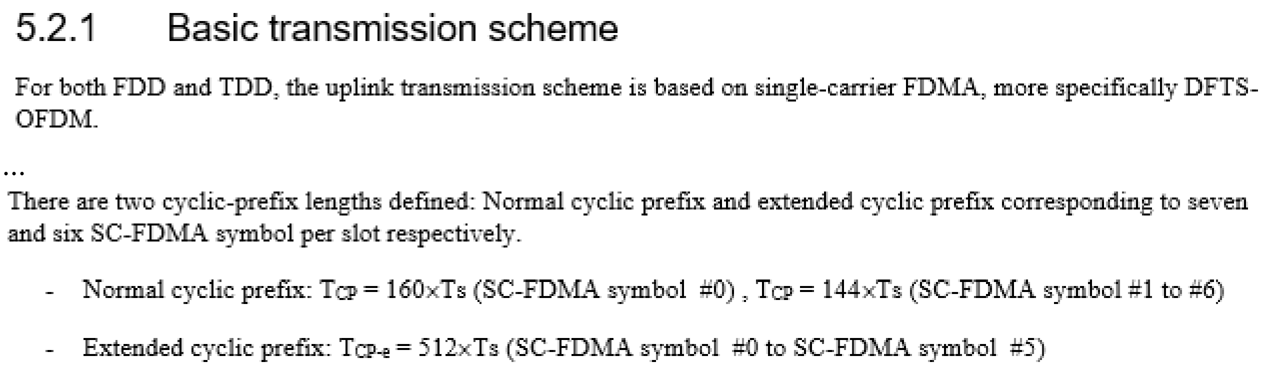


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

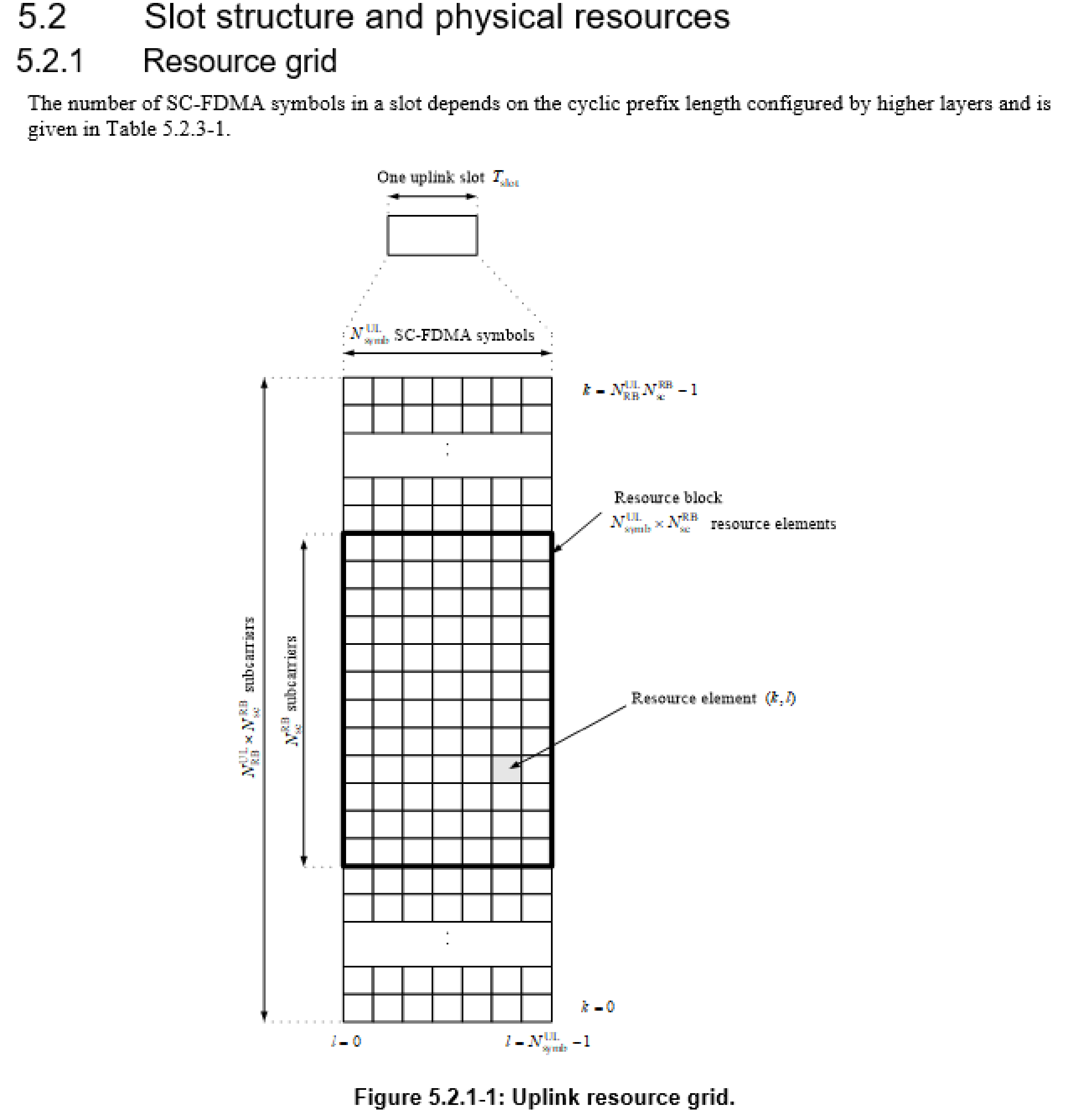
See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Honda's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_{s} Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{\mathrm{CP}} = 160 \times T_\mathrm{s}$ (SC-FDMA symbol #0) , $T_{\mathrm{CP}} = 144 \times T_\mathrm{s}$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{\mathrm{CP\text{-}e}} = 512 \times T_\mathrm{s}$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)

"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



5.2 Slot structure and physical resources

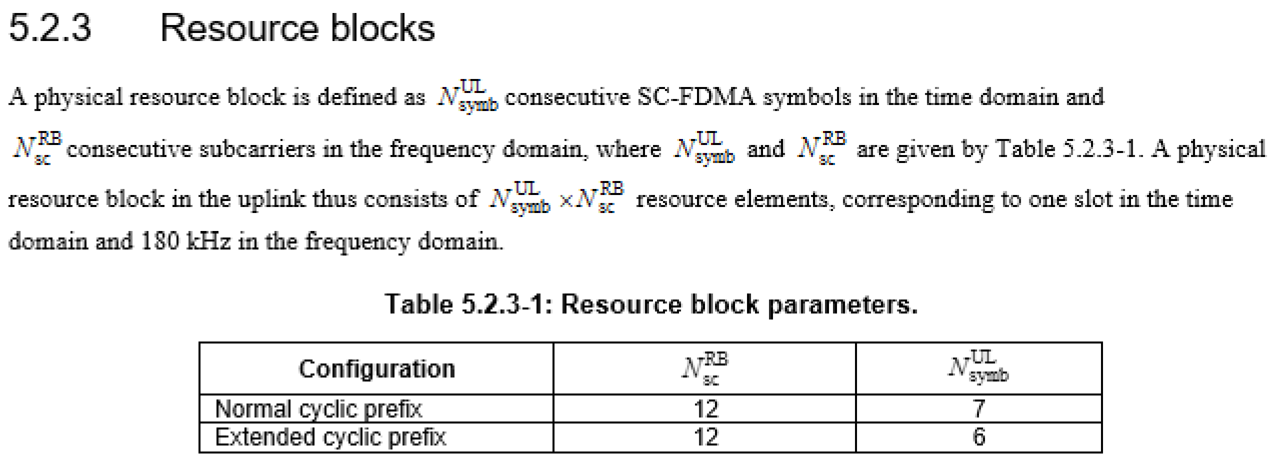
5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

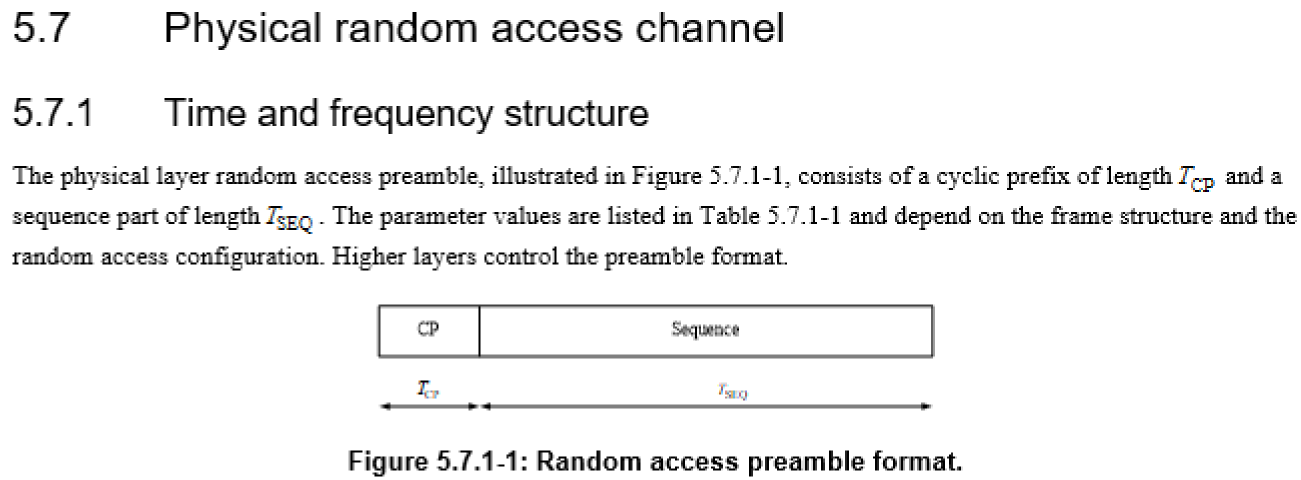
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

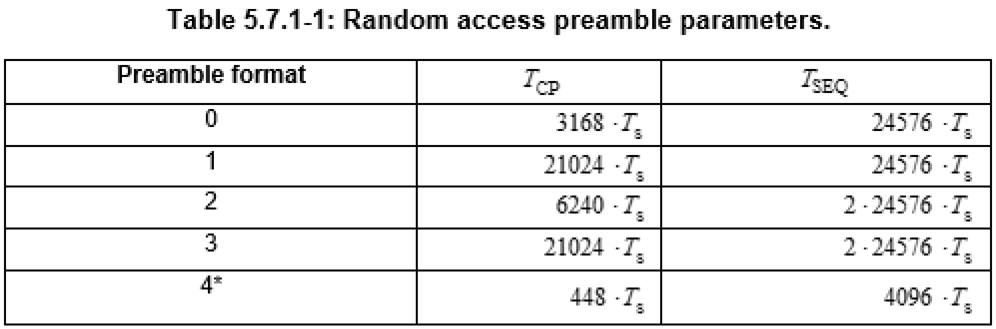


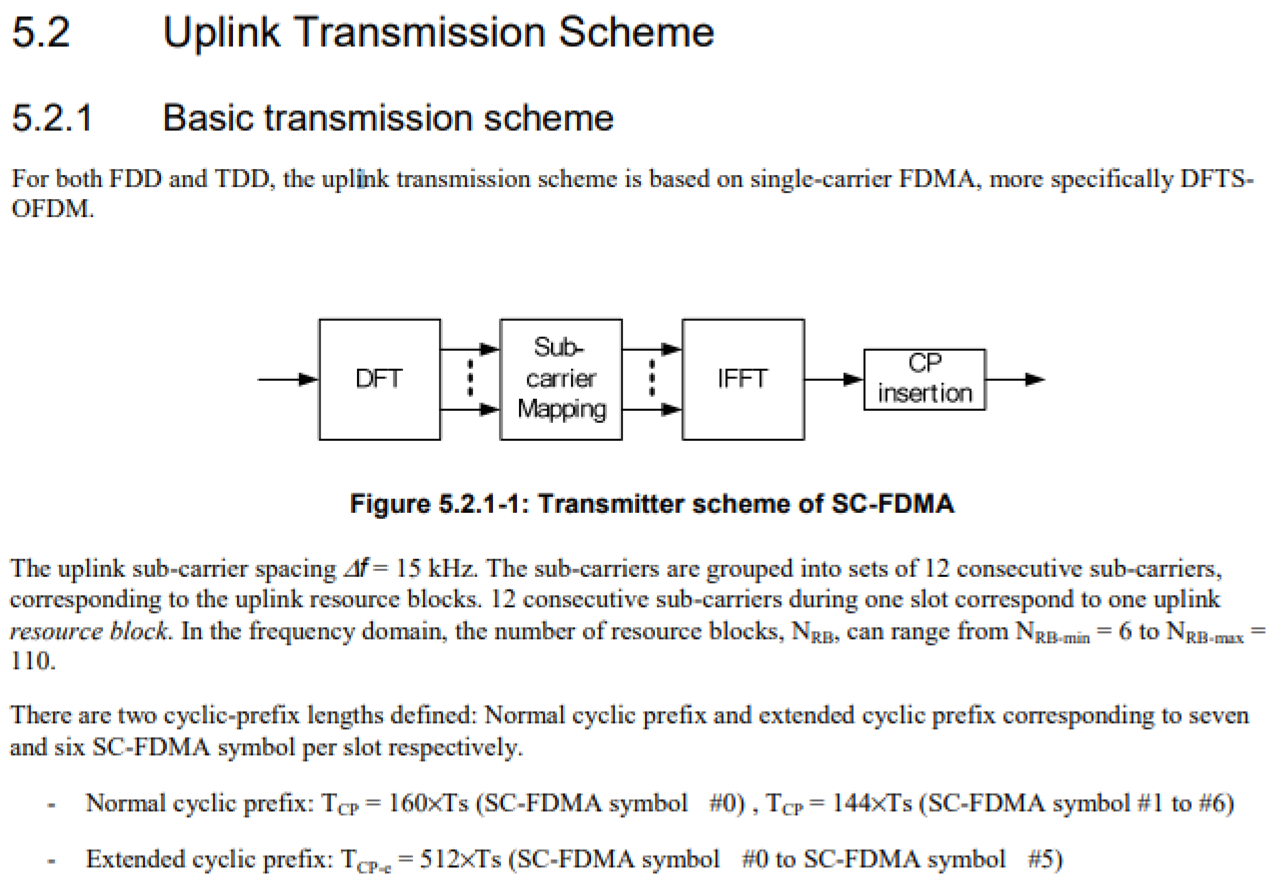
Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)

“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	Honda’s Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, Honda’s Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

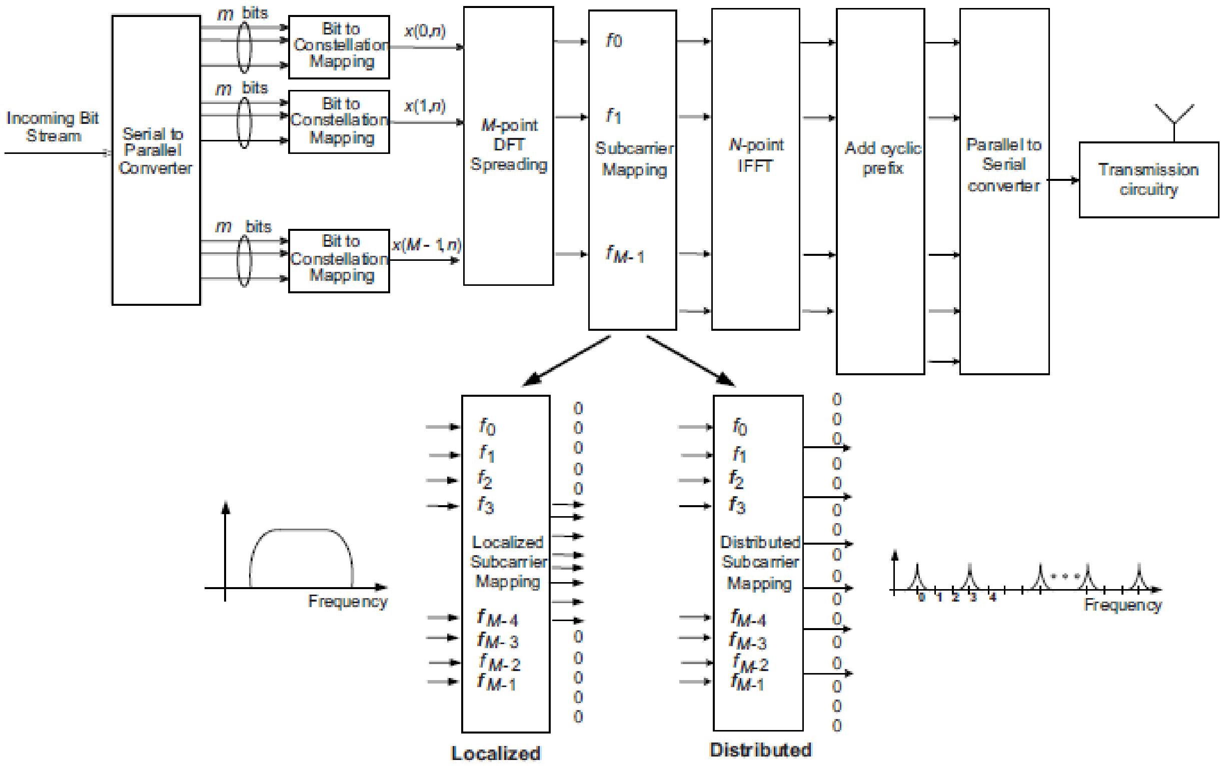


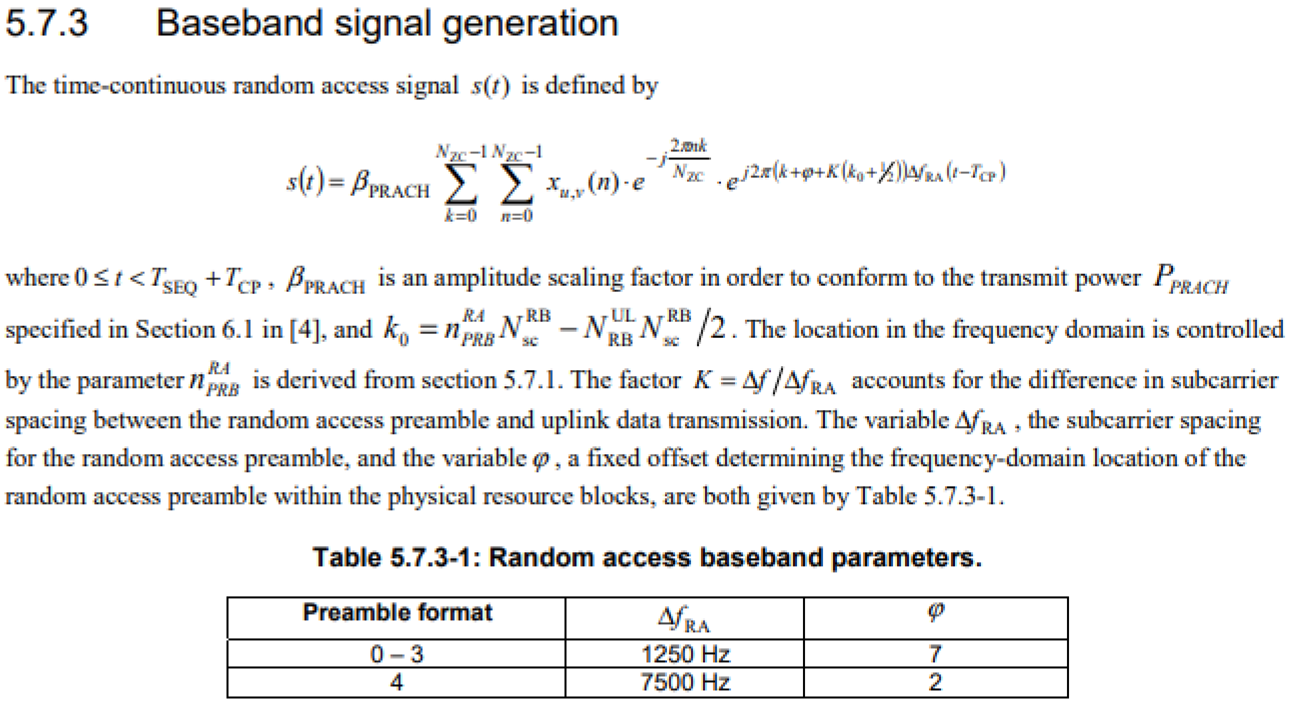
Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;

Honda's Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

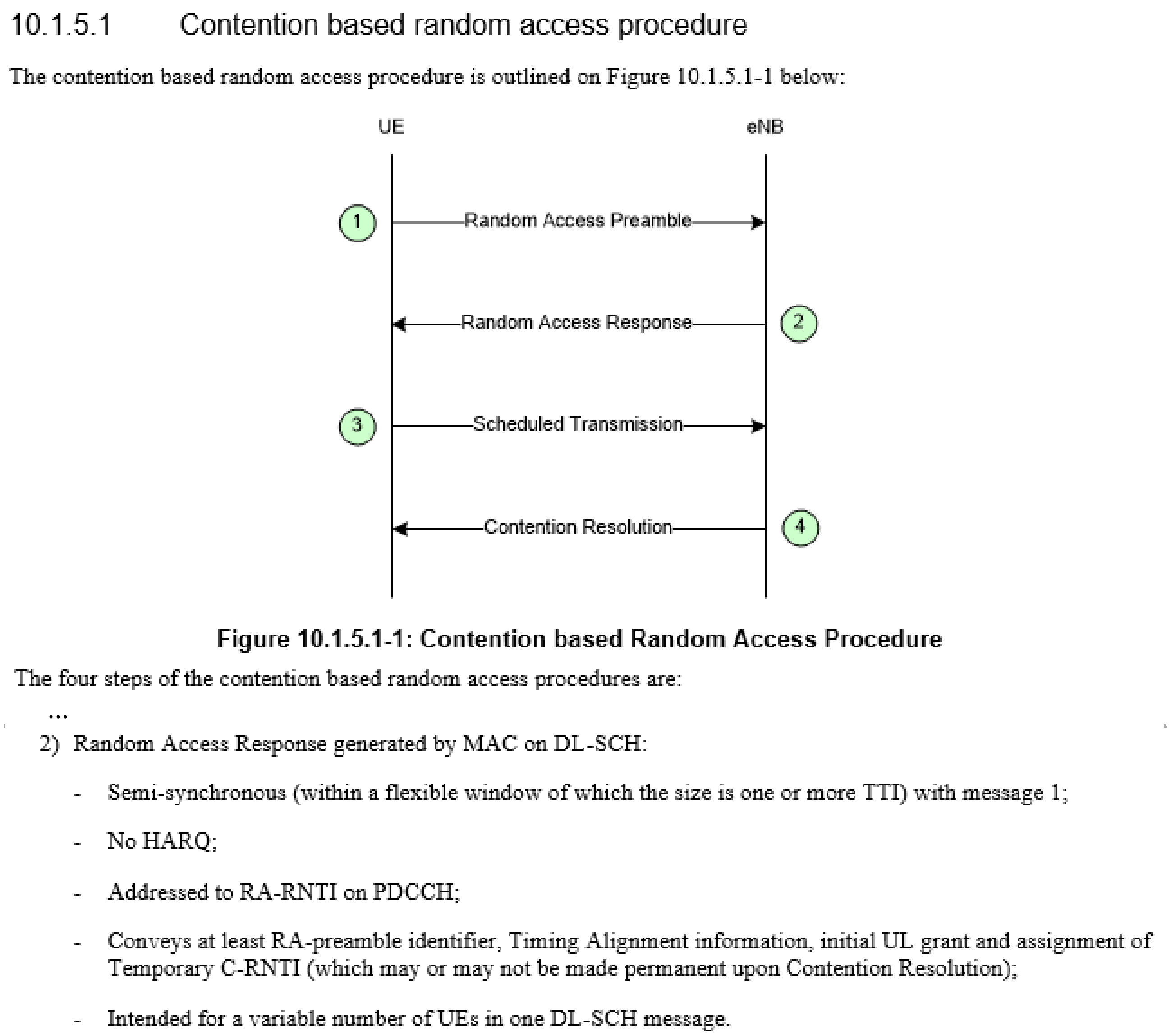
where $0 \le t < T_{\mathrm{SEQ}} + T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\mathrm{sc}}^{\mathrm{RB}} - N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}} / 2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

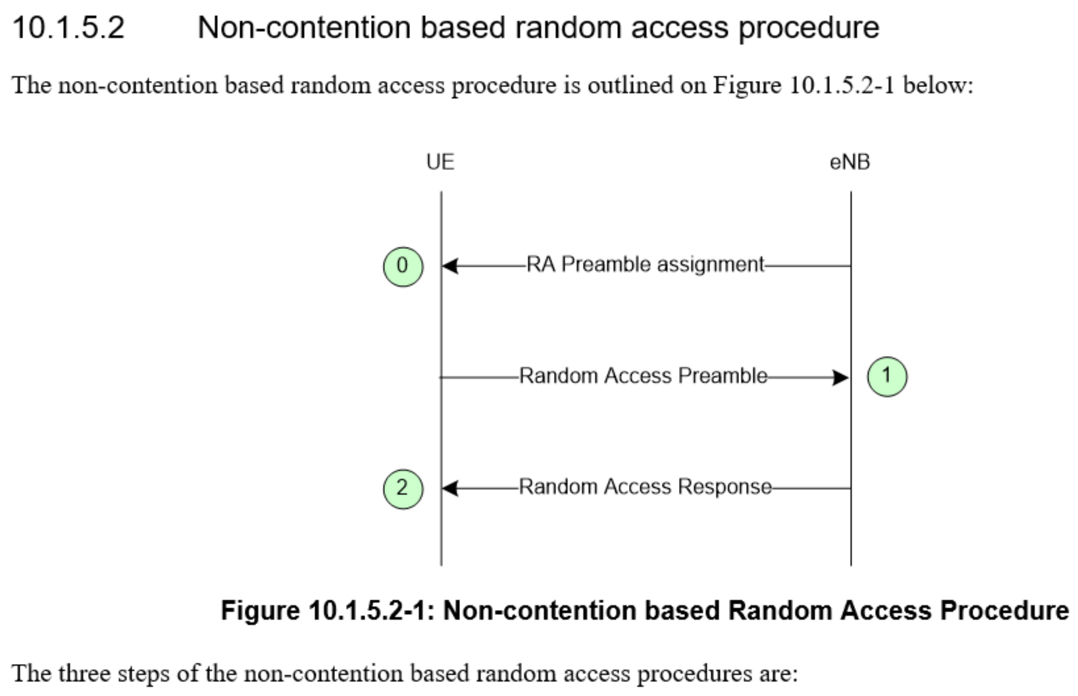
See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

wherein the mobile station is further configured to receive, from the base station, a second analog signal	Honda’s Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



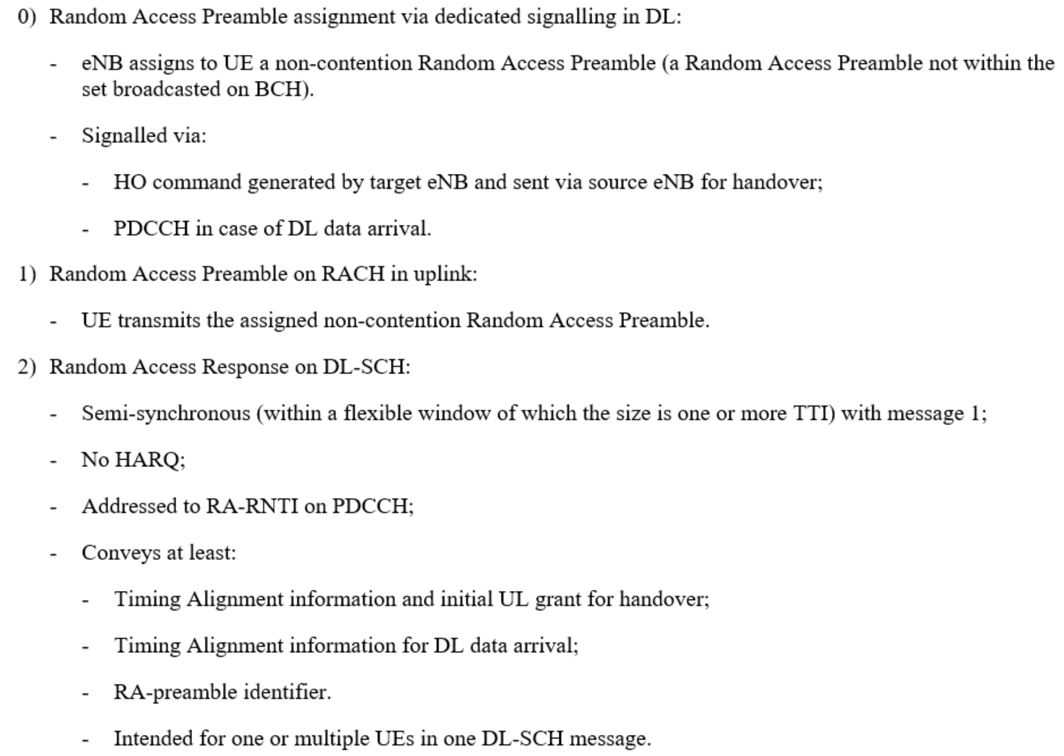
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

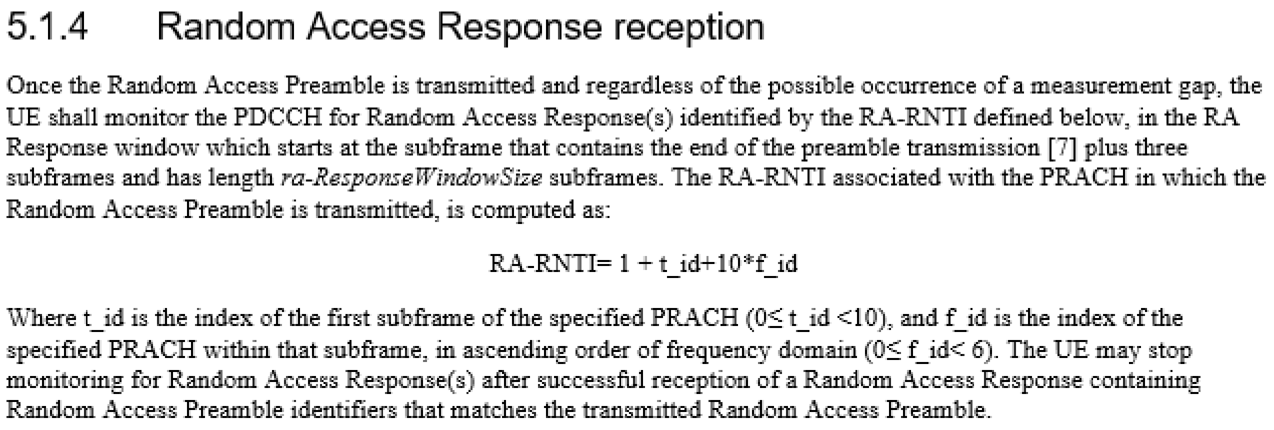
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

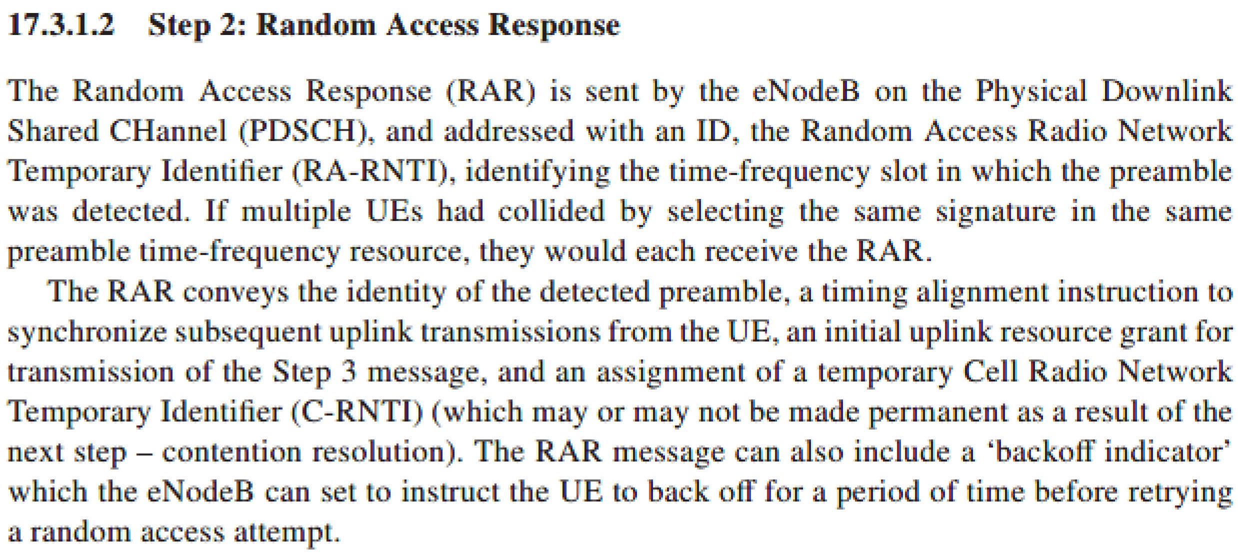
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

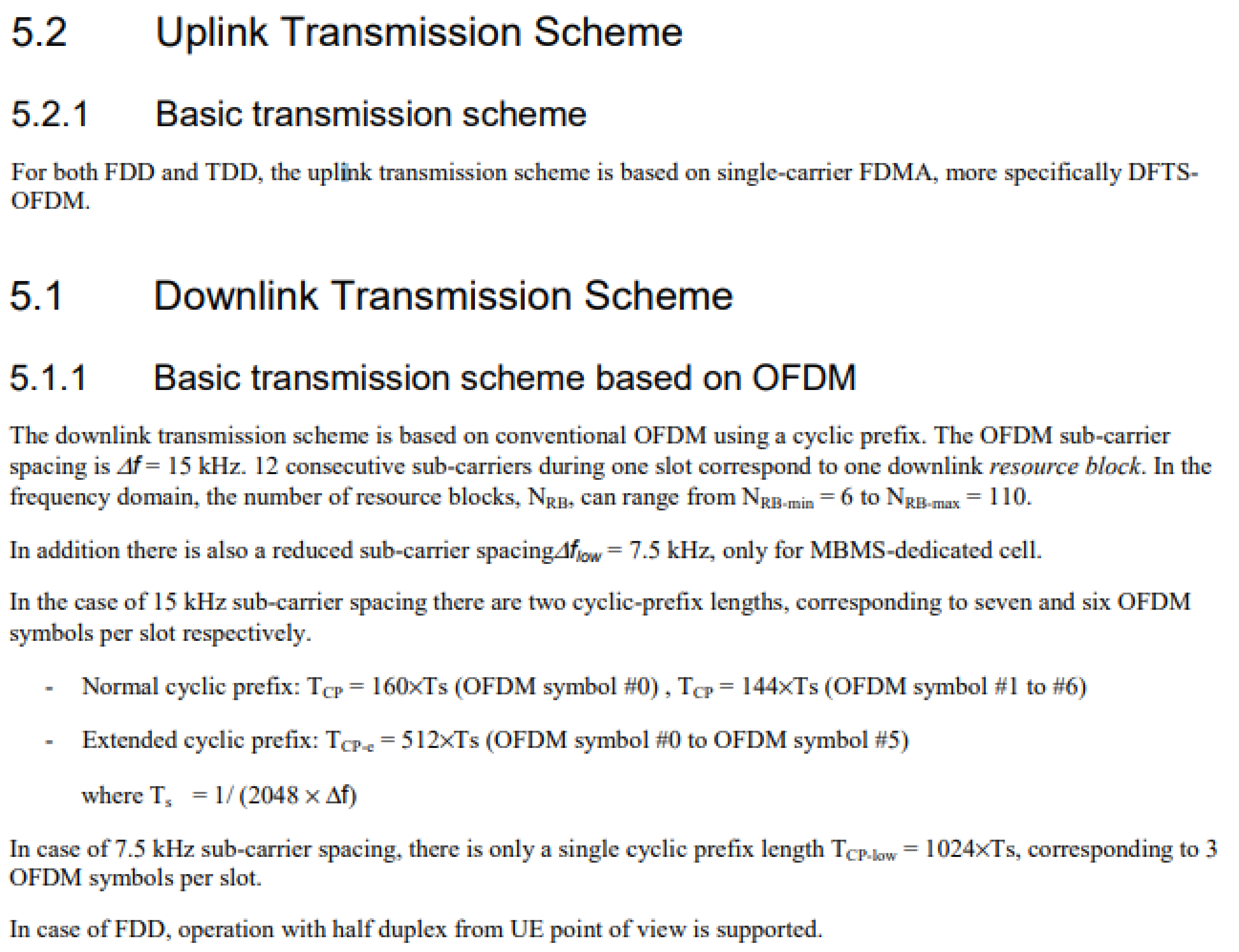
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	Honda's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, Honda's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. 5.1 Downlink Transmission Scheme 5.1.1 Basic transmission scheme based on OFDM The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110. In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (OFDM symbol #0) , T_{CP} = 144×Ts (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low}$ = 1024×Ts, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

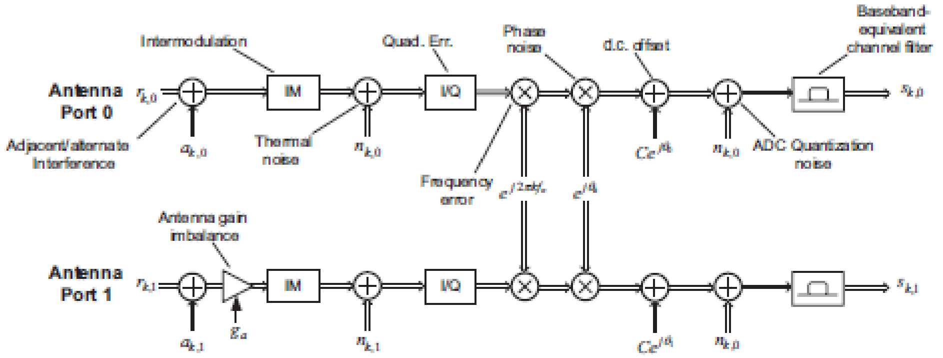


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.

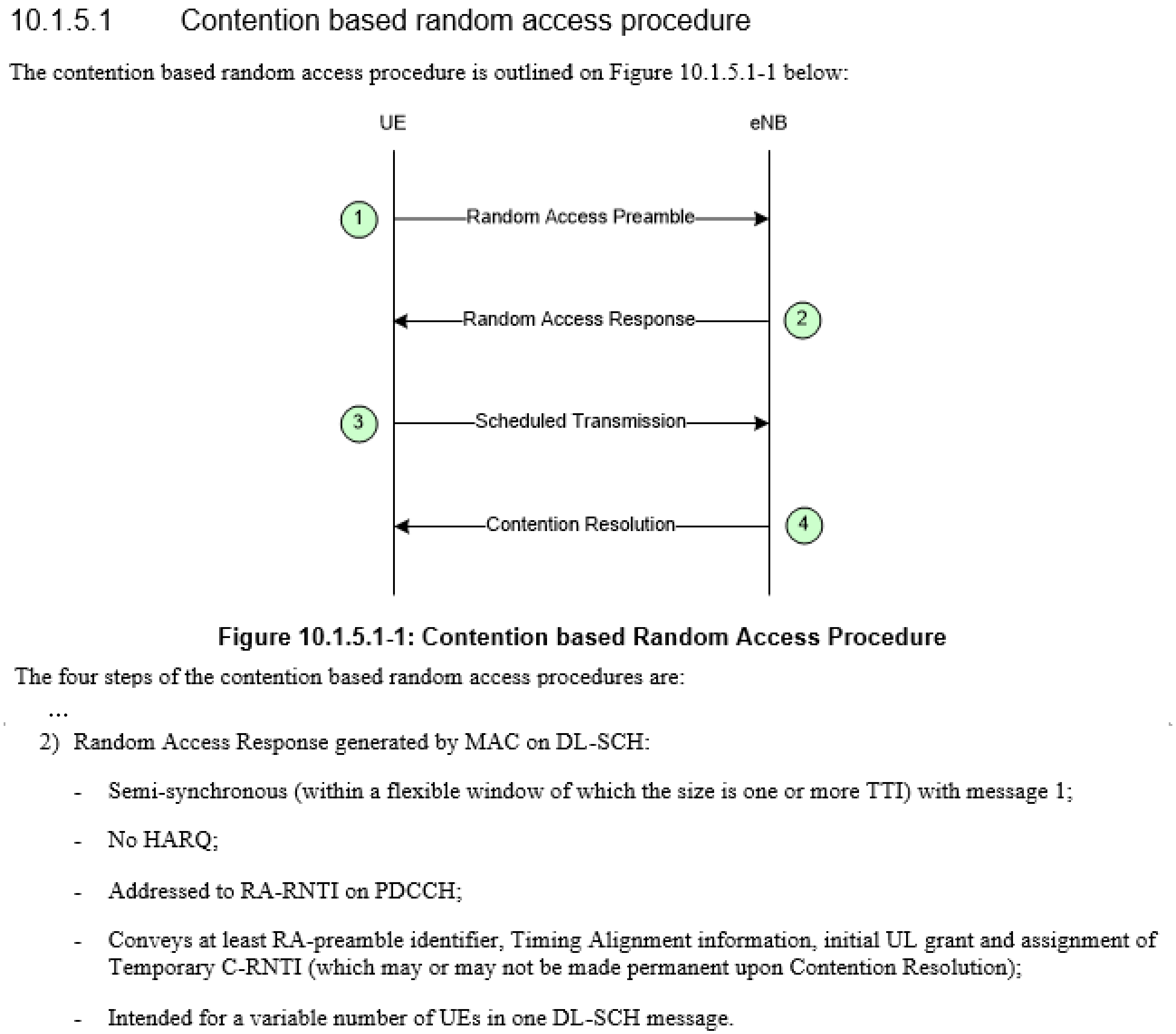
- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

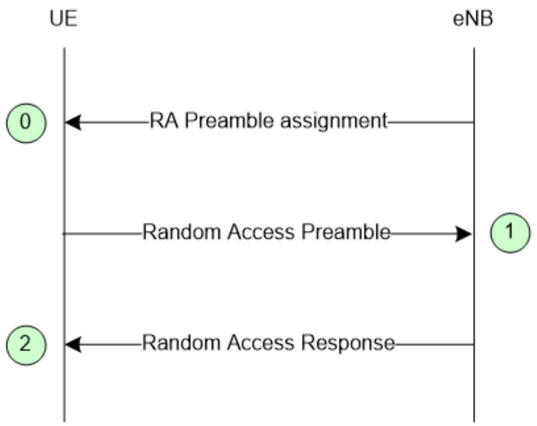
...

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

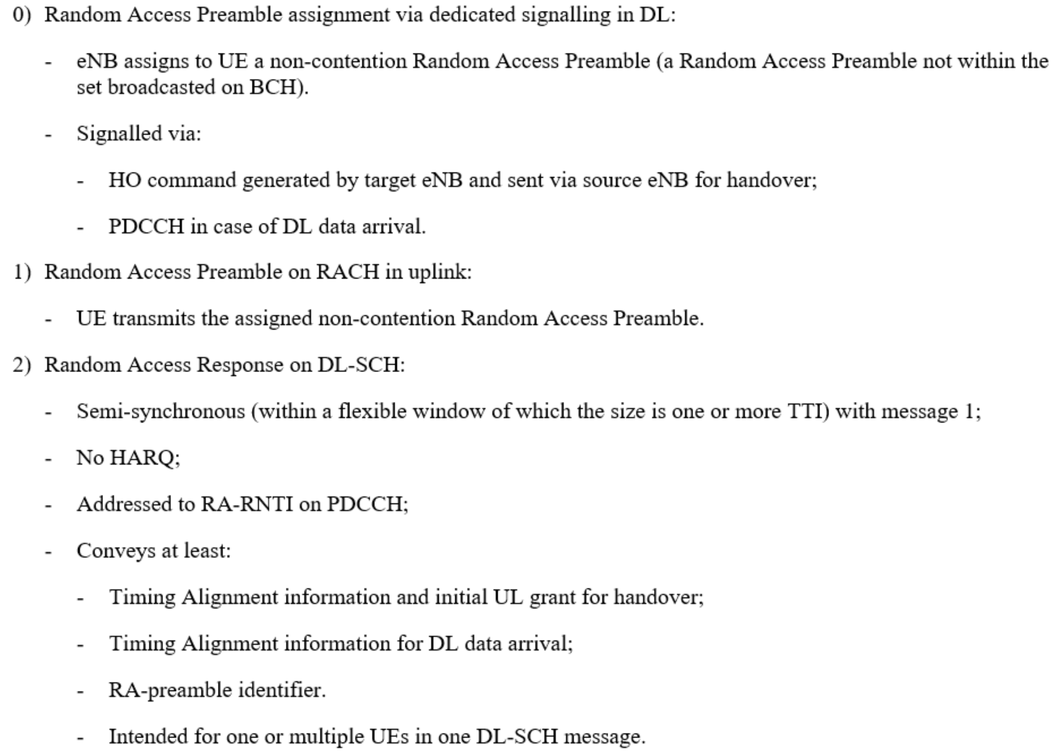
See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 21(h)
“wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message..”

	10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

“wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message..”

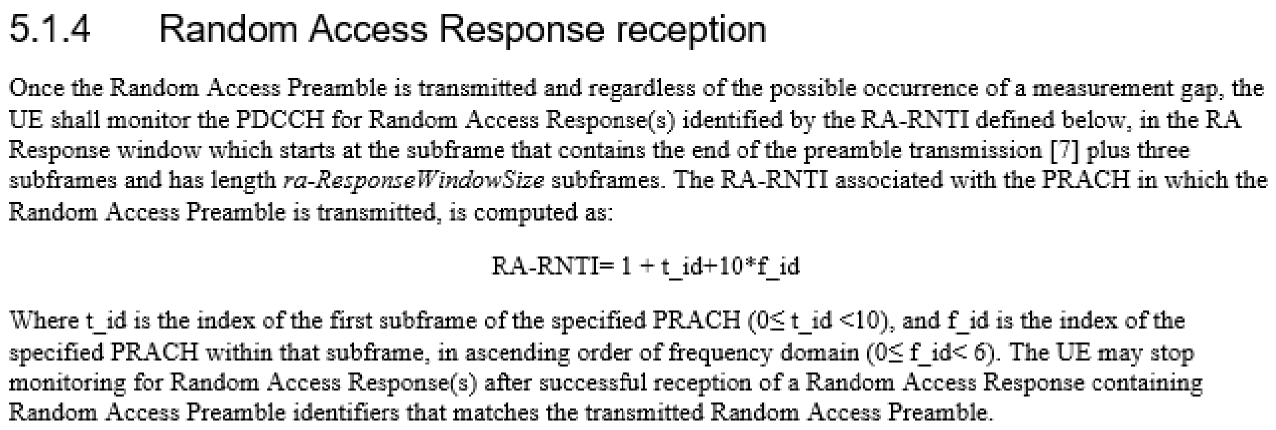


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



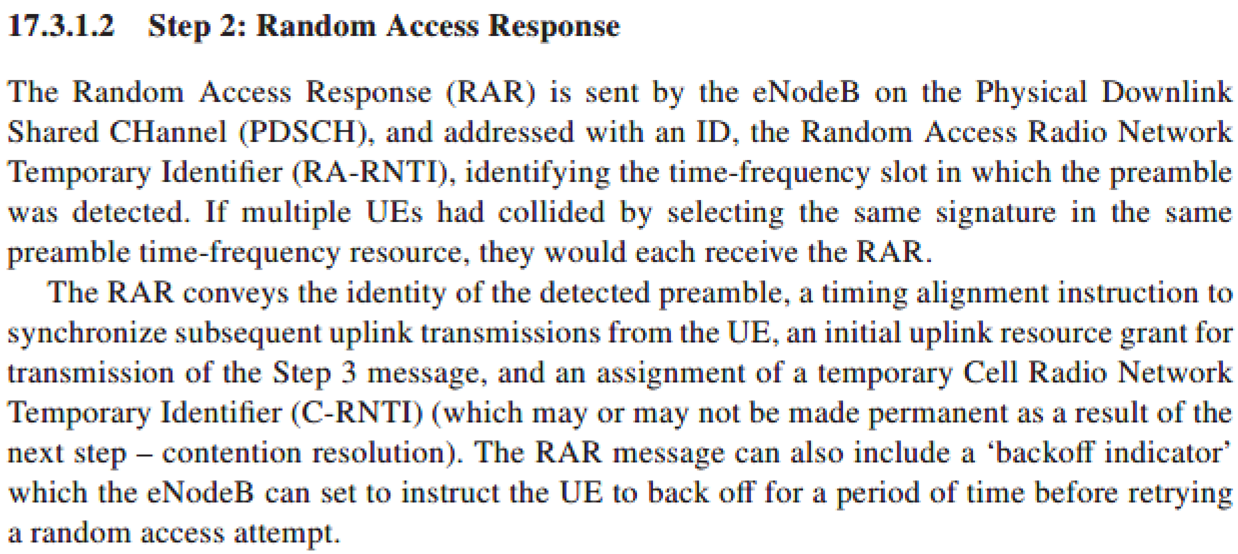
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

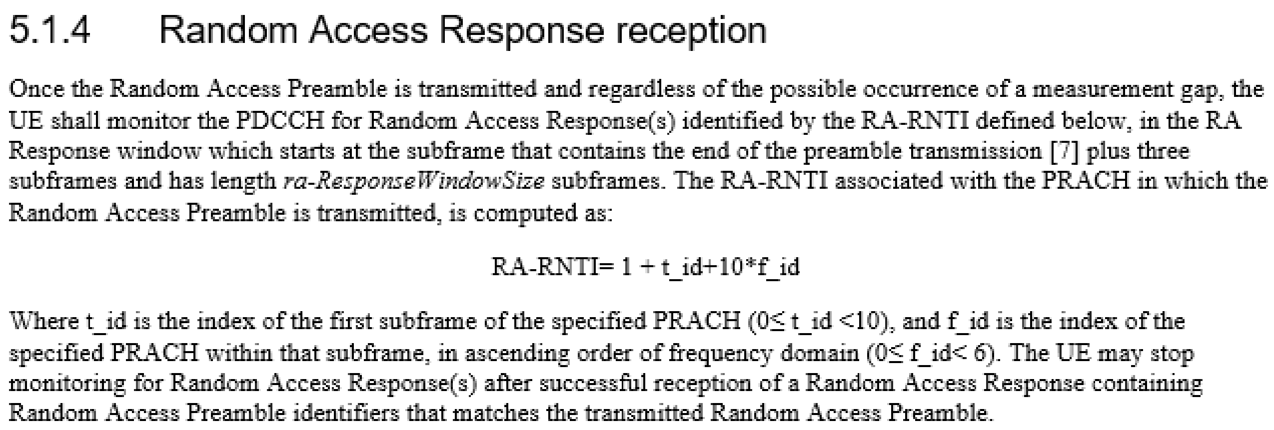
US Patent No. 10,833,908: Claim 21(h)
“wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message..”

	See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

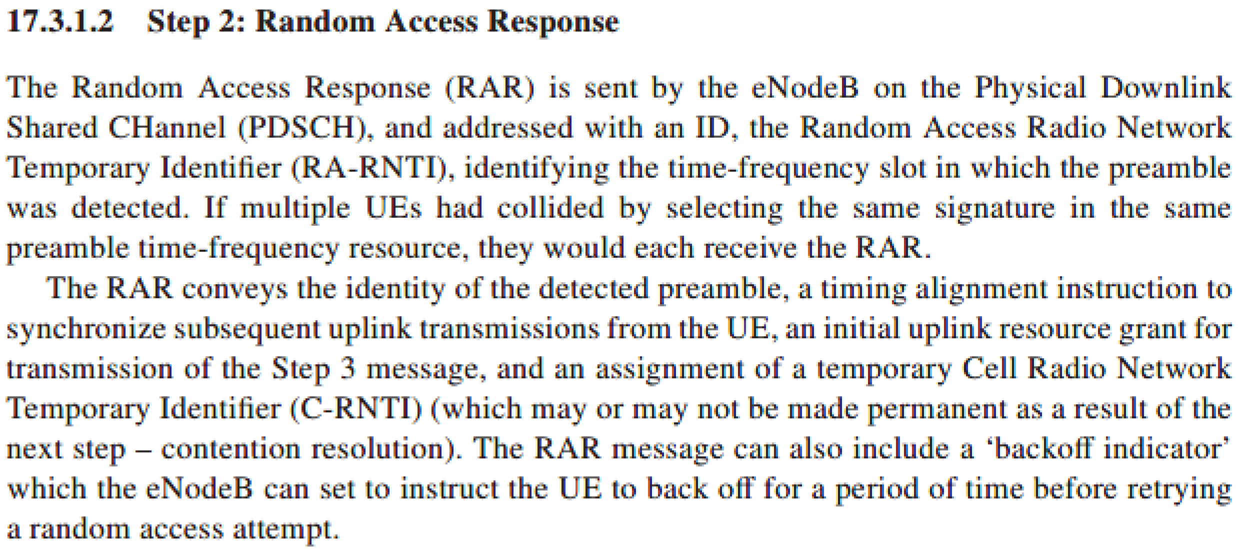
US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

22. The mobile station of claim 21, wherein:	*See* Claim 21.

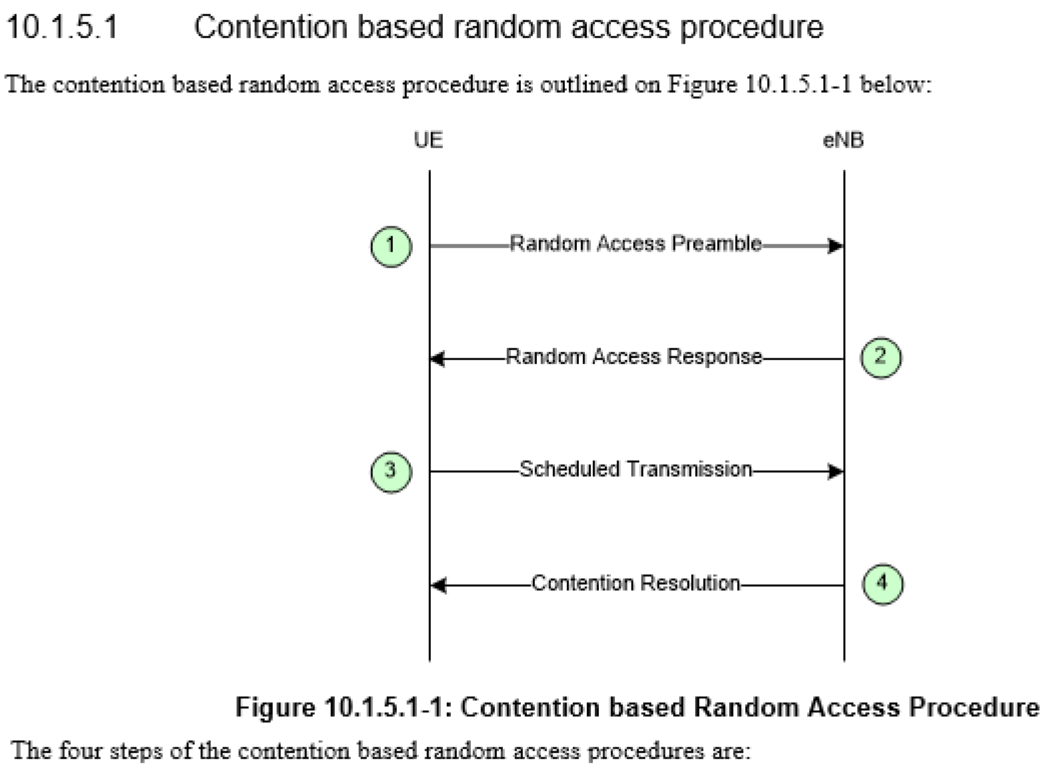
US Patent No. 10,833,908: Claim 22(b)
"the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and"

the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	Honda's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

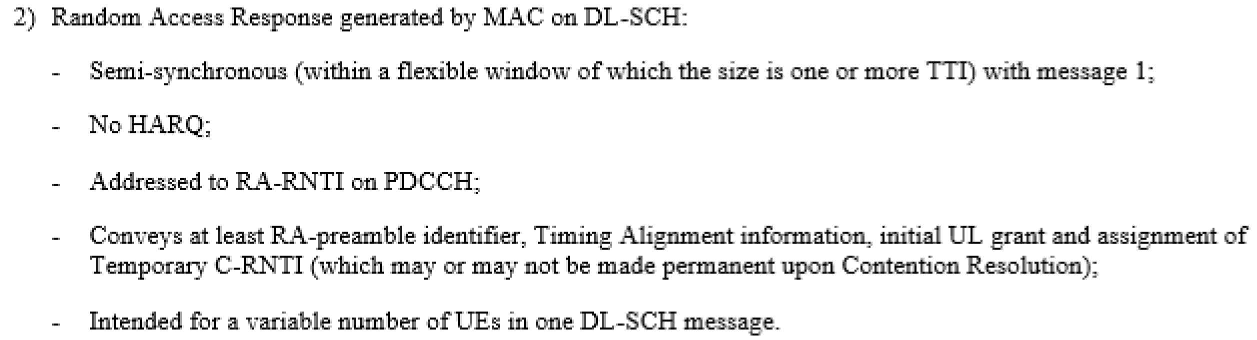
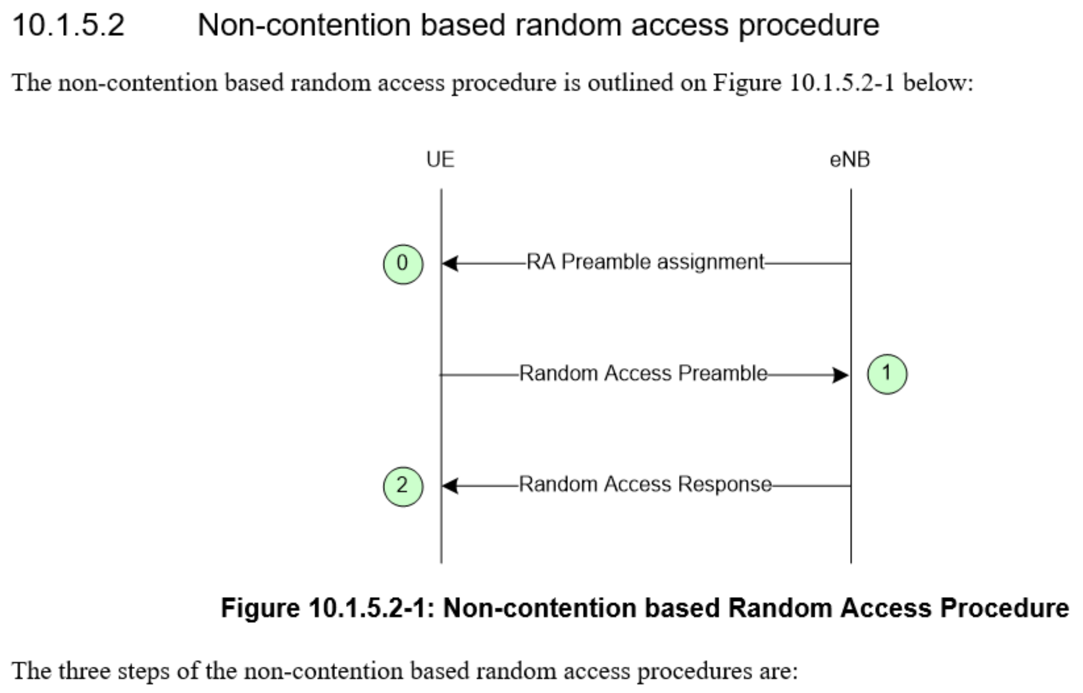
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

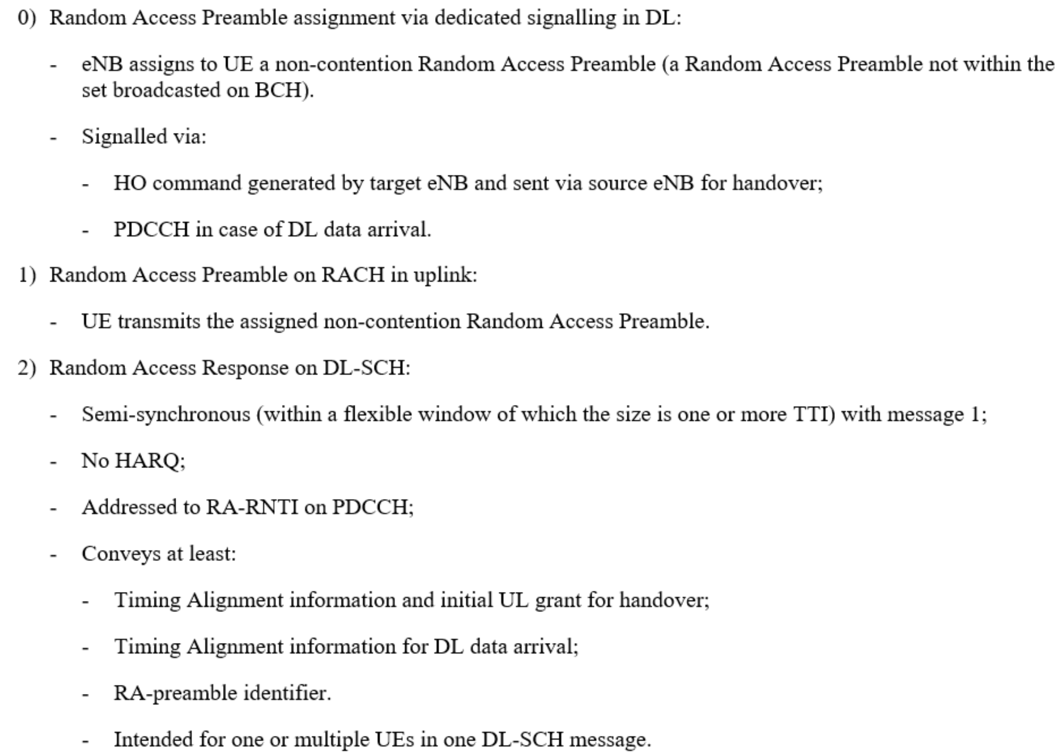
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Honda's Accused Instrumentalities transmits a second uplink signal. *E.g.*, When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

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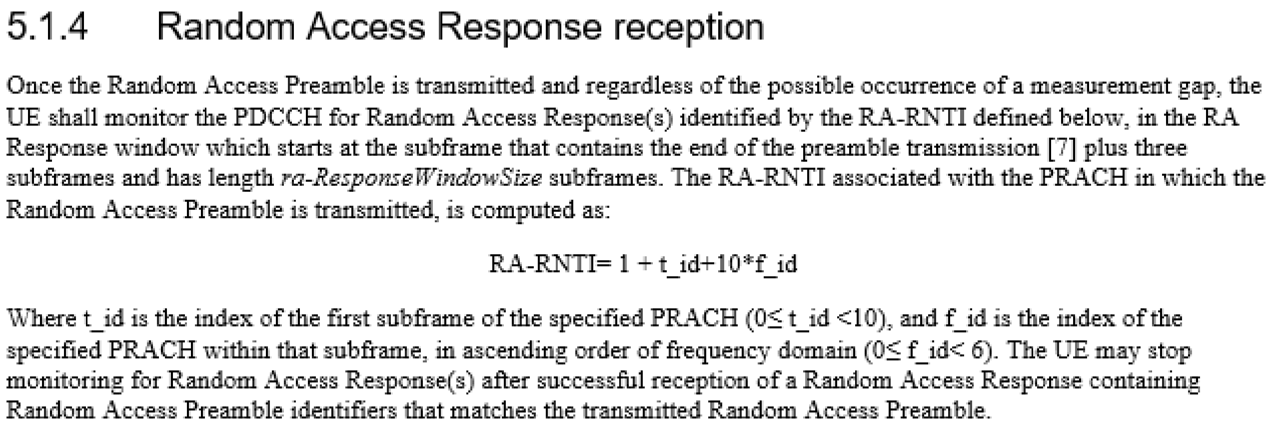
- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

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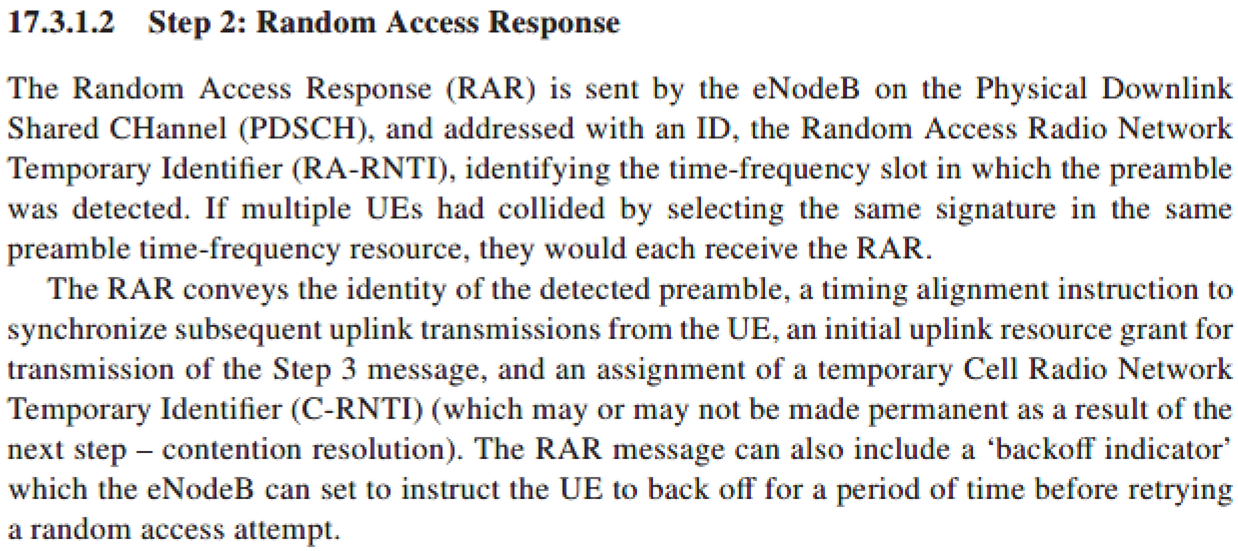
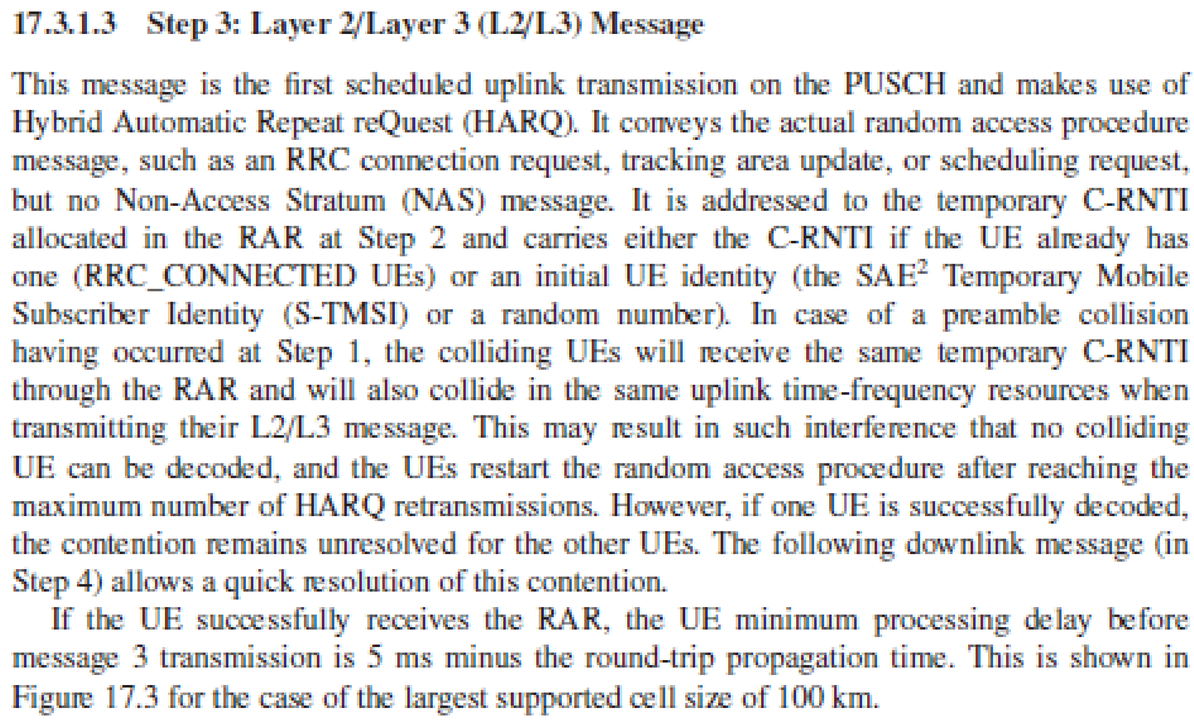
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

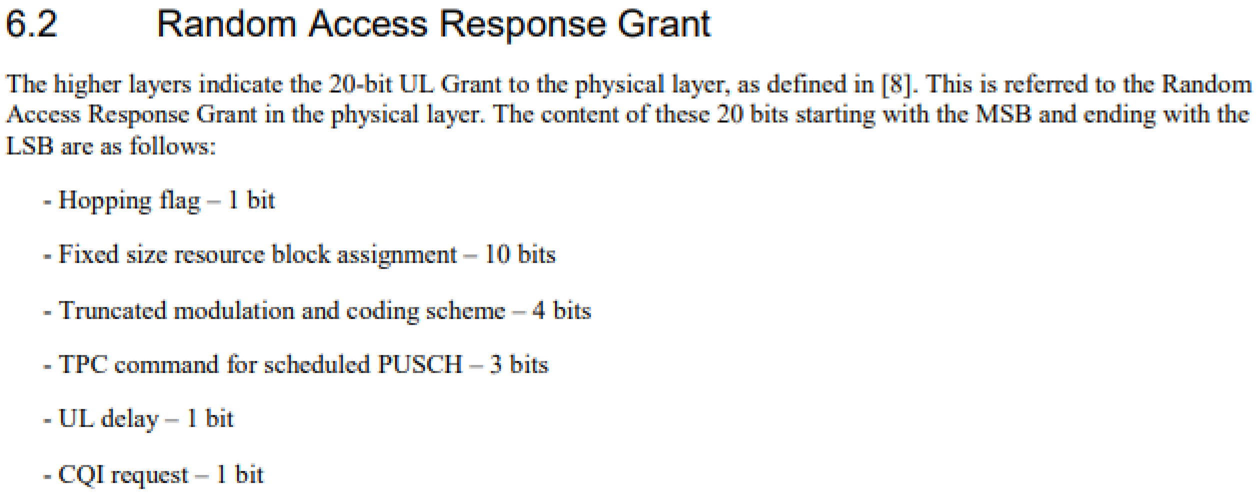
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

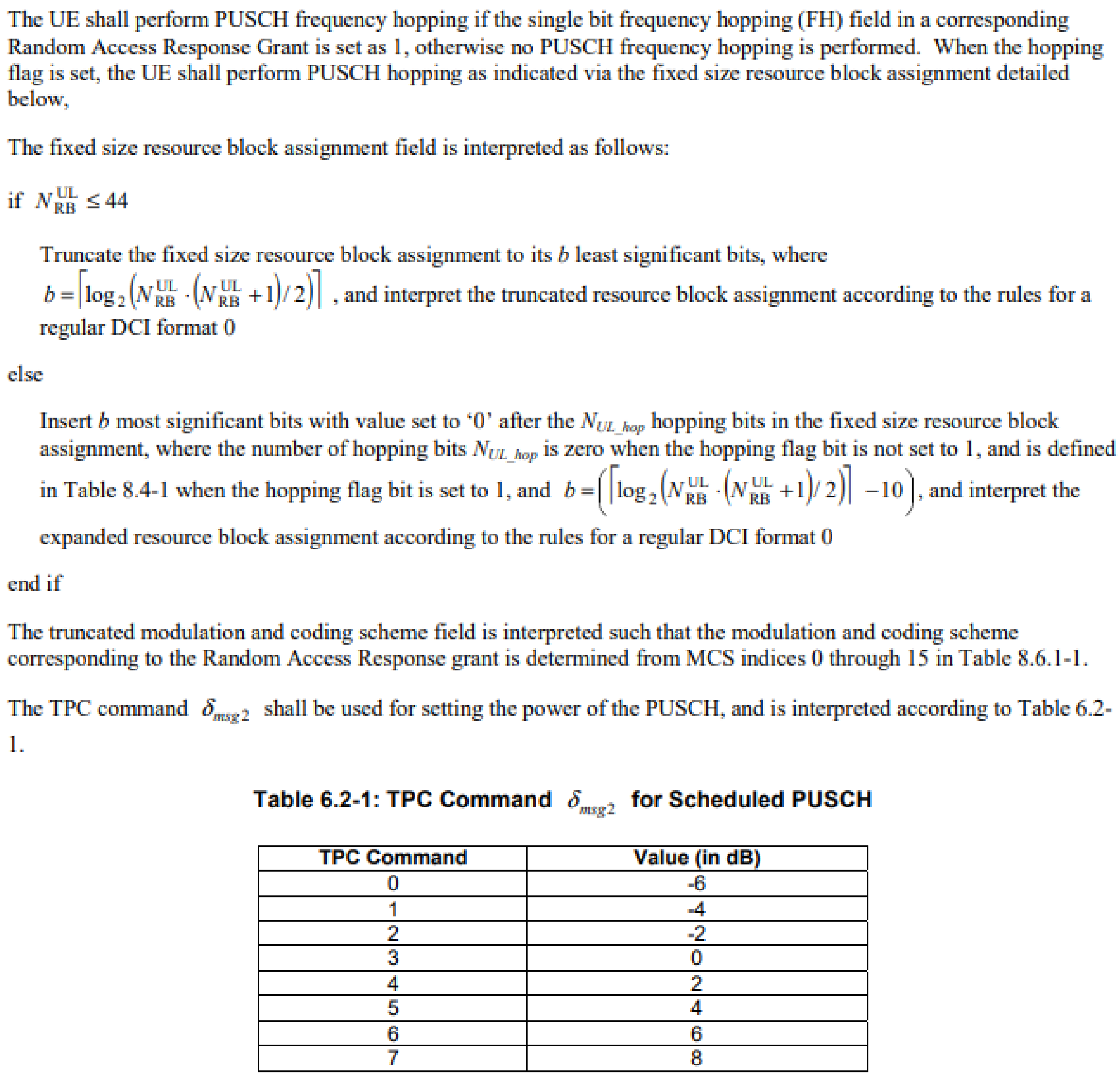
US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by Honda's Accused Instrumentalities includes power adjustment information. *E.g.,* *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

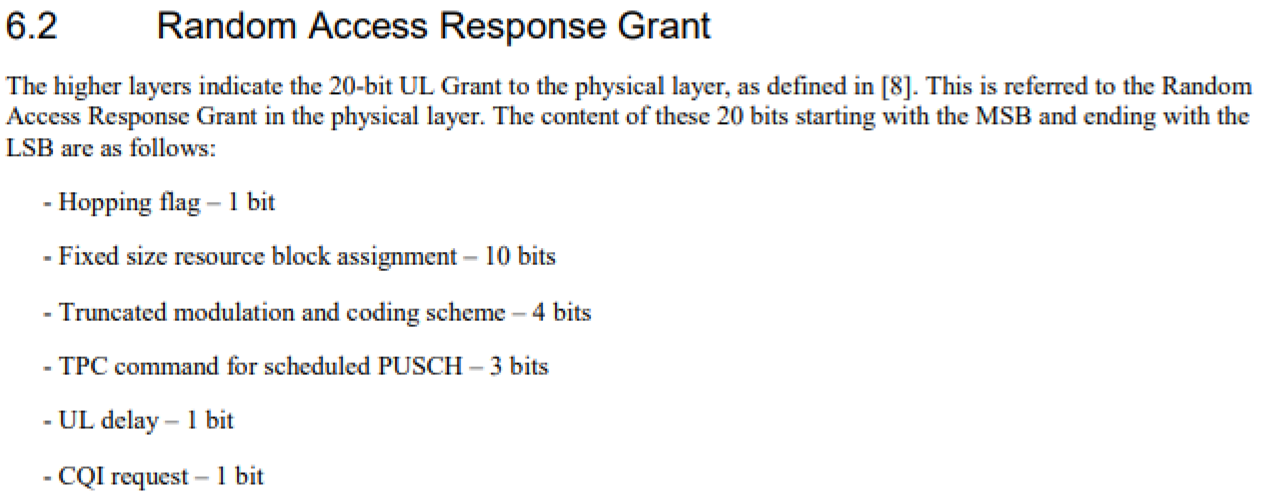
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

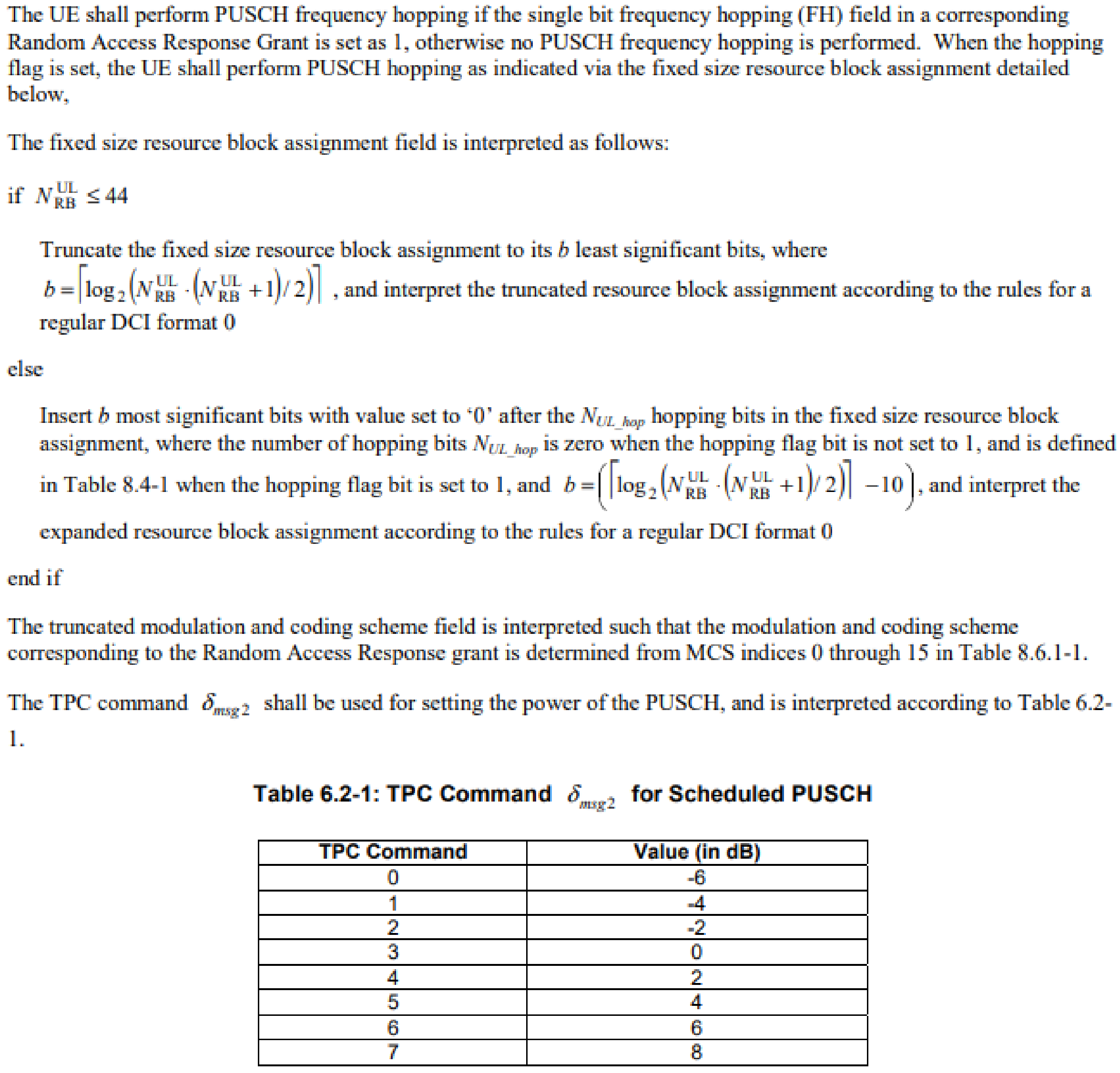
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	Honda's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

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0	-6
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2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

<table>
<tr>
<td>24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.</td>
<td>

The portion of the frequency band used for transmission of the random access signal by Honda’s Accused Instrumentalities does not include control channels. *E.g.,*

See Claim 21.

The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.

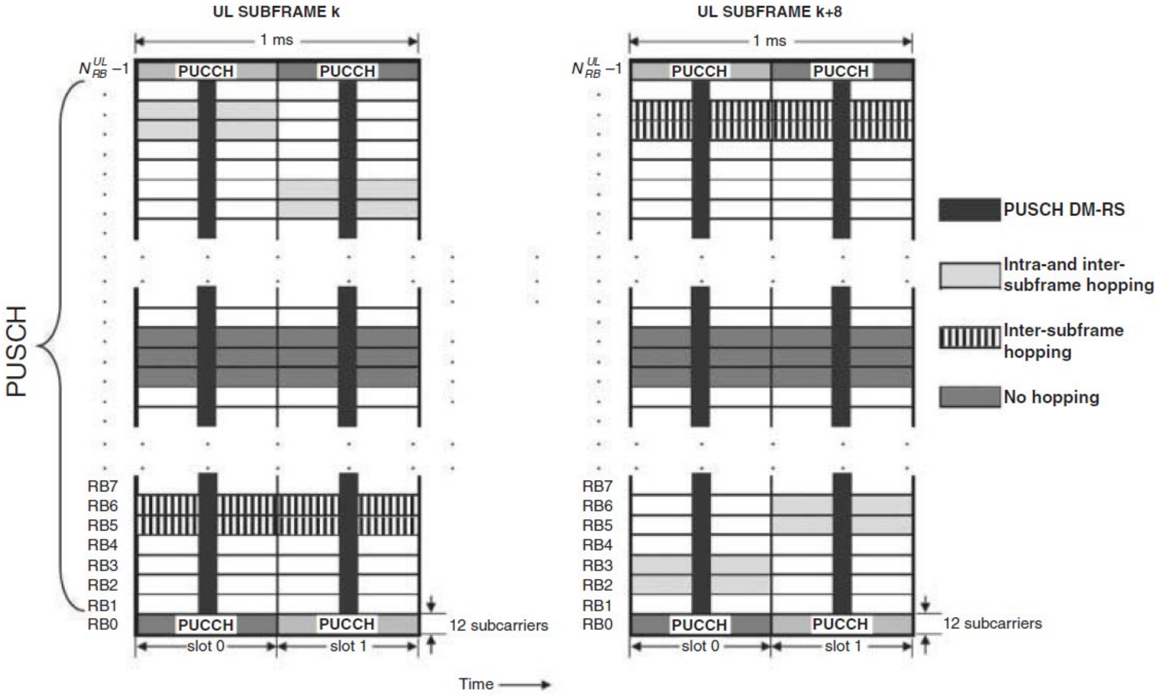


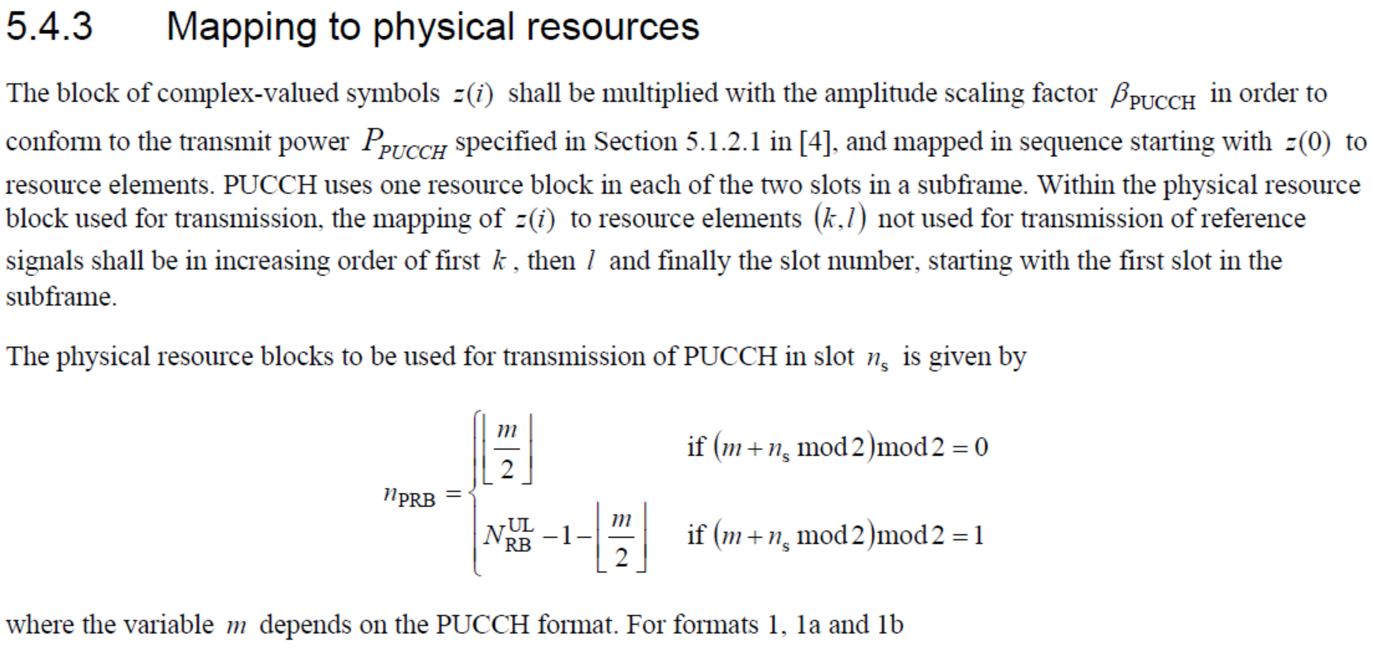
Figure 16.3: Uplink physical data channel processing.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

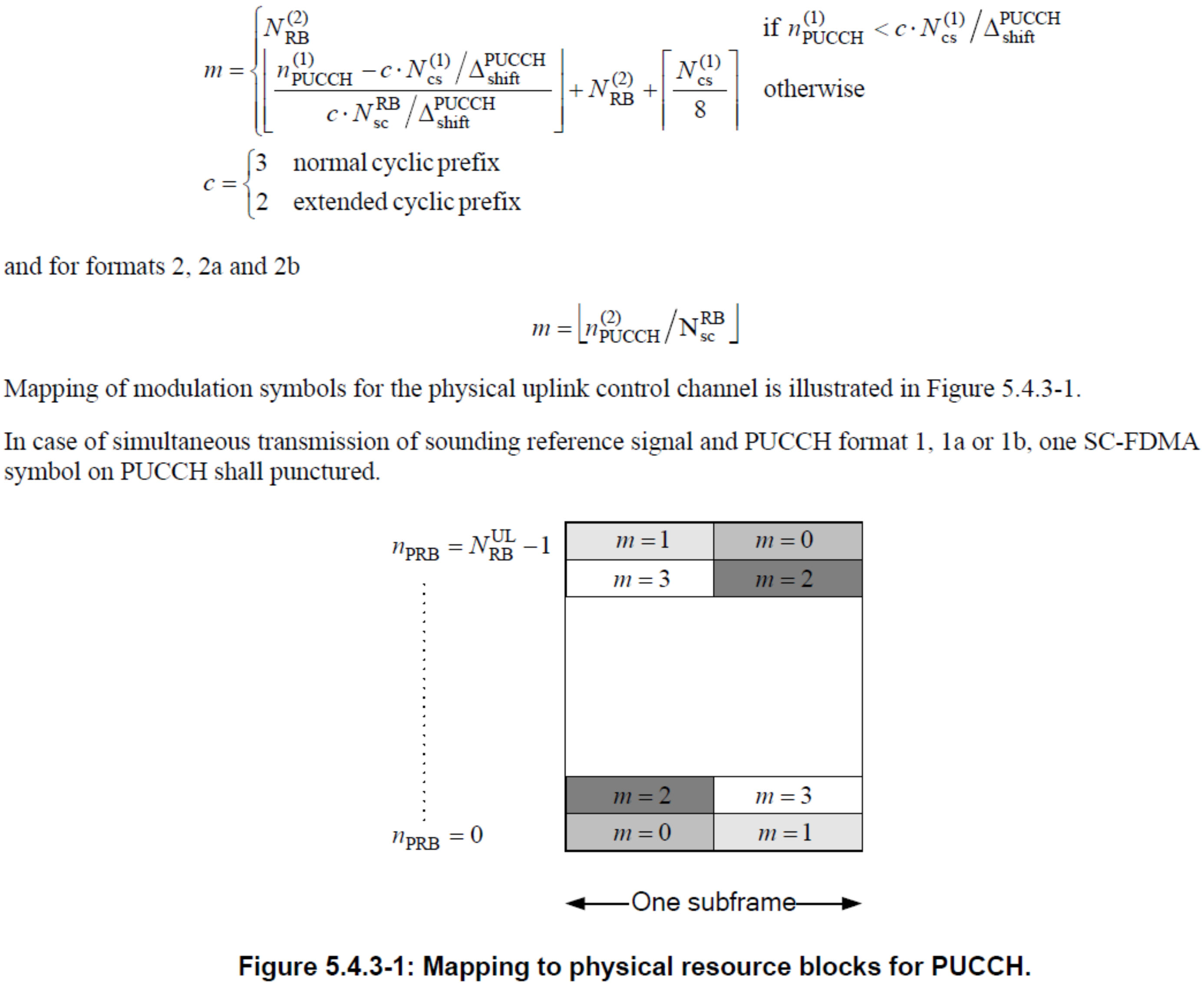
The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_\text{s} \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_\text{s} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

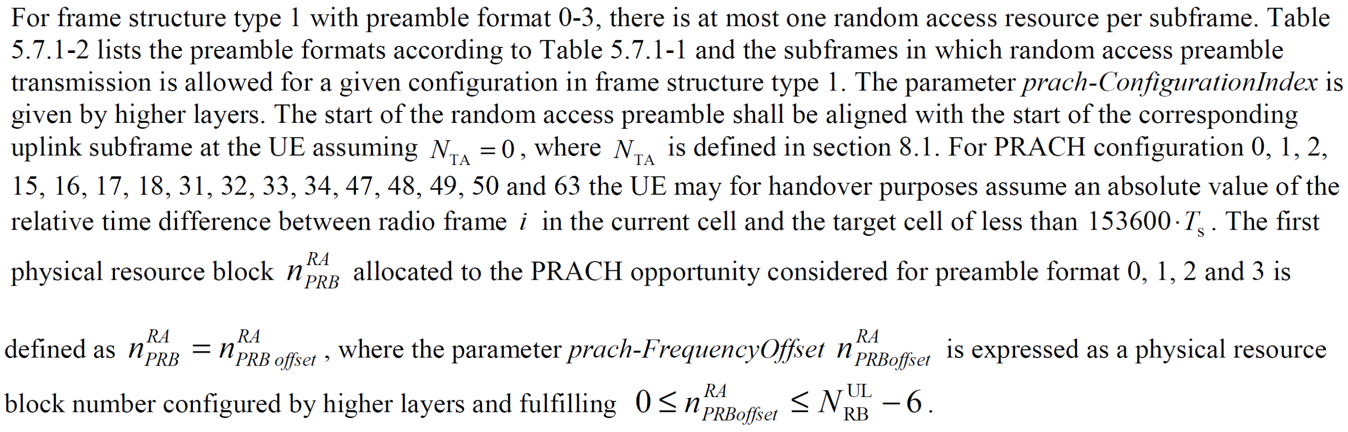
In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

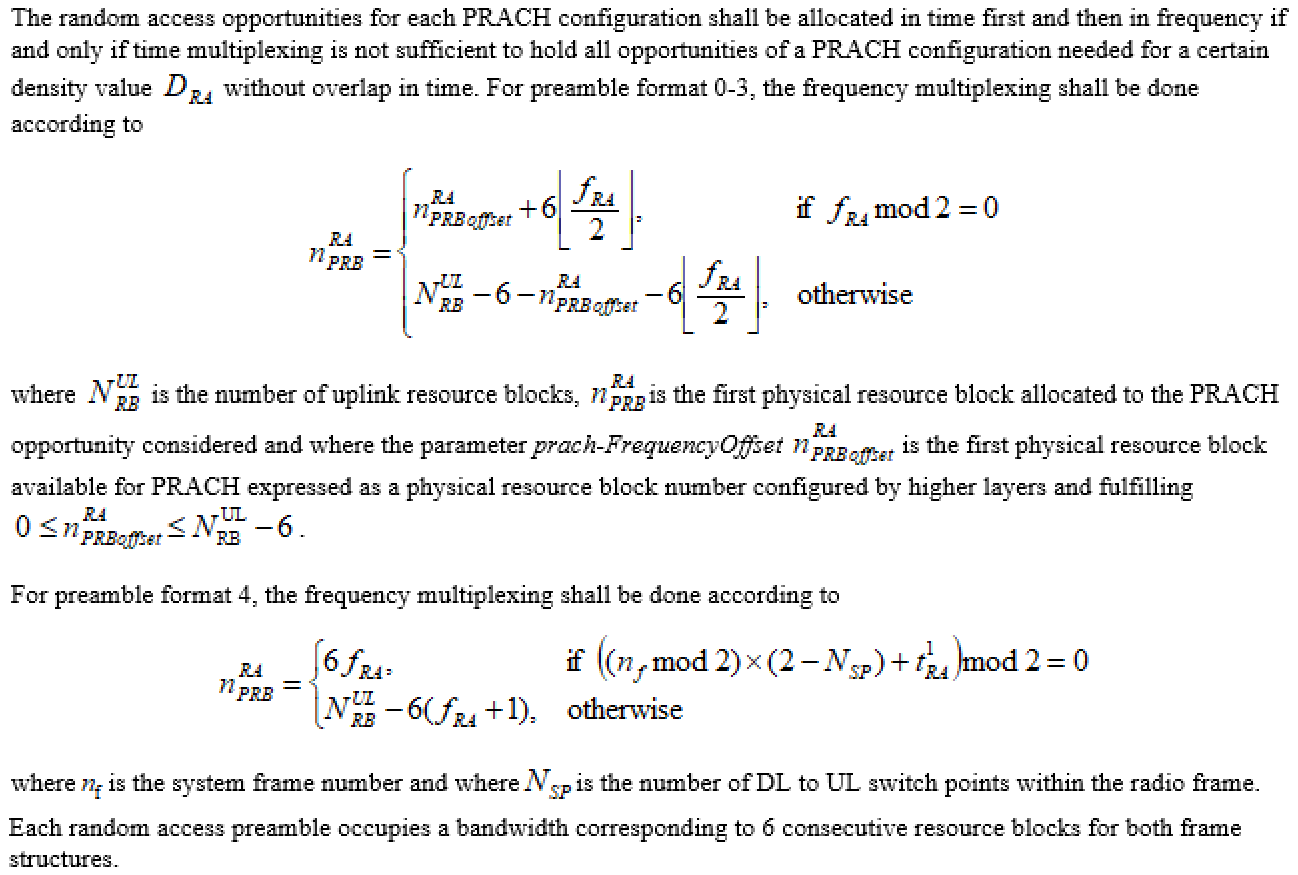
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure …  For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\,offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. …

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA} . Each quadruple of the format $(f_{RA}, t_{RA}^0, t_{RA}^1, t_{RA}^2)$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^0 = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^1 = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^2 is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^2 is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_s$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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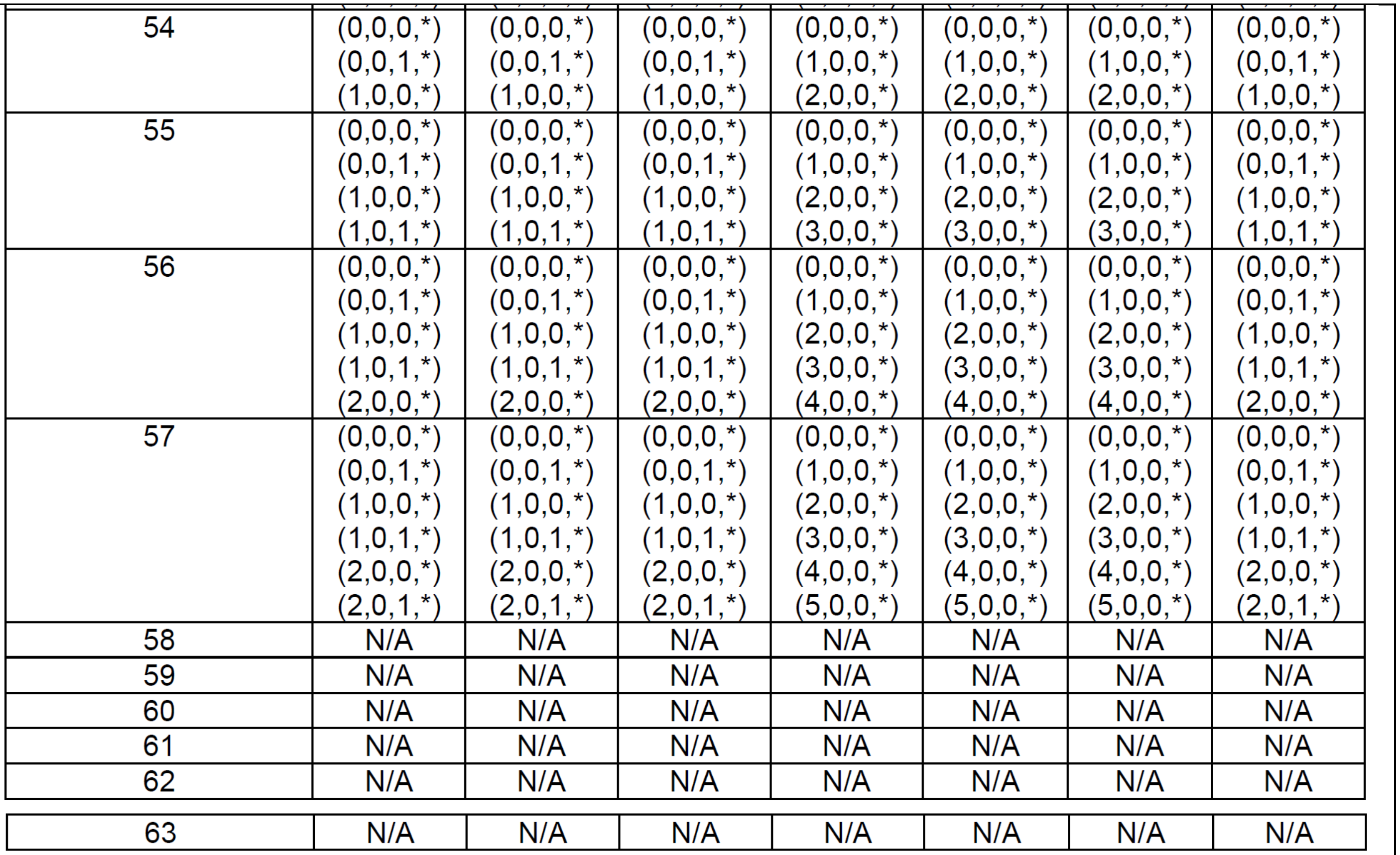
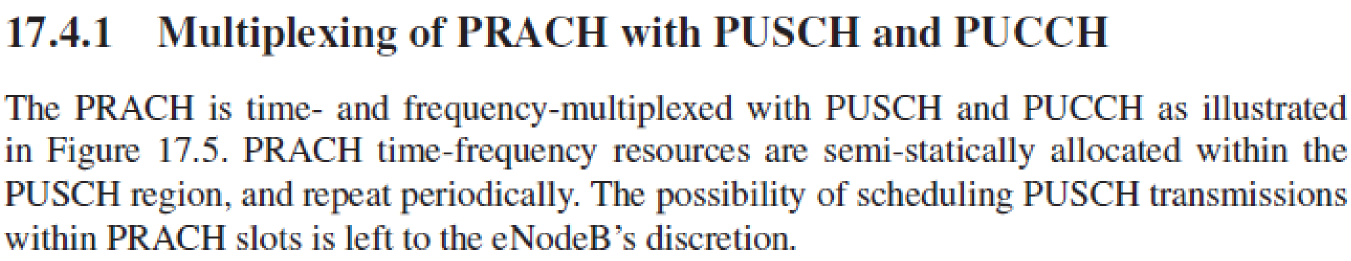


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

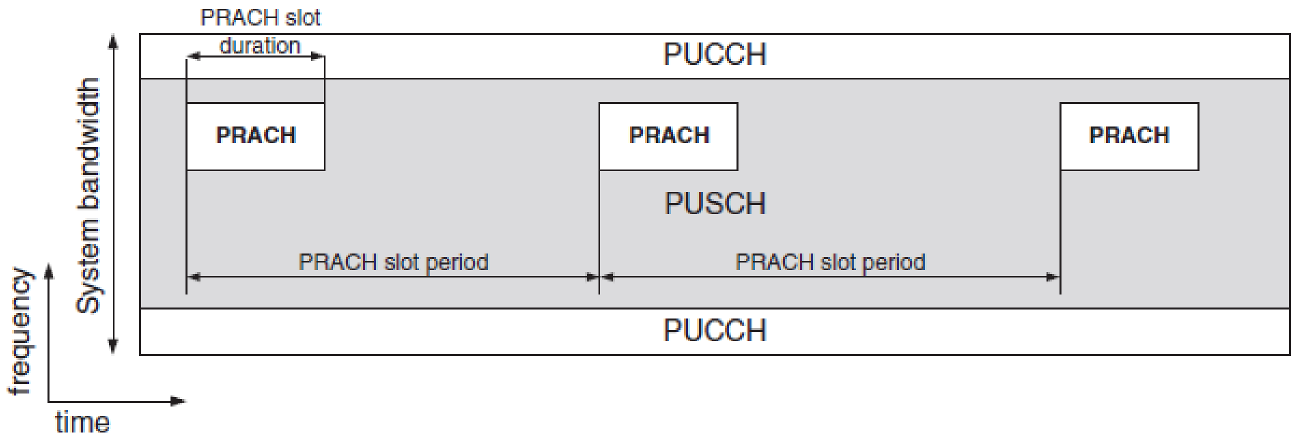


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

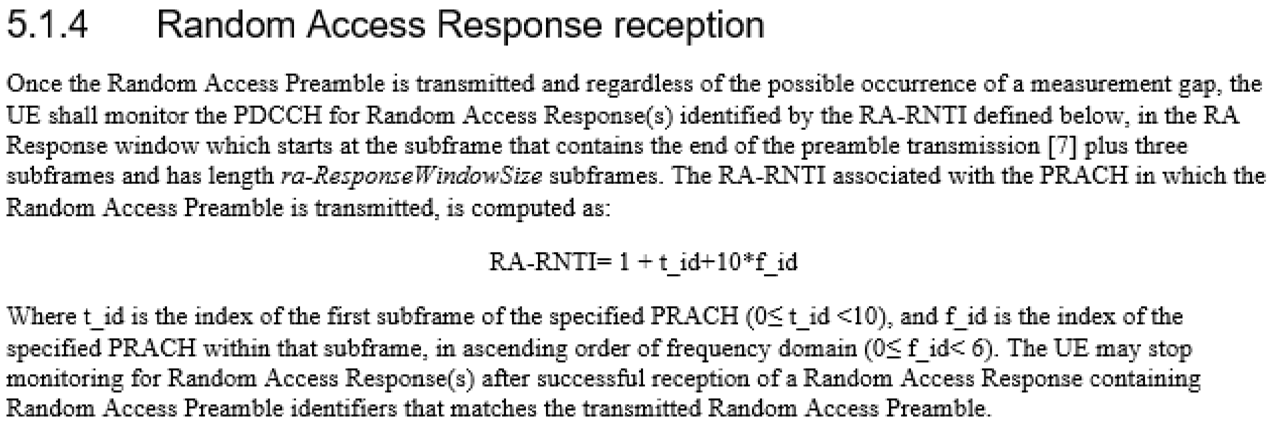
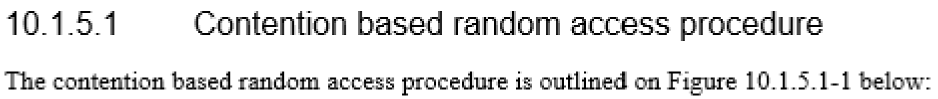
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Honda's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

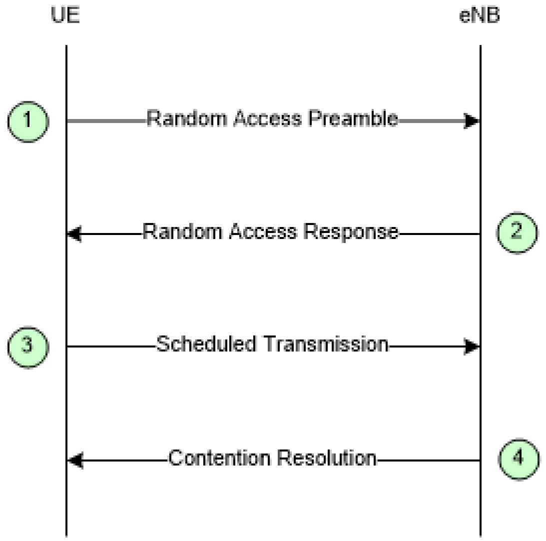


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

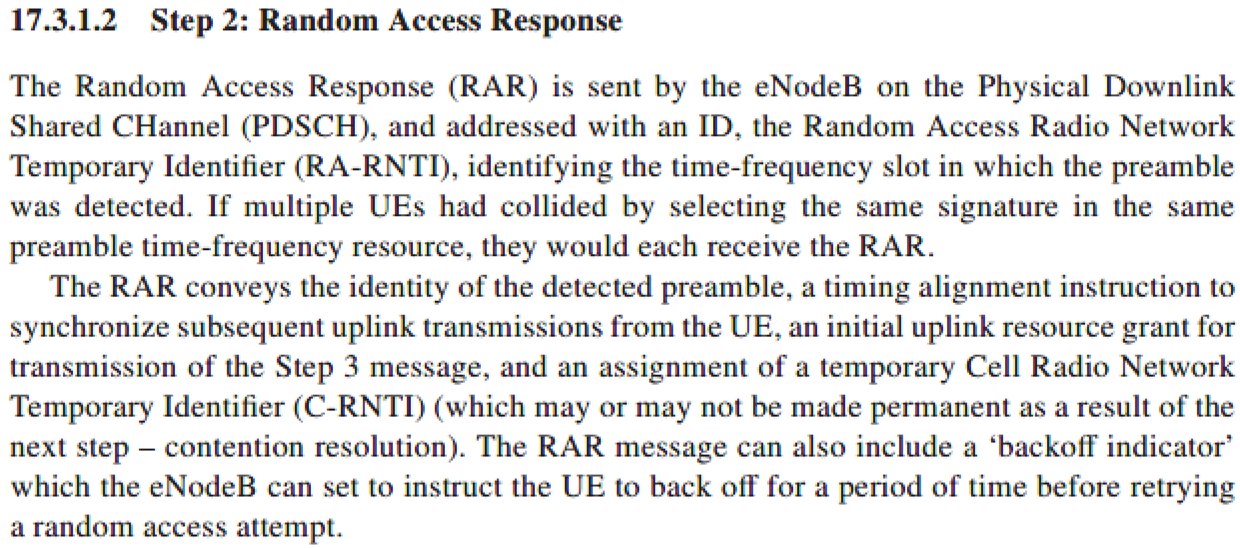
...

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

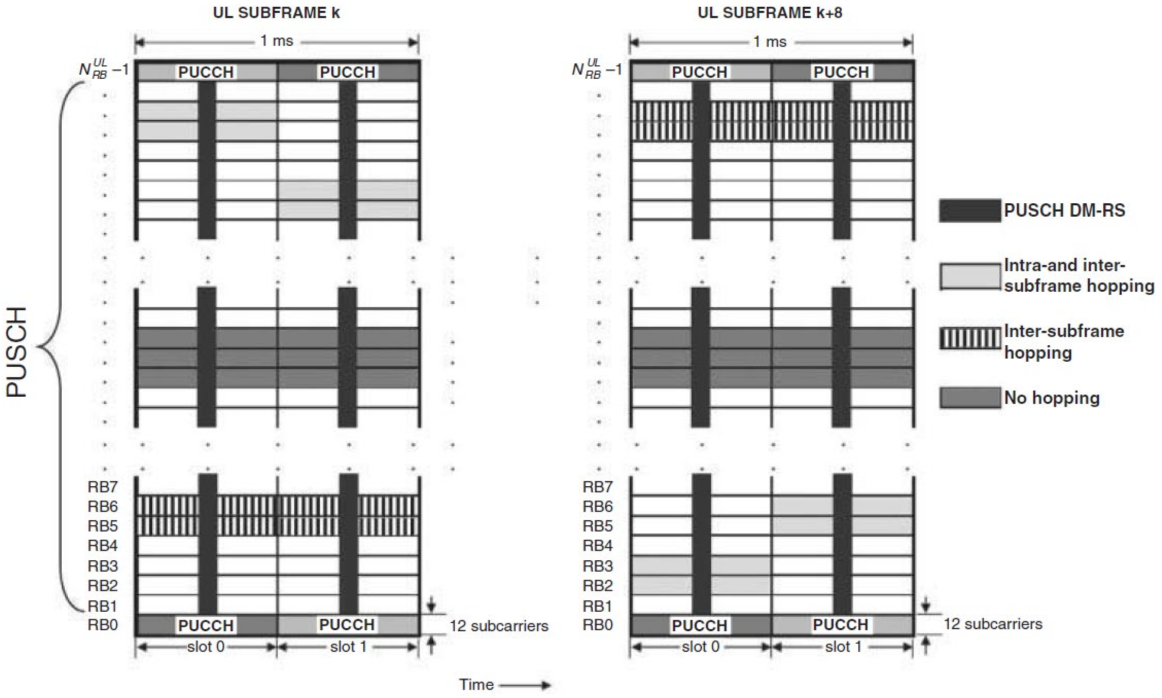
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

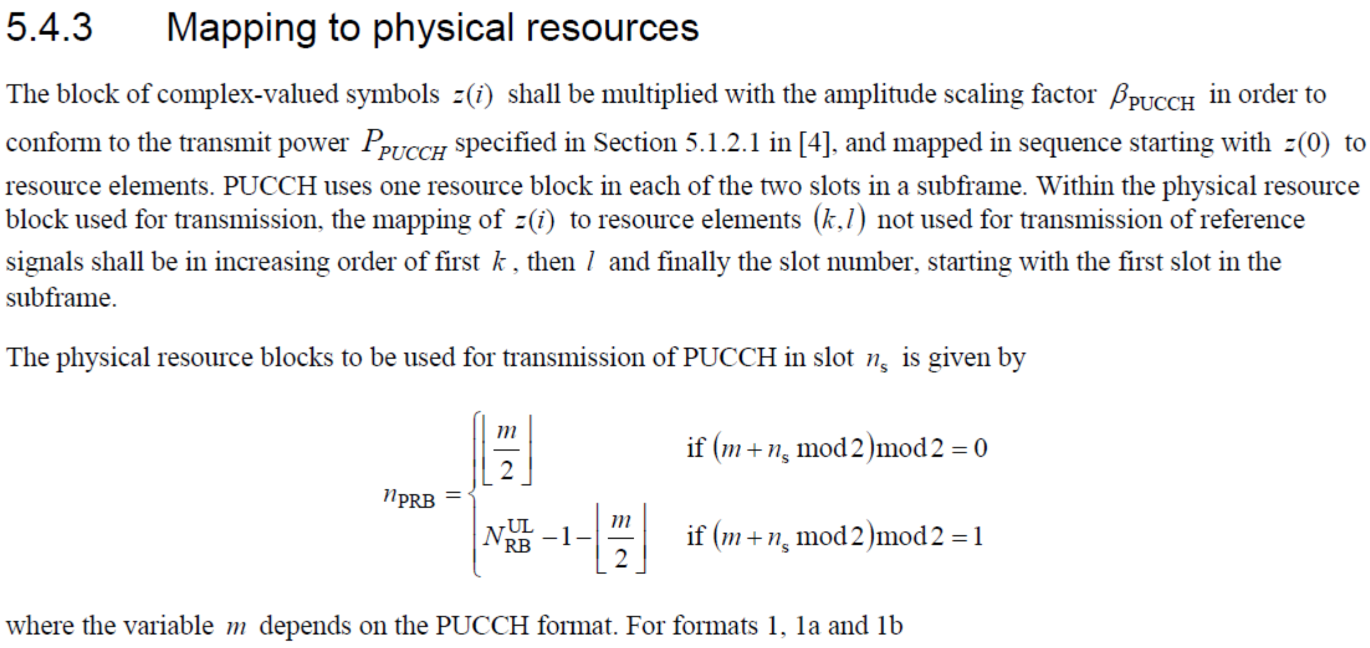
26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Honda's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Honda's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing.

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure"). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  **5.4.3 Mapping to physical resources** The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by $$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 1 \end{cases}$$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

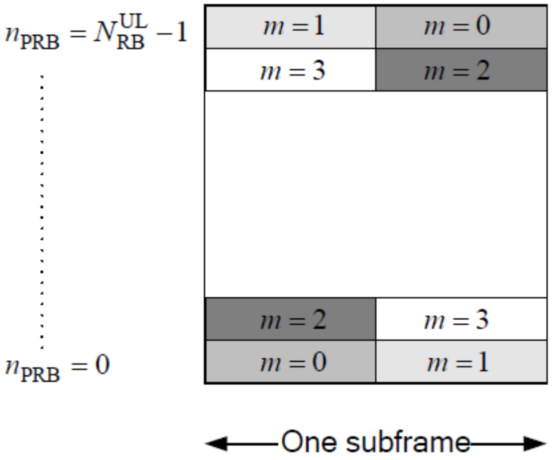


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 27
“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

<table>
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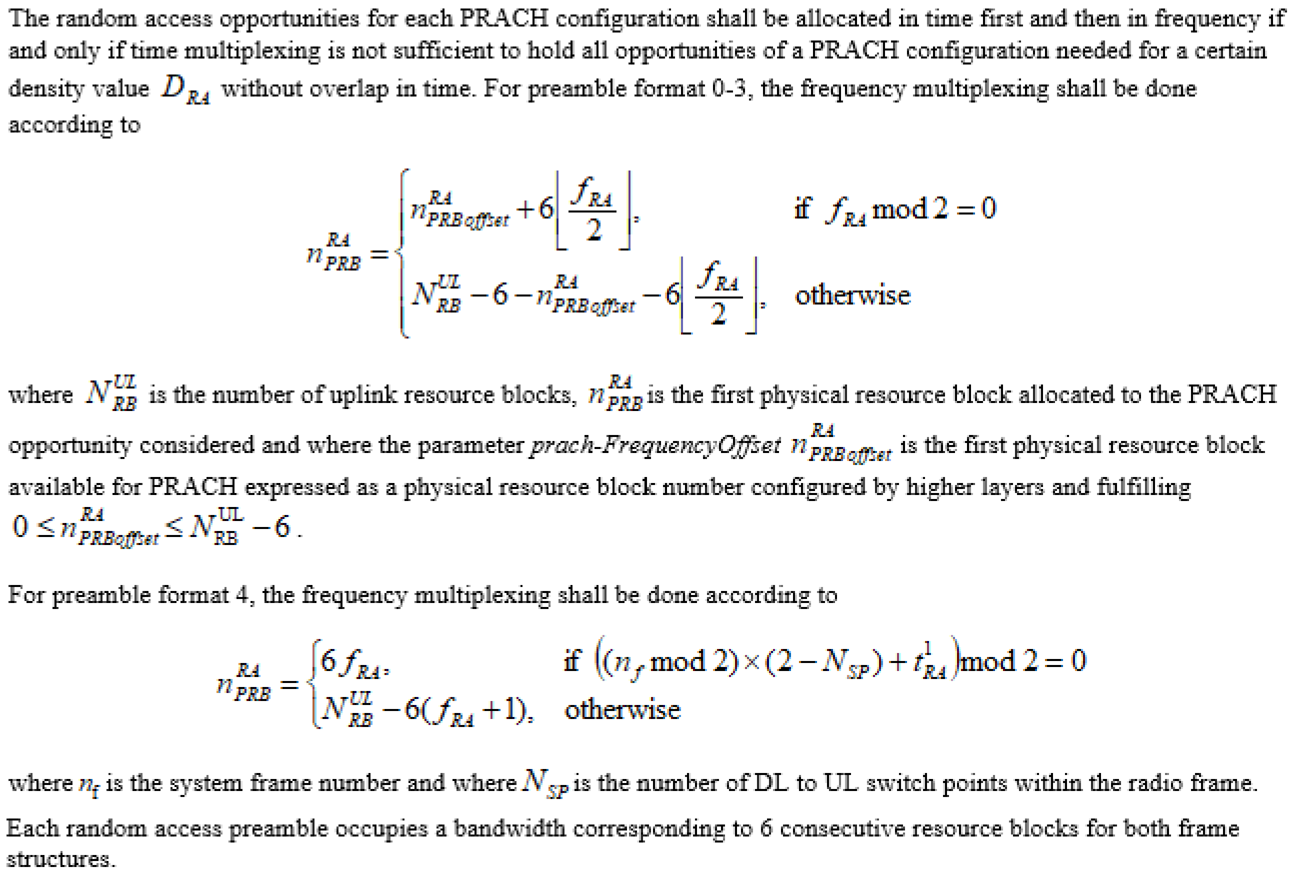

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

</td>
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</table>

US Patent No. 10,833,908: Claim 27

“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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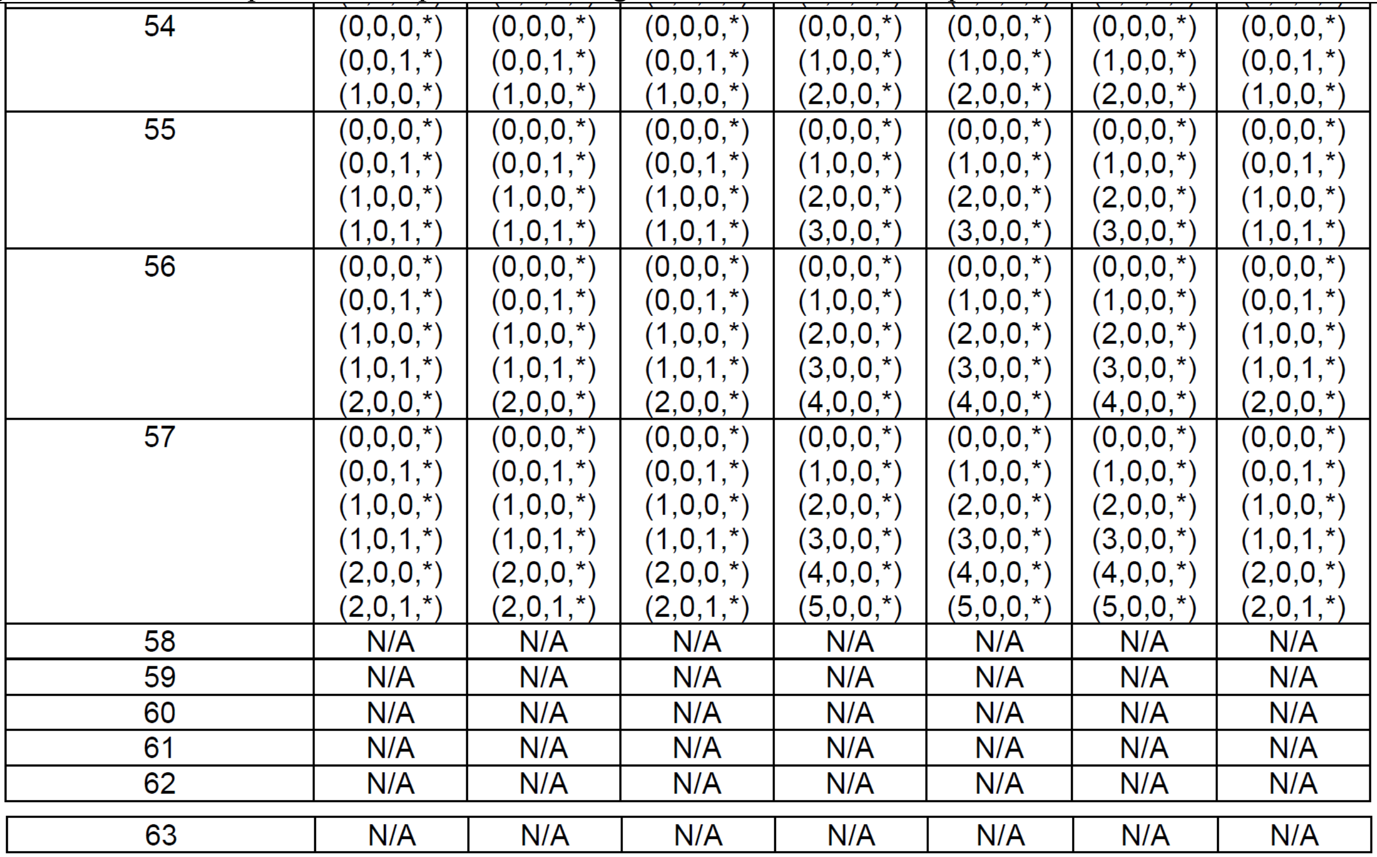
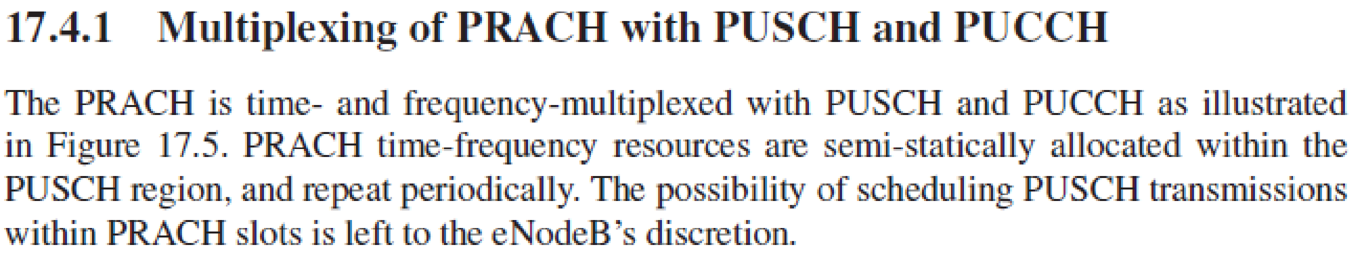


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

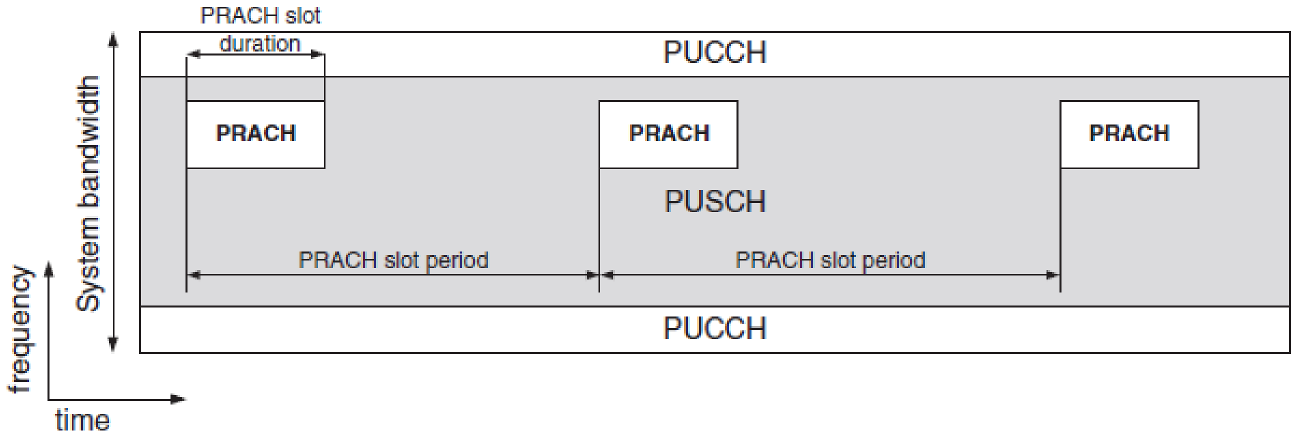


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

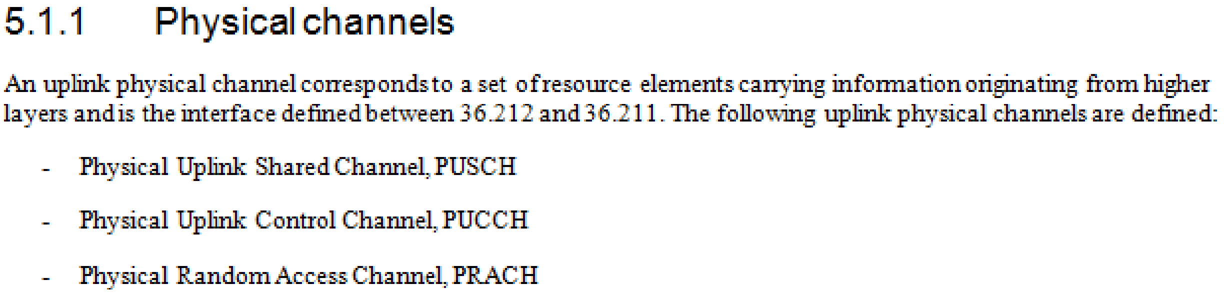
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 27

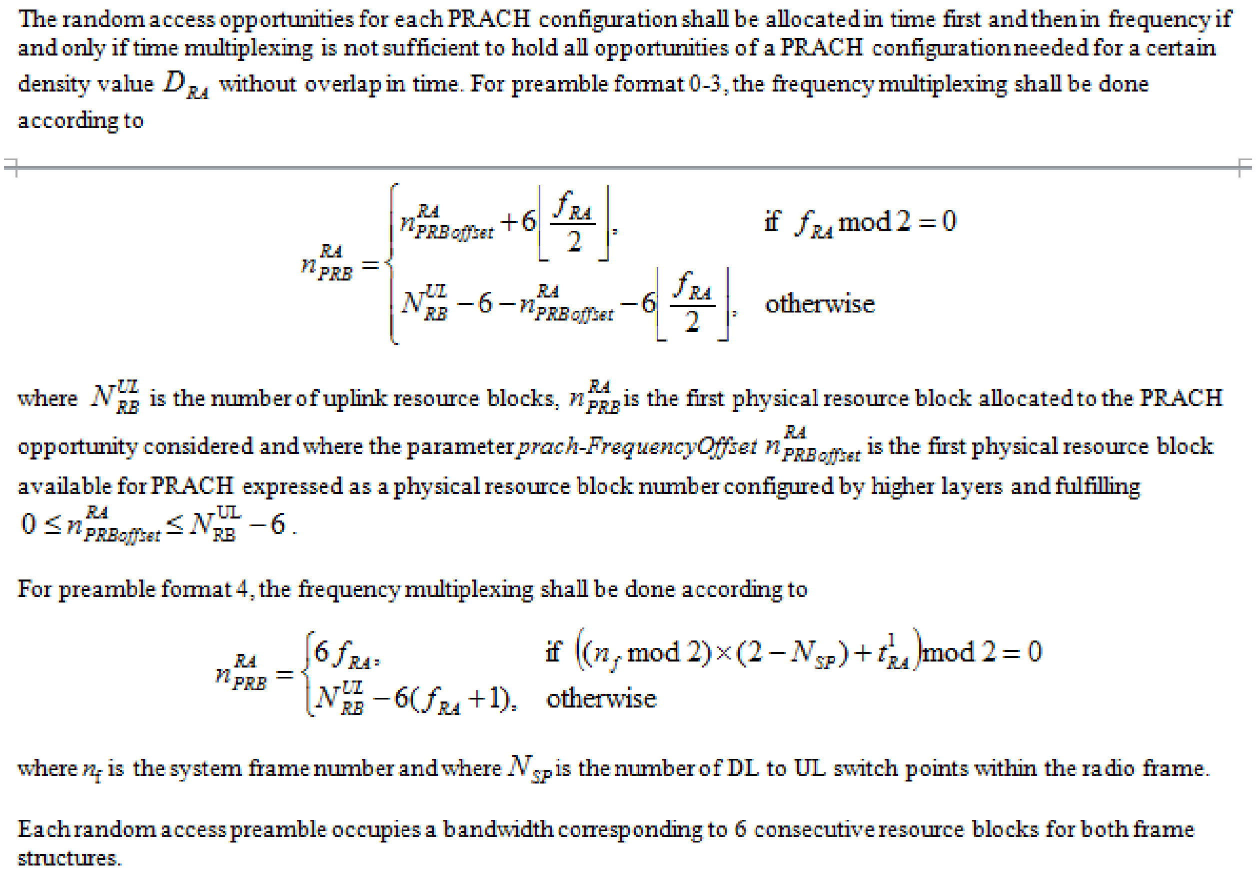
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with Honda's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

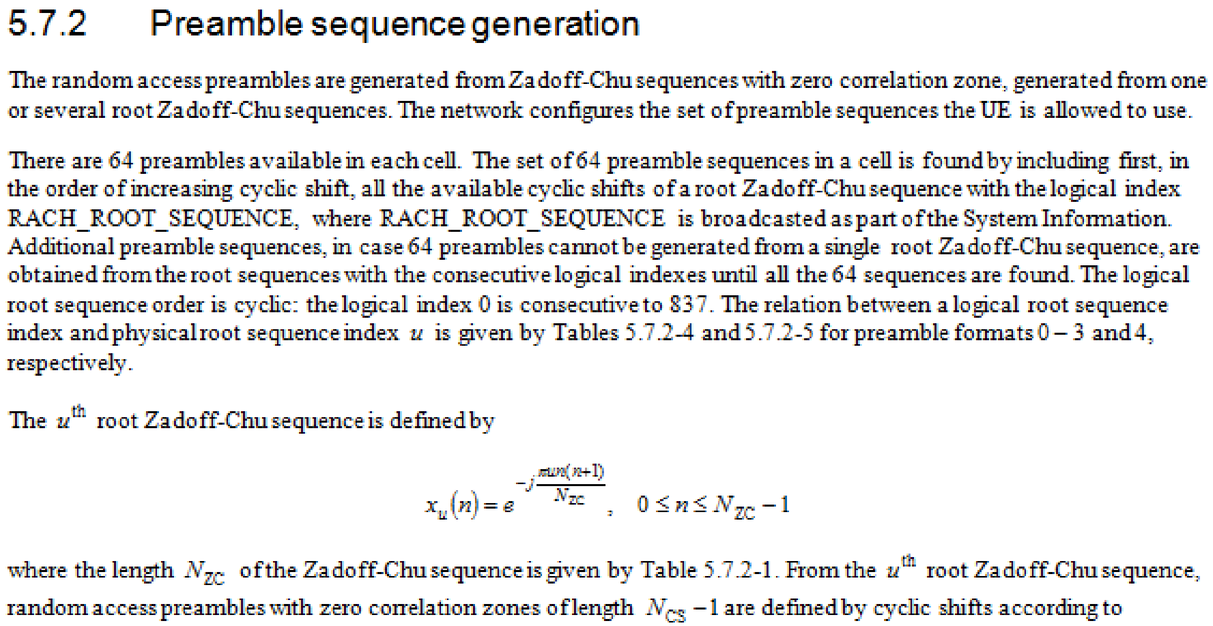
Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28

"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

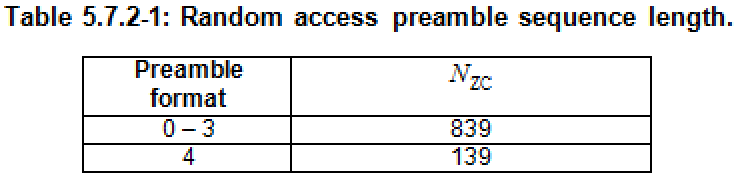
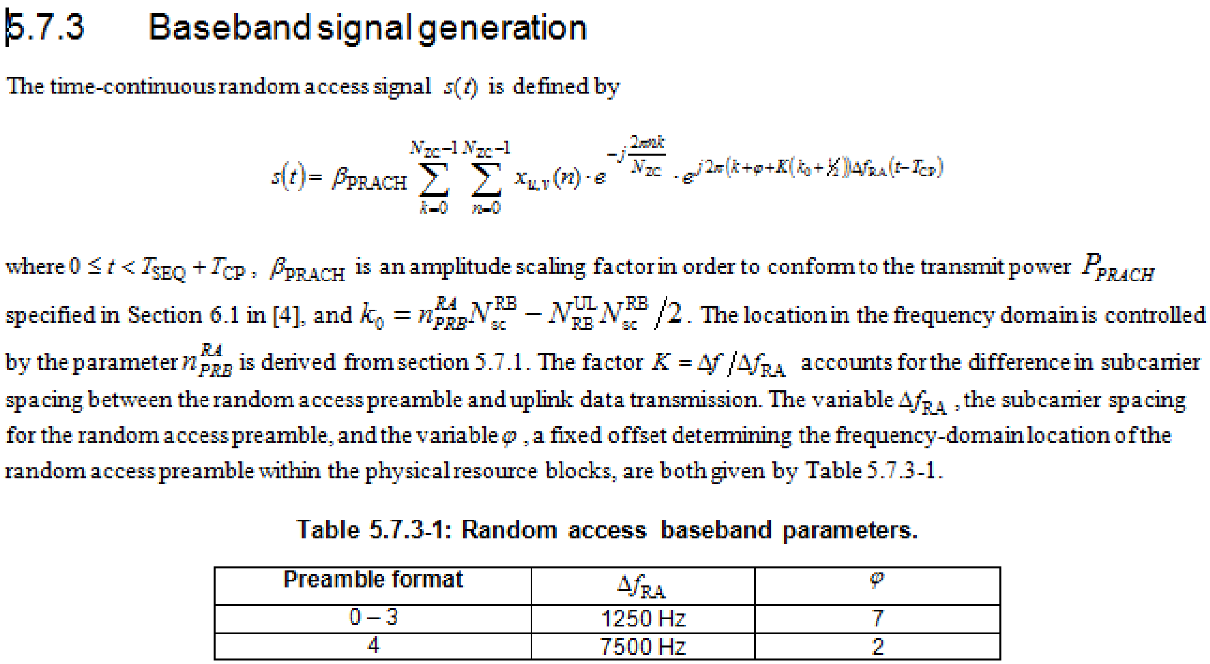


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\text{RA}}\left(t-T_{\text{CP}}\right)}$$

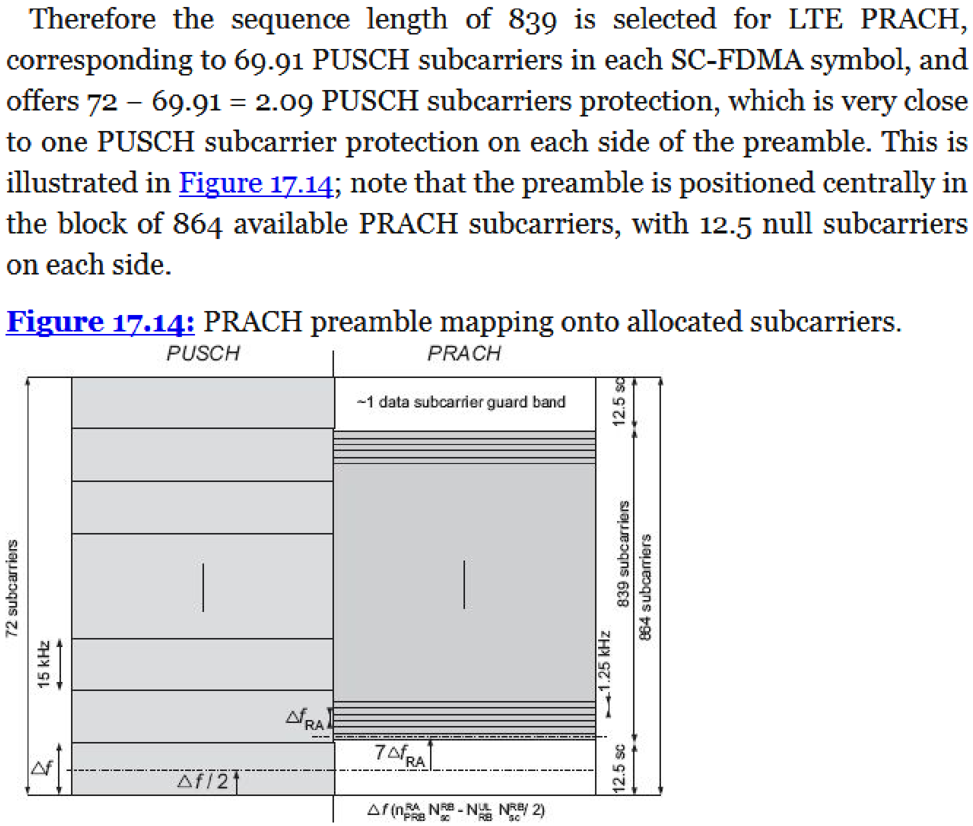
where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

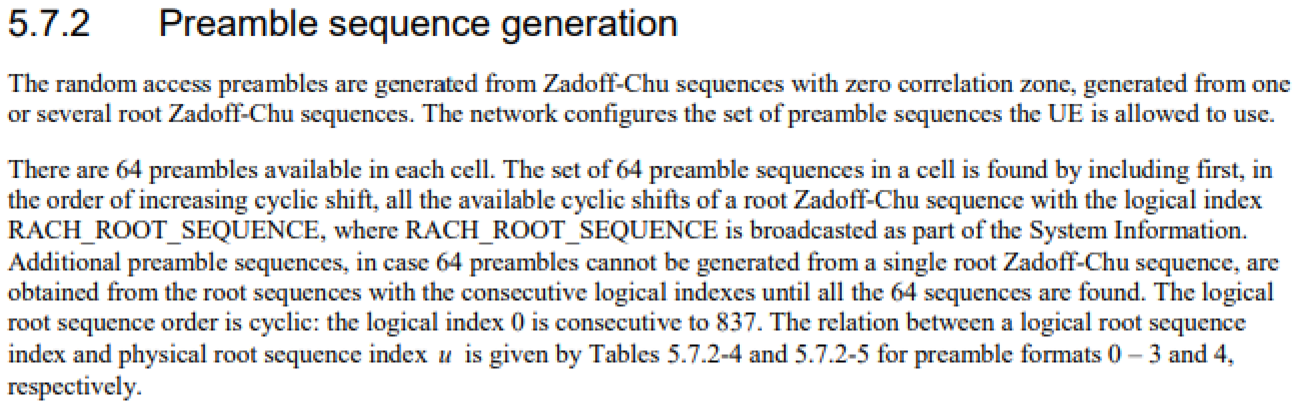
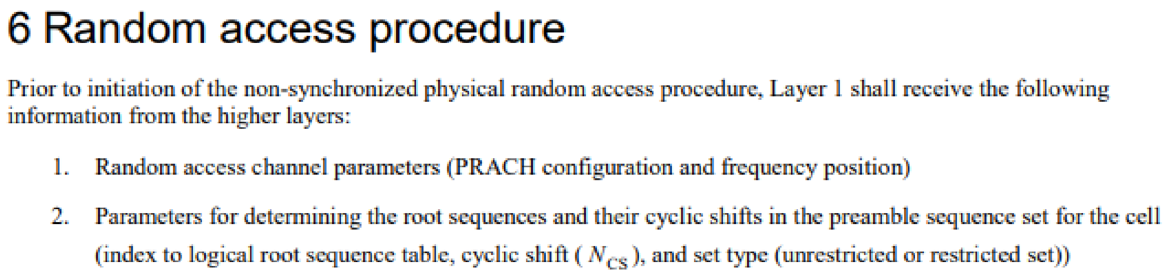


Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Honda’s Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

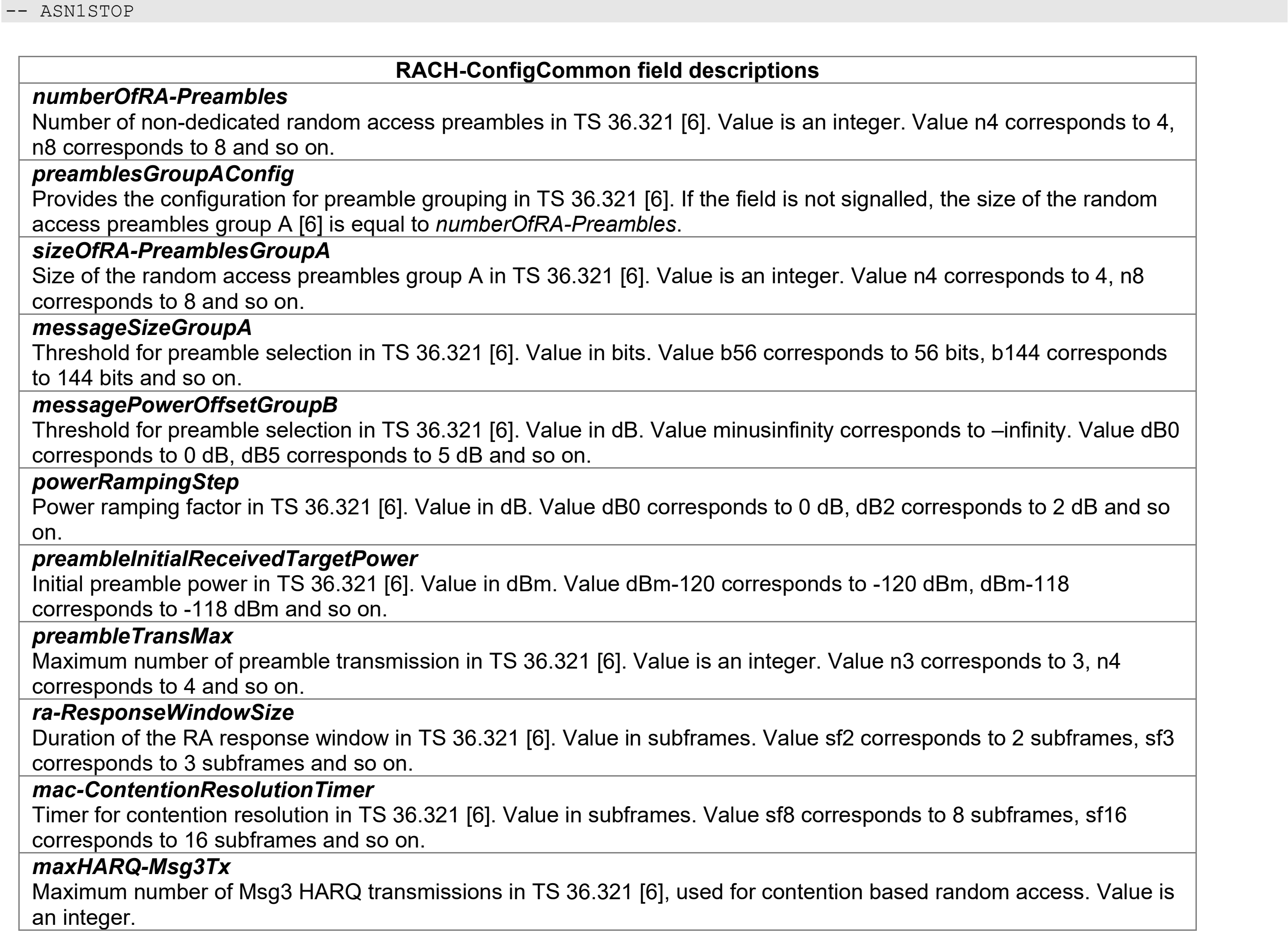
The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."



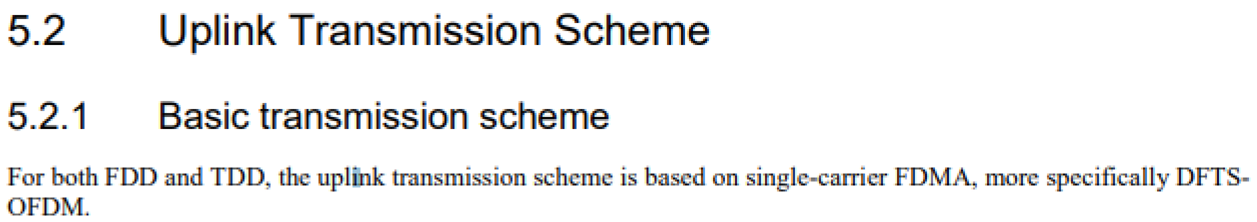
```
-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

US Patent No. 10,833,908: Claim 30
“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 Honda’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Honda’s Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

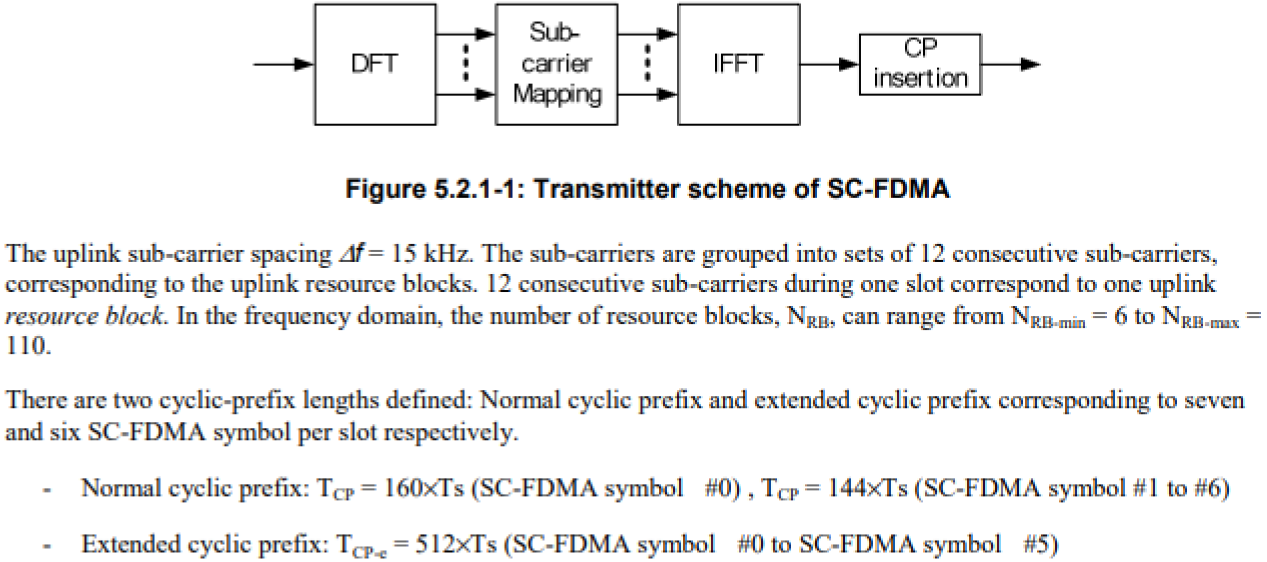


Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

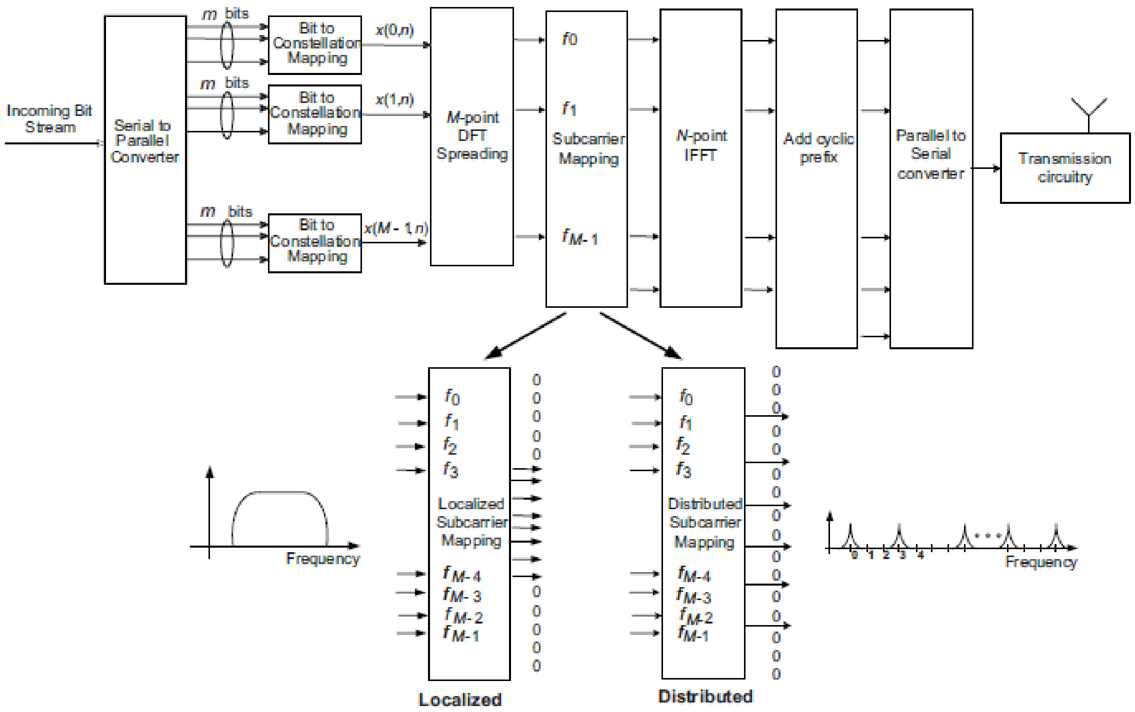


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

See also Claim 10.

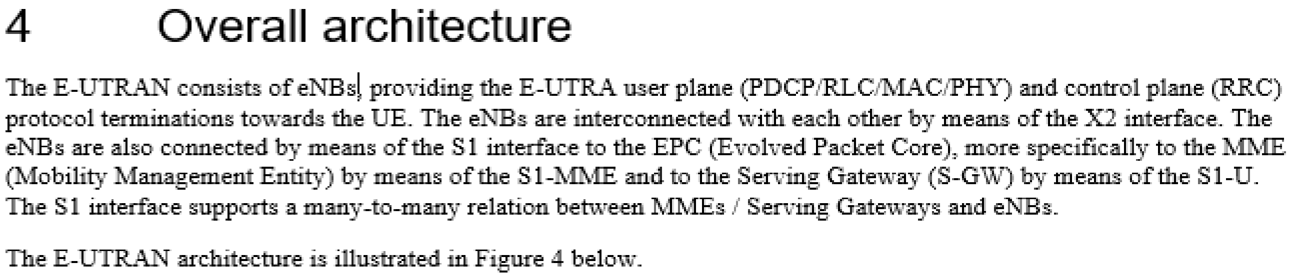
Plaintiff’s Infringement Contentions to Volkswagen

Exhibit 908

U.S. Patent No. 10,833,908

Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, Volkswagen's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* Volkswagen's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Volkswagen offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

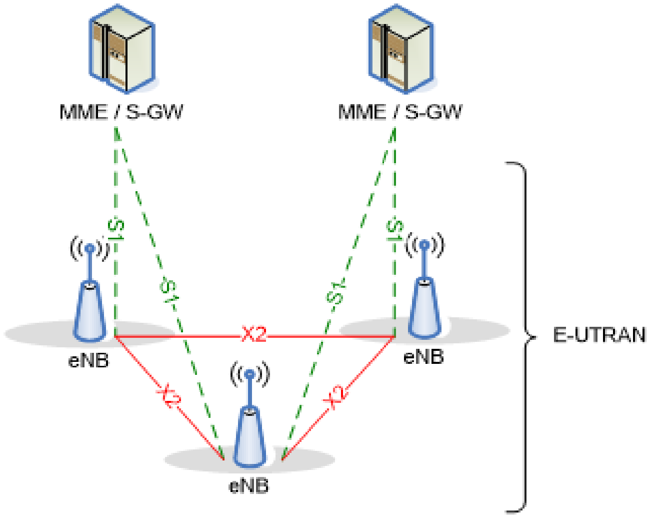


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

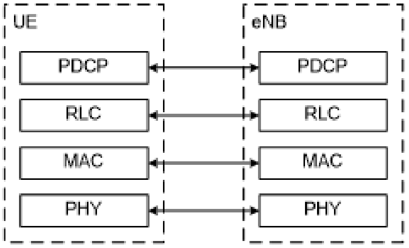


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

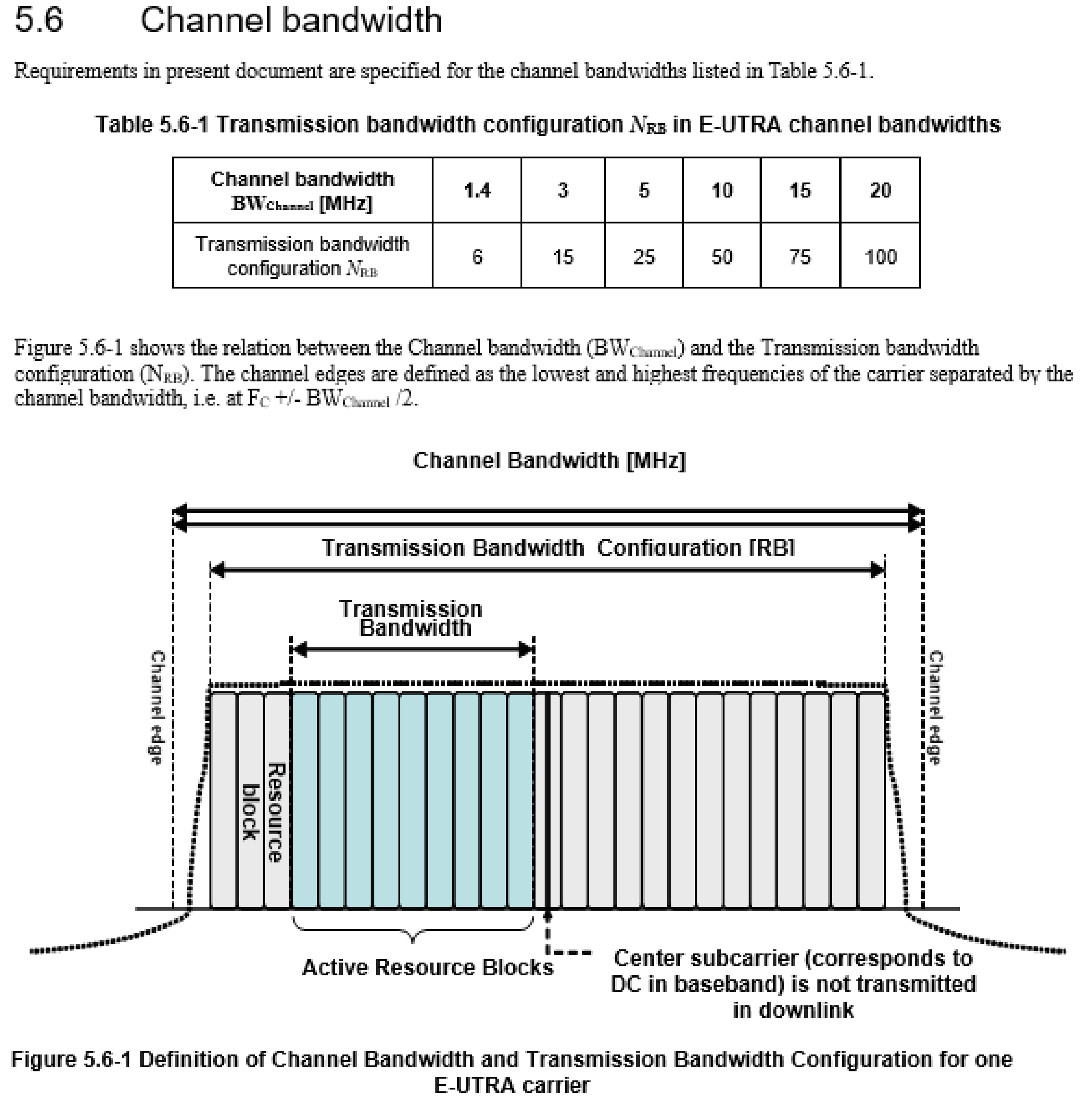
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Volkswagen's Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, Volkswagen's Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

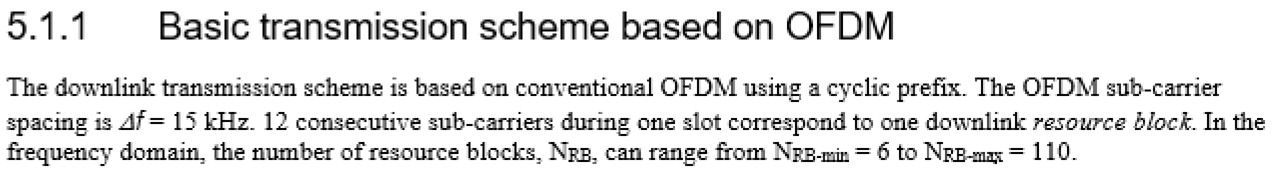
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

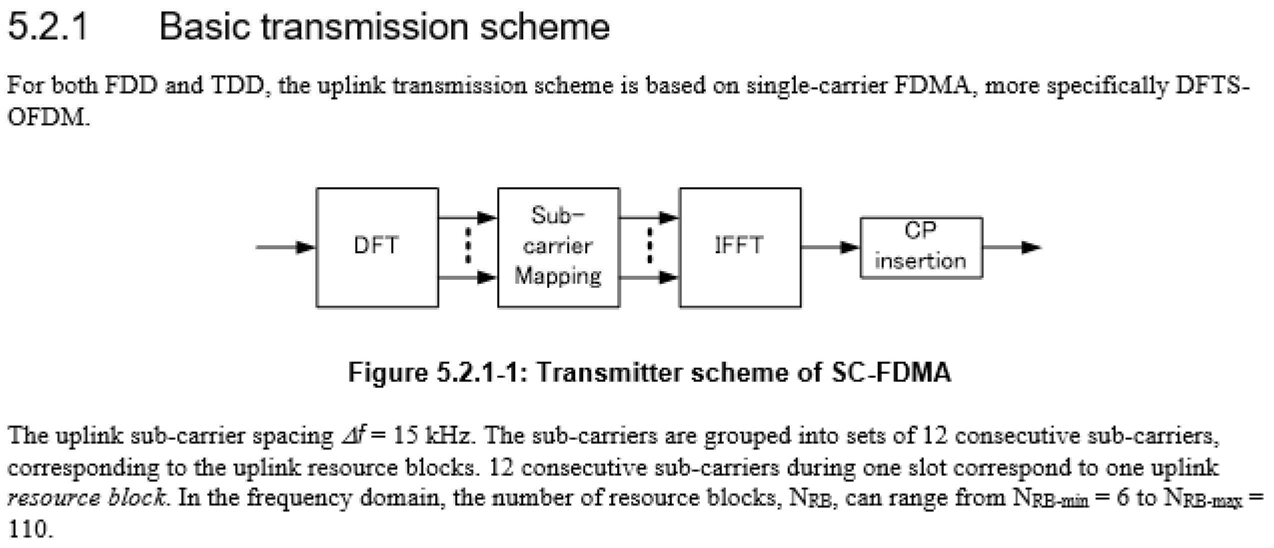
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from N_{RB-min} = 6 to N_{RB-max} = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

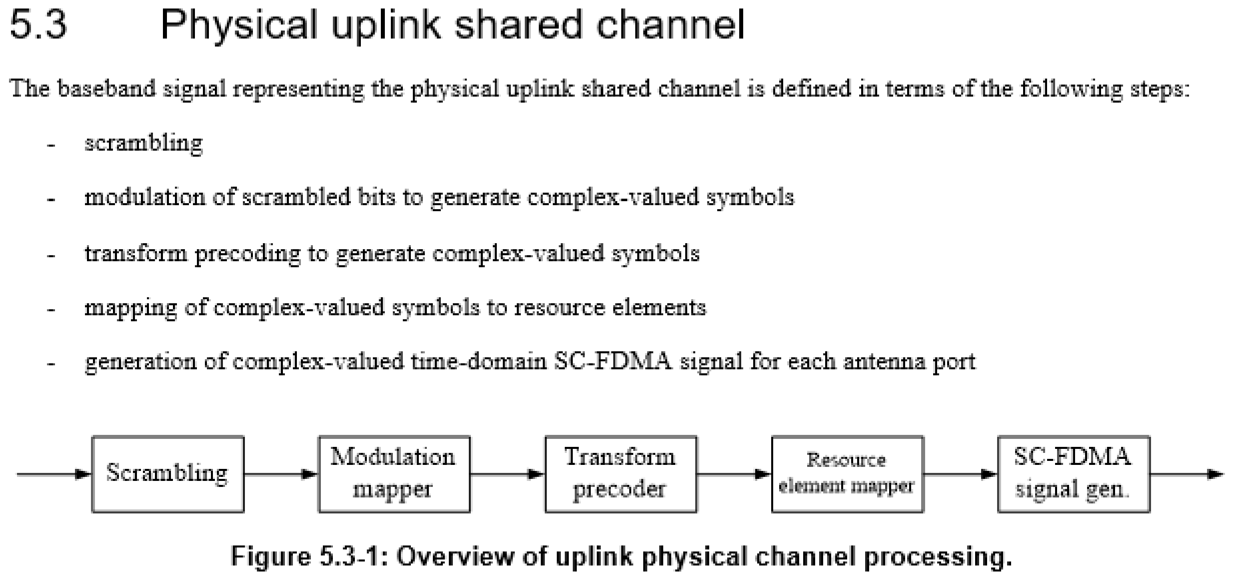
The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from N_{RB-min} = 6 to N_{RB-max} = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.3 Physical uplink shared channel

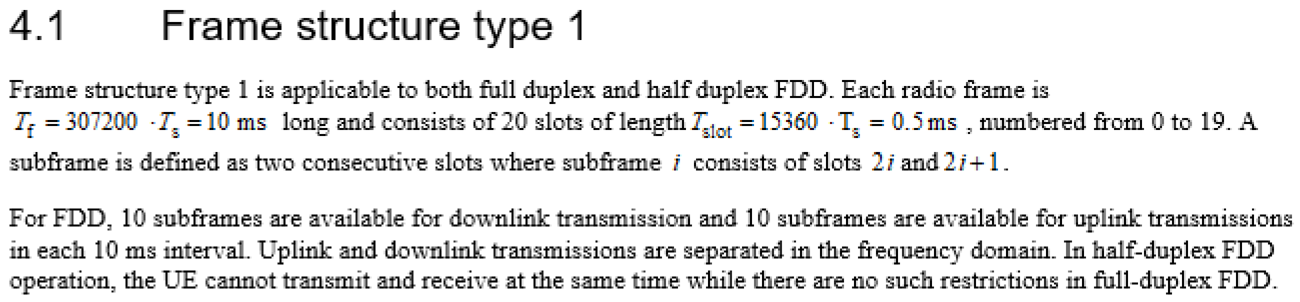
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

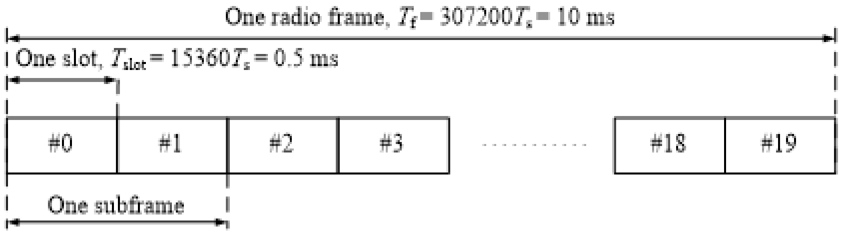
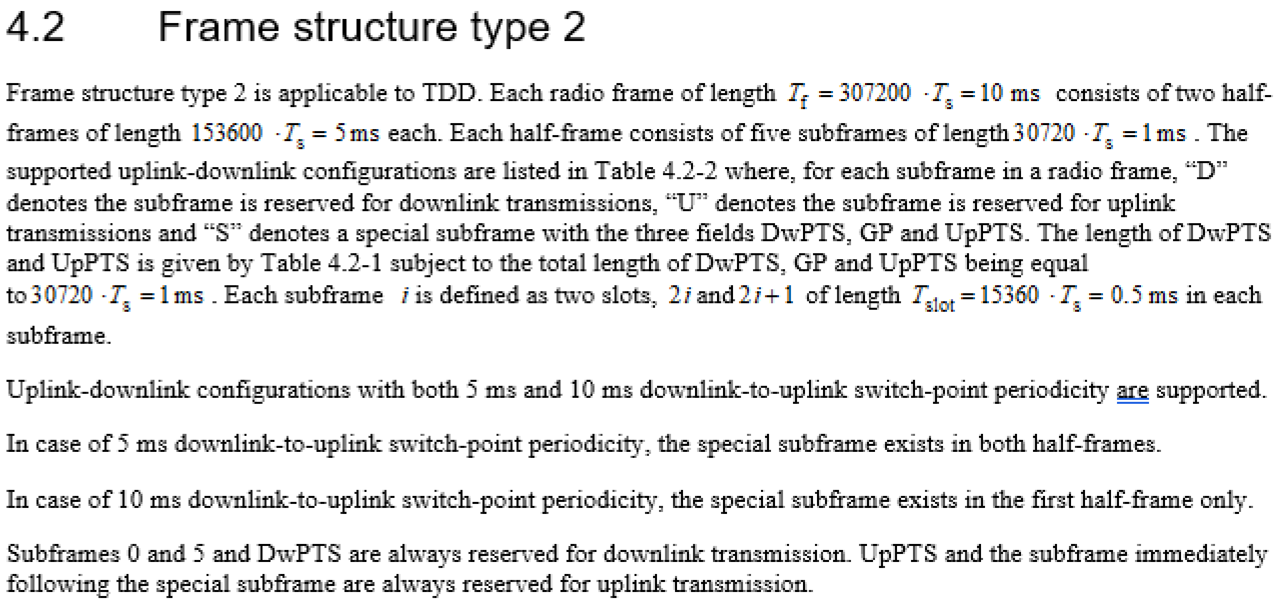


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

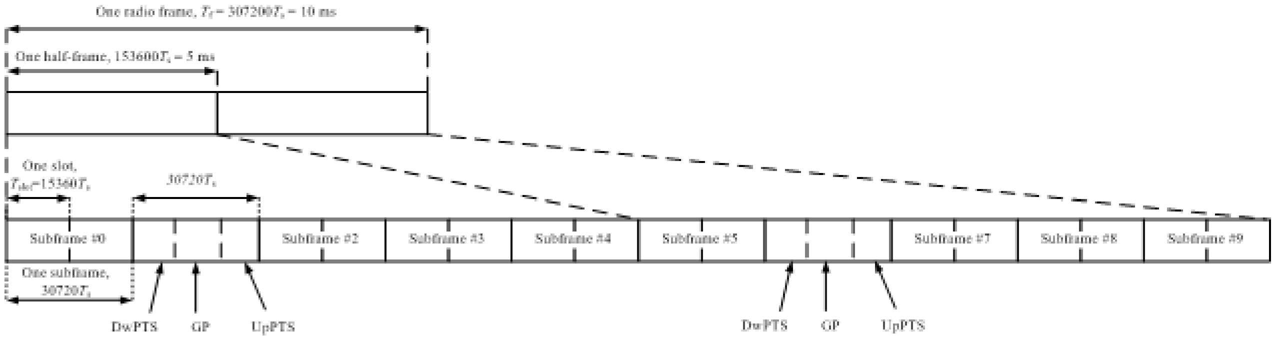
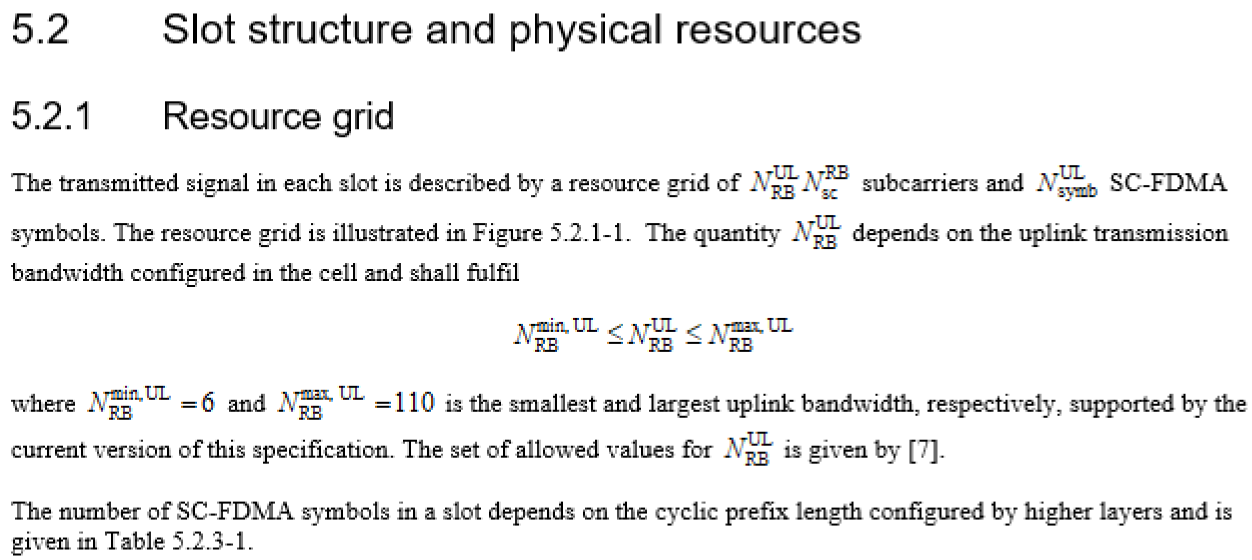


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

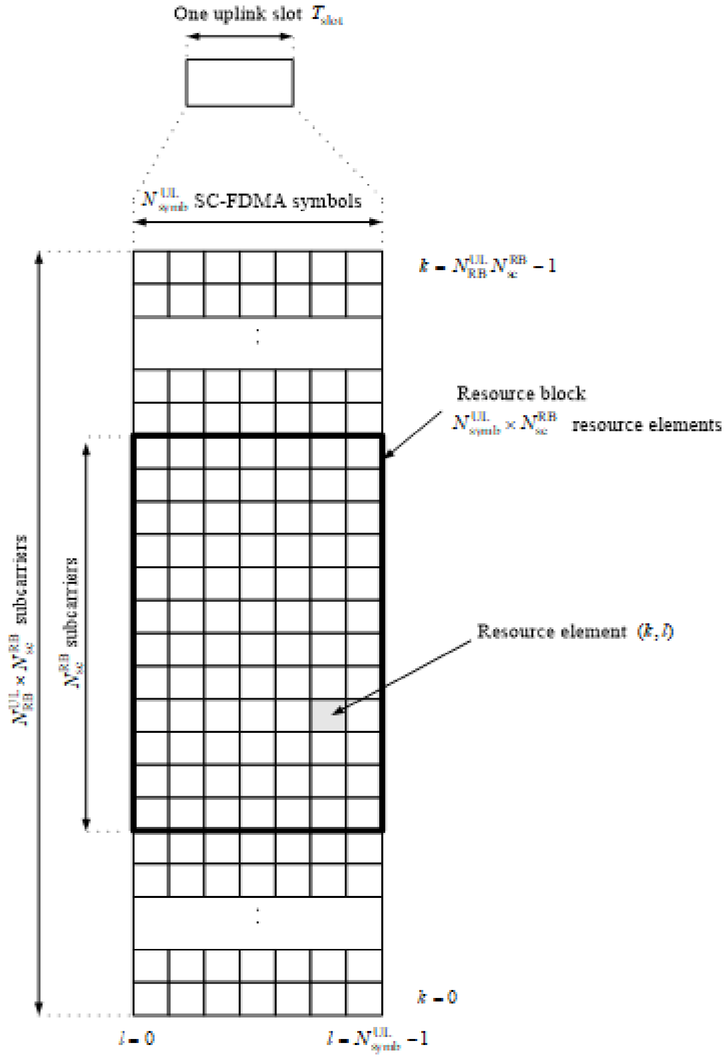
$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

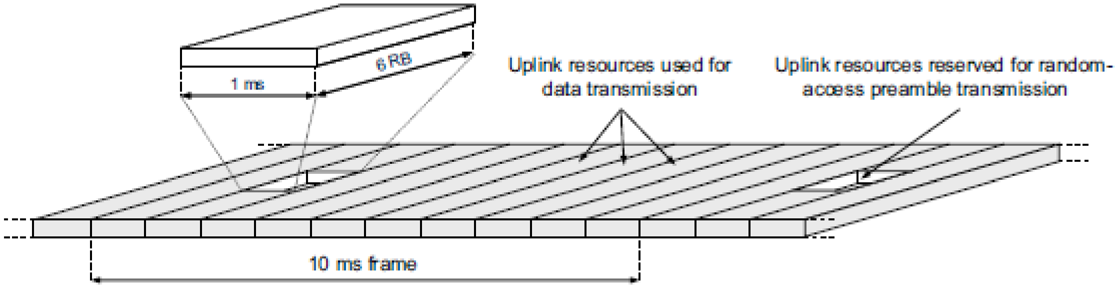
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

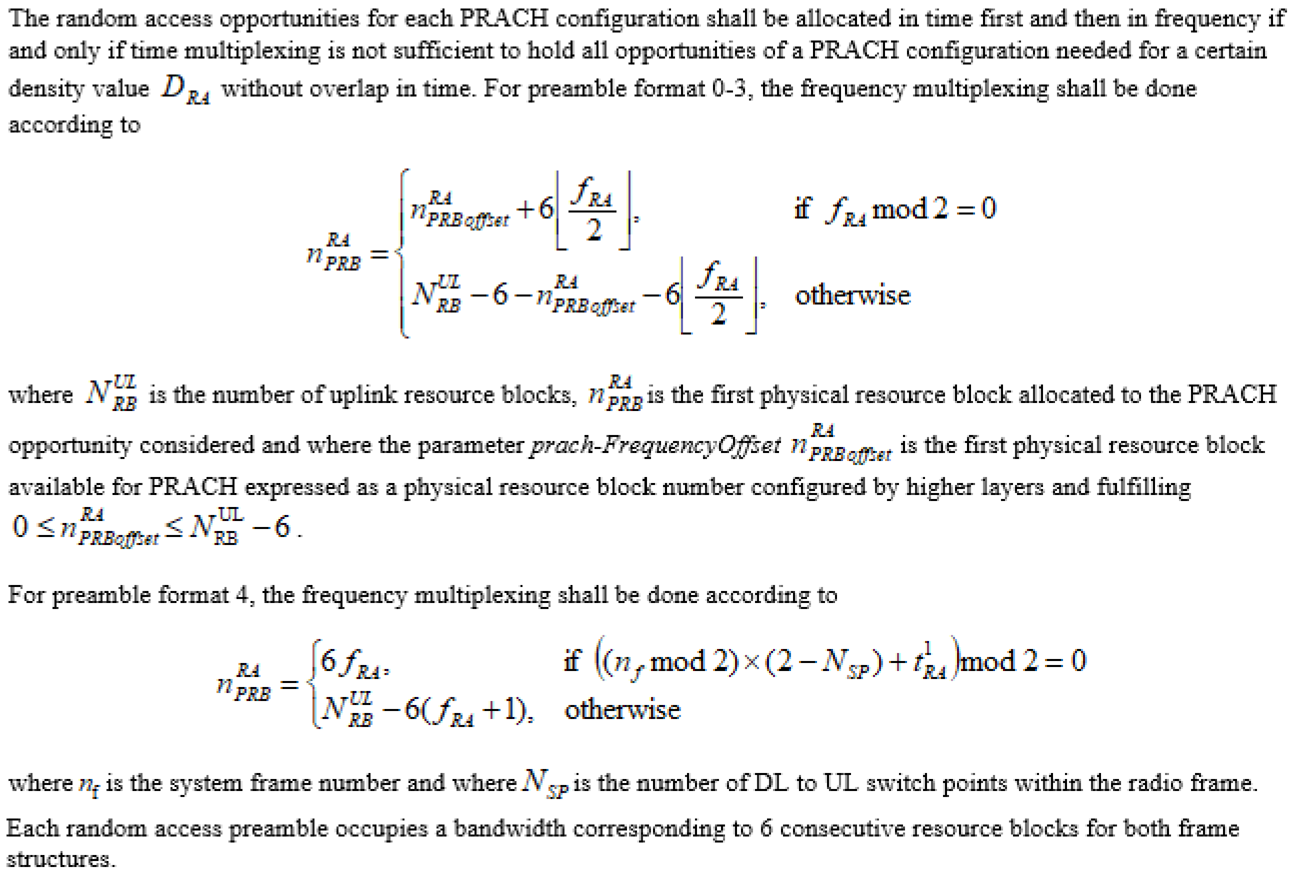
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

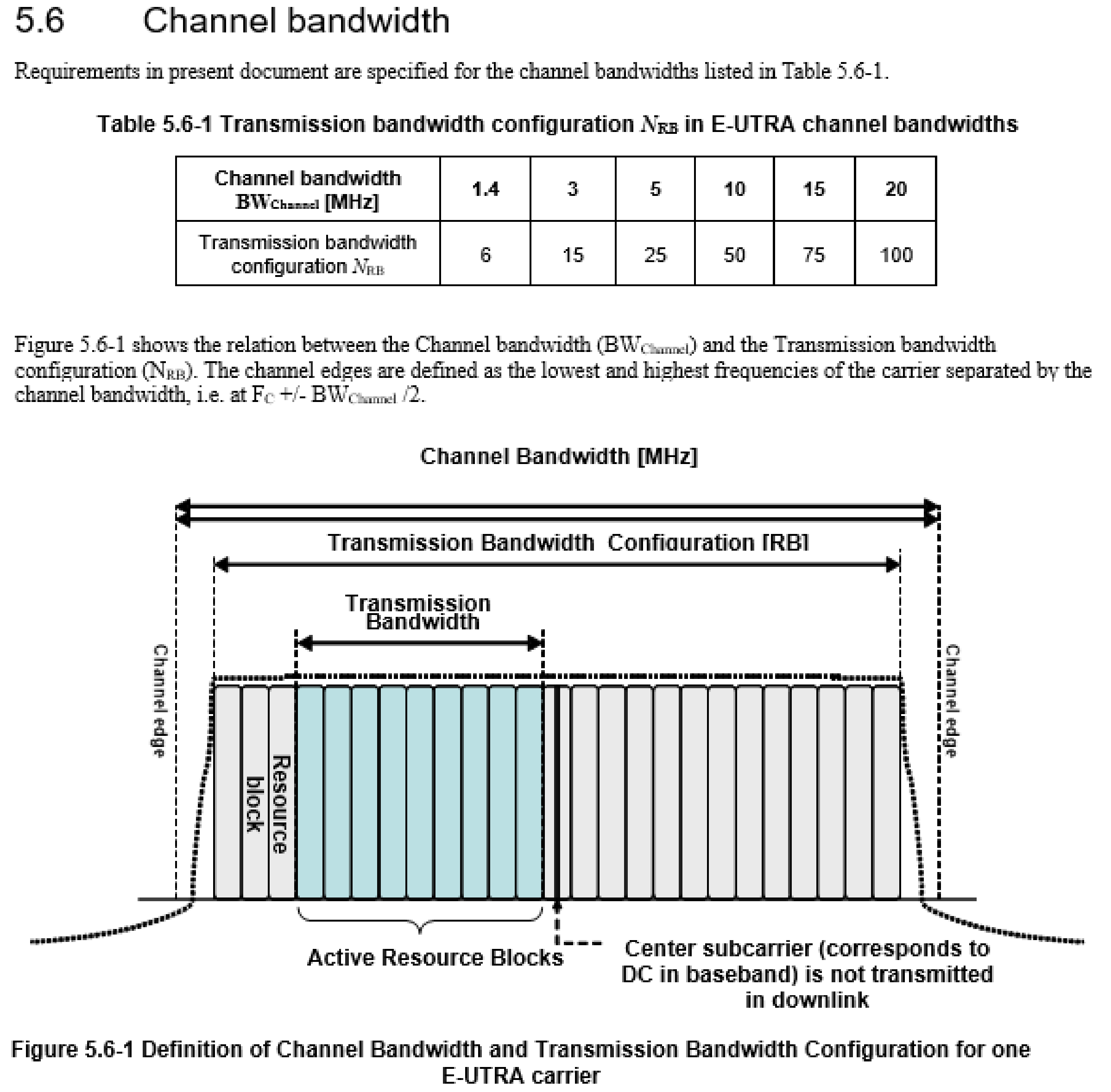
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	Volkswagen's Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

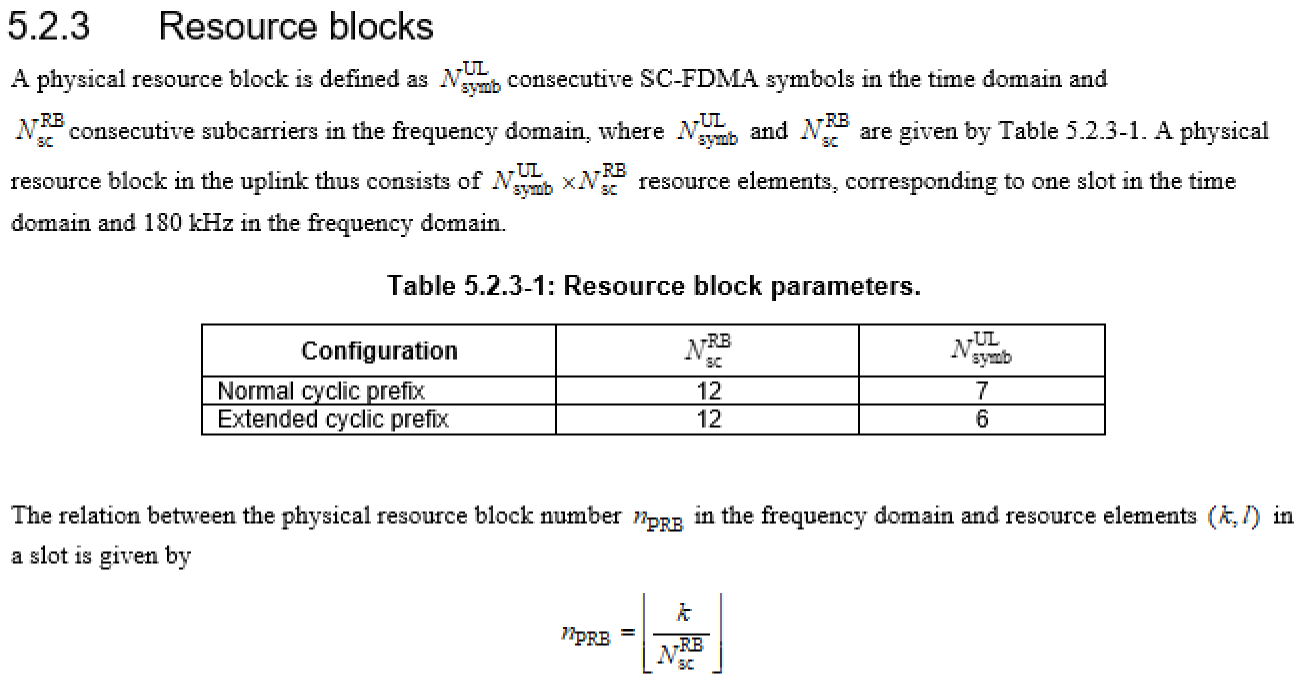
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

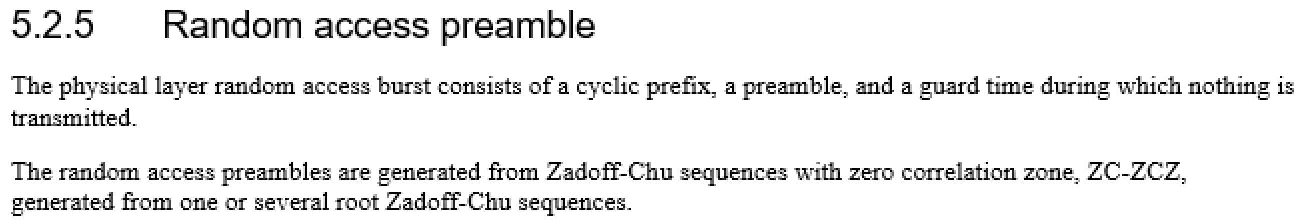
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

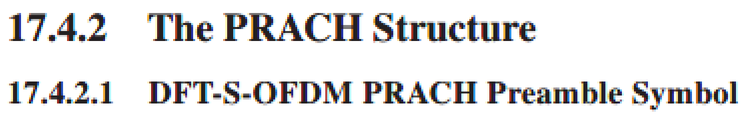


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.



17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional

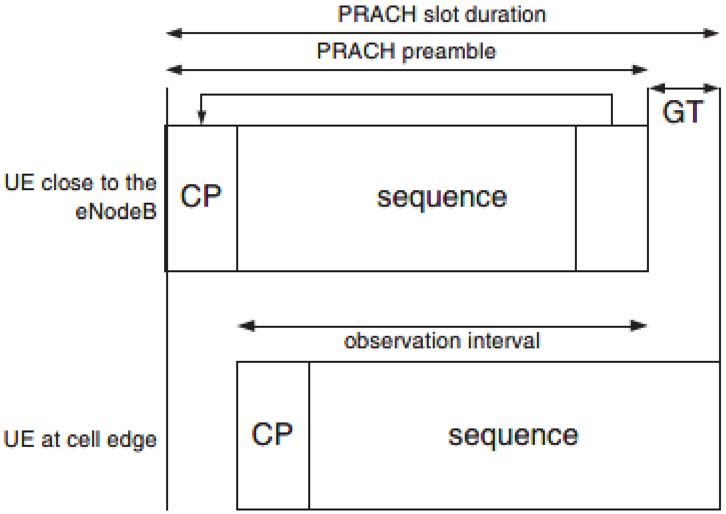


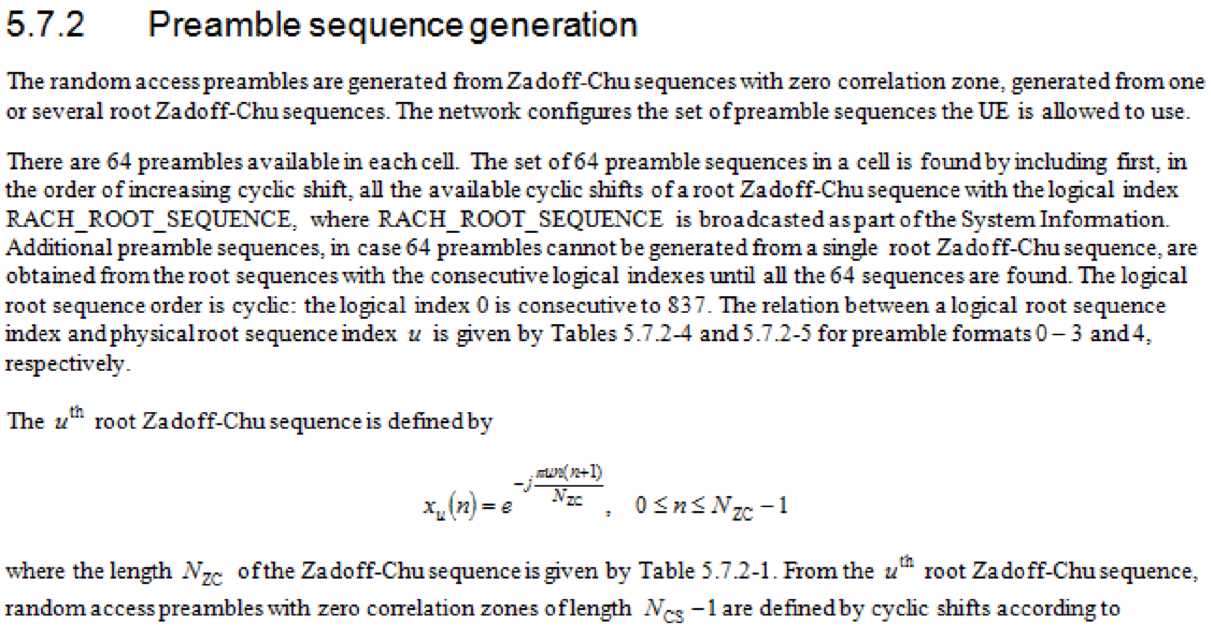
Figure 17.6: PRACH preamble received at the eNodeB.

OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378.

The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

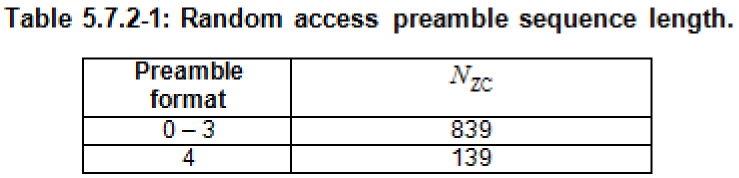
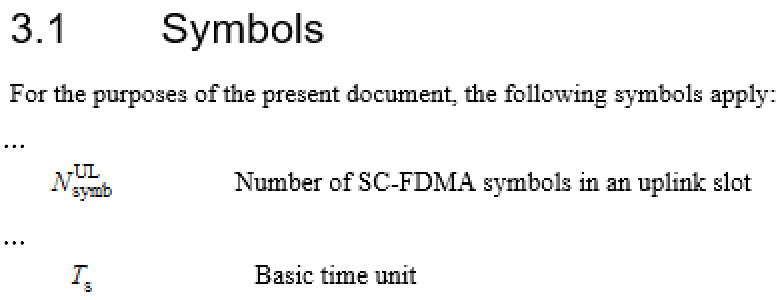
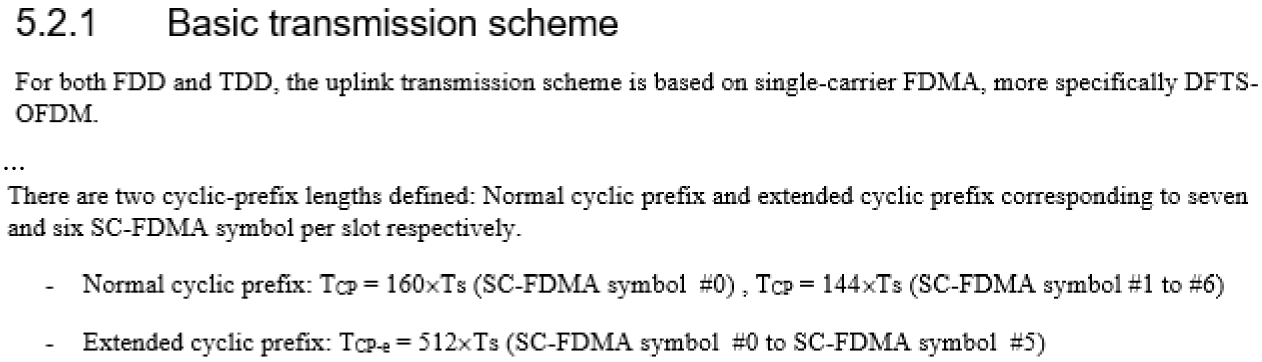


Table 5.7.2-1: Random access preamble sequence length.

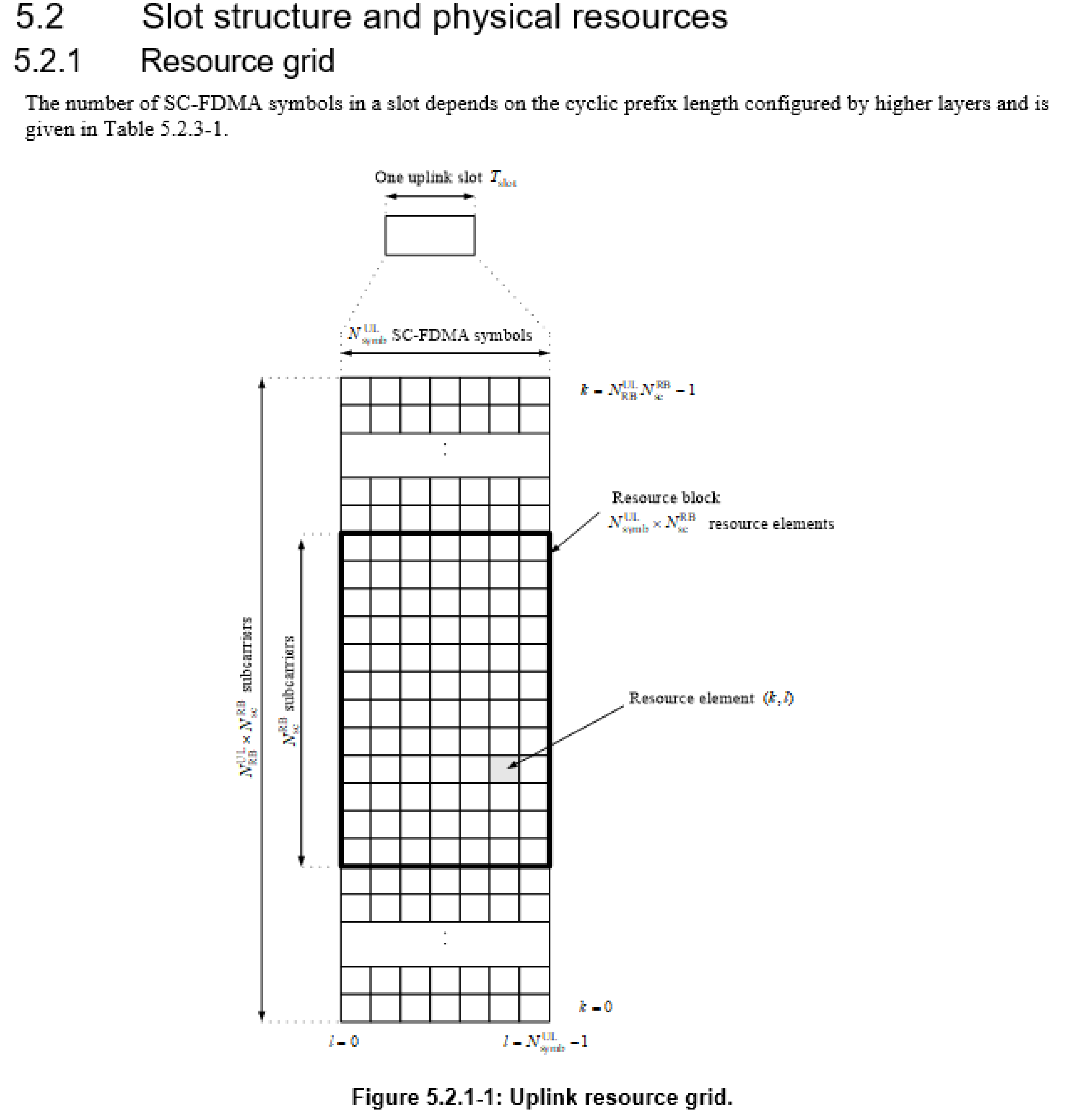
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using Volkswagen's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160\times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144\times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512\times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”



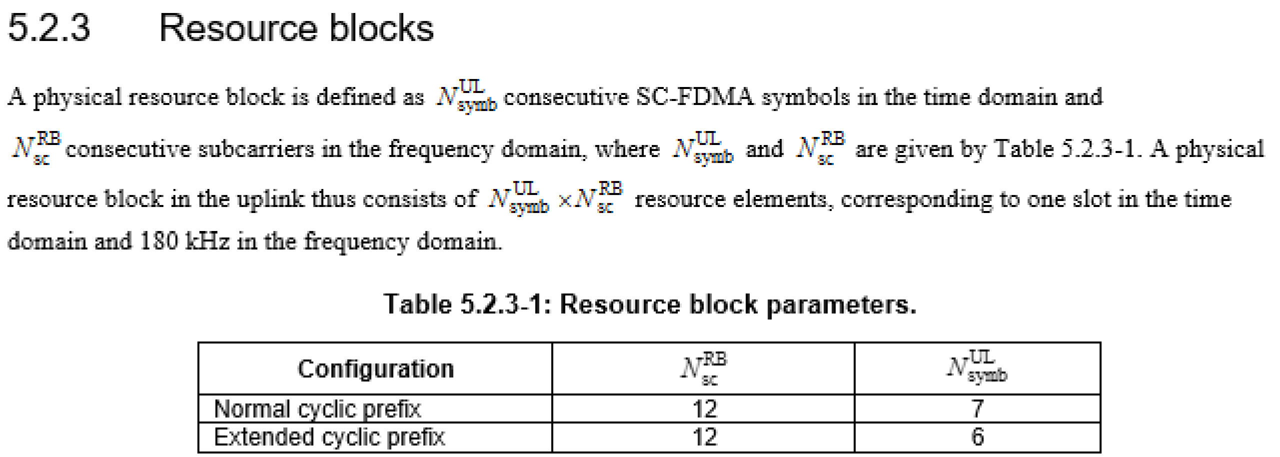
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

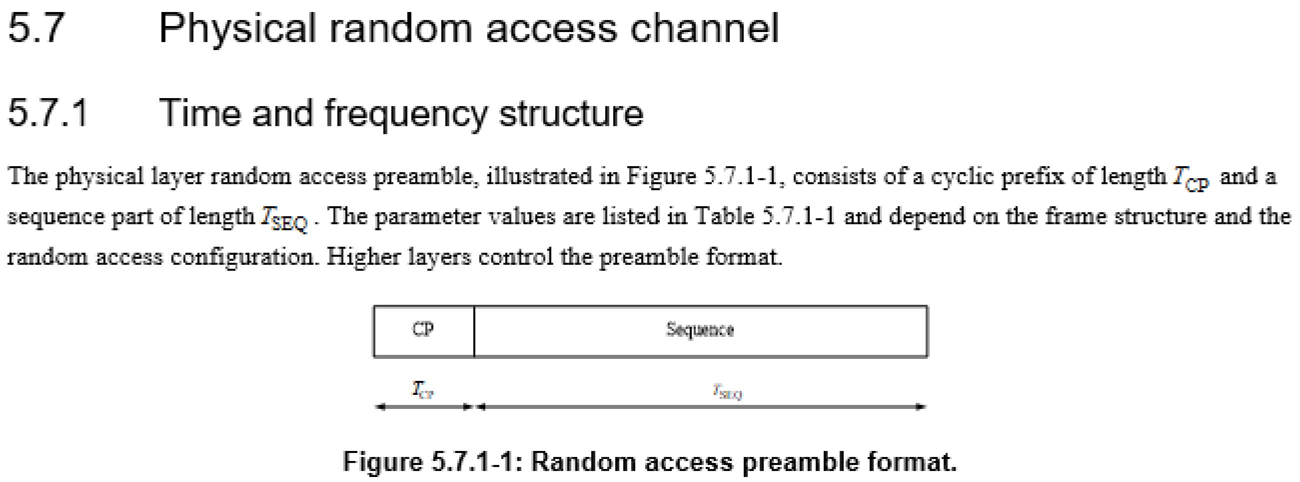
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

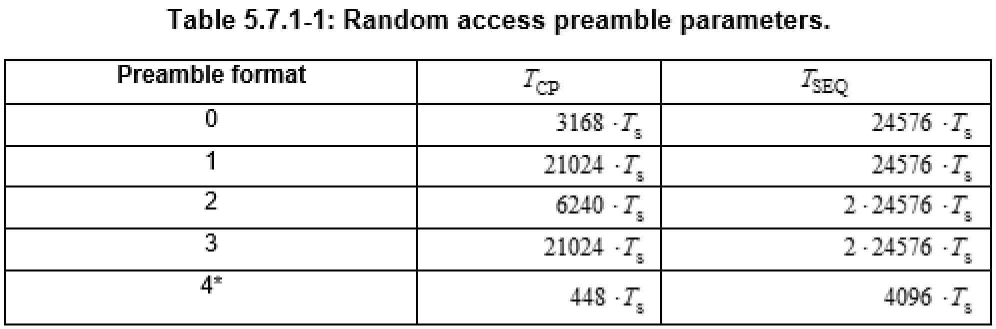
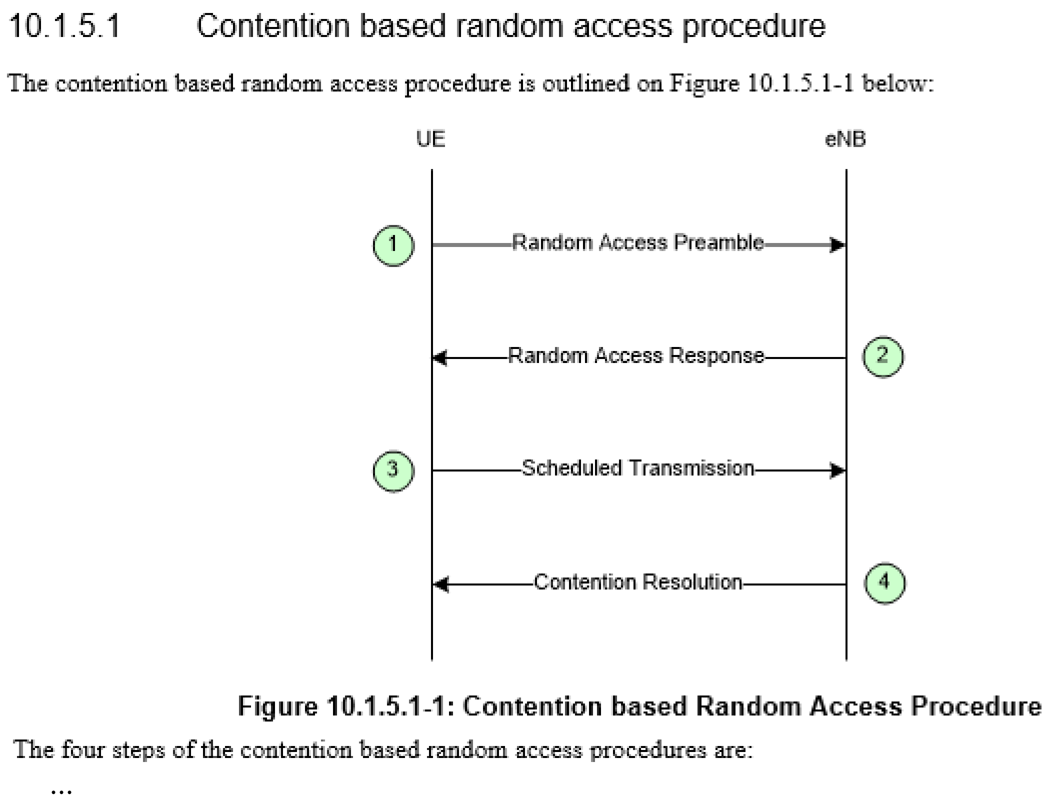


Table 5.7.1-1: Random access preamble parameters.

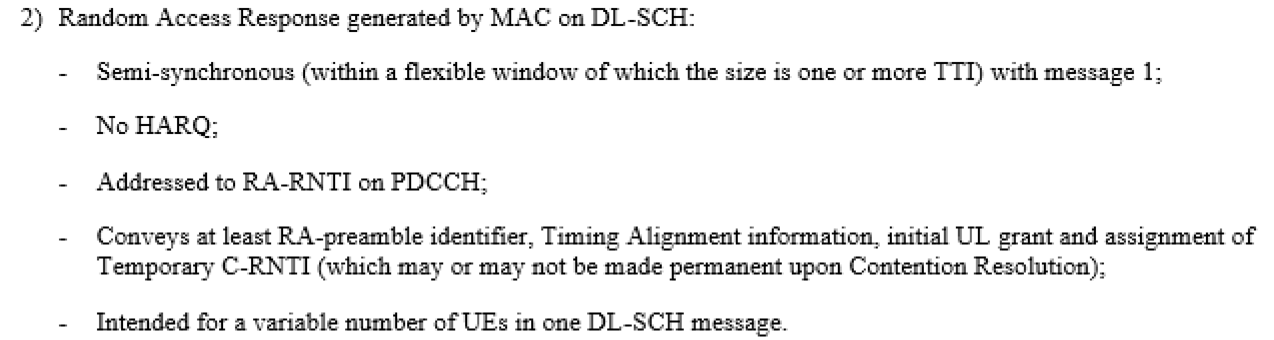
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

a receiver configured to receive, from the base station, a response message.	Volkswagen’s Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

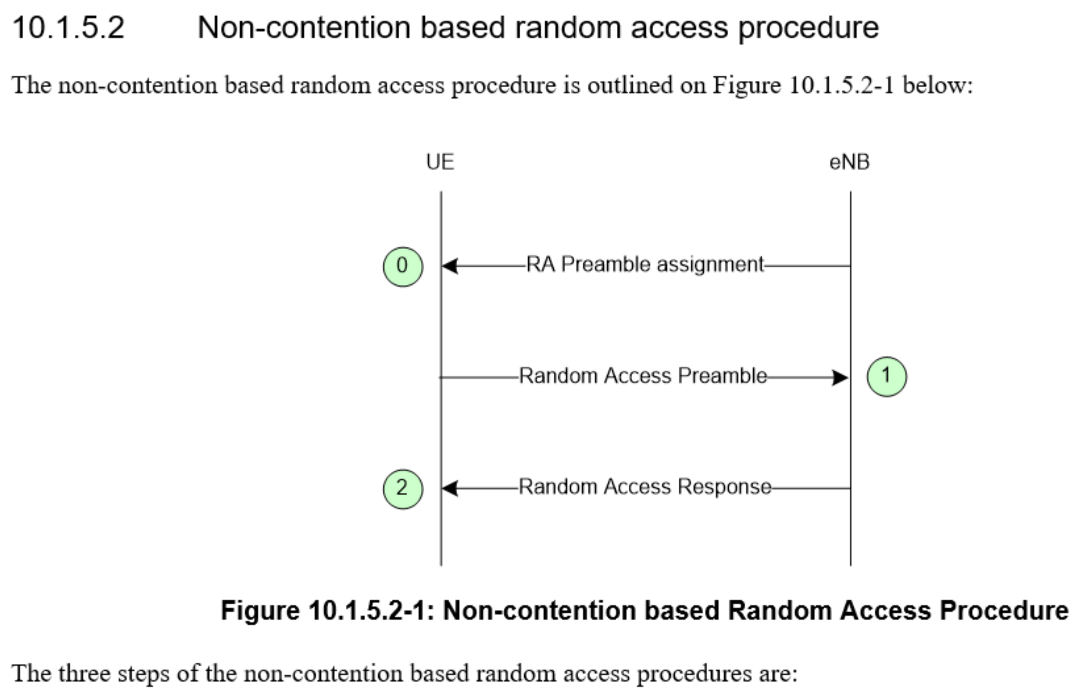
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



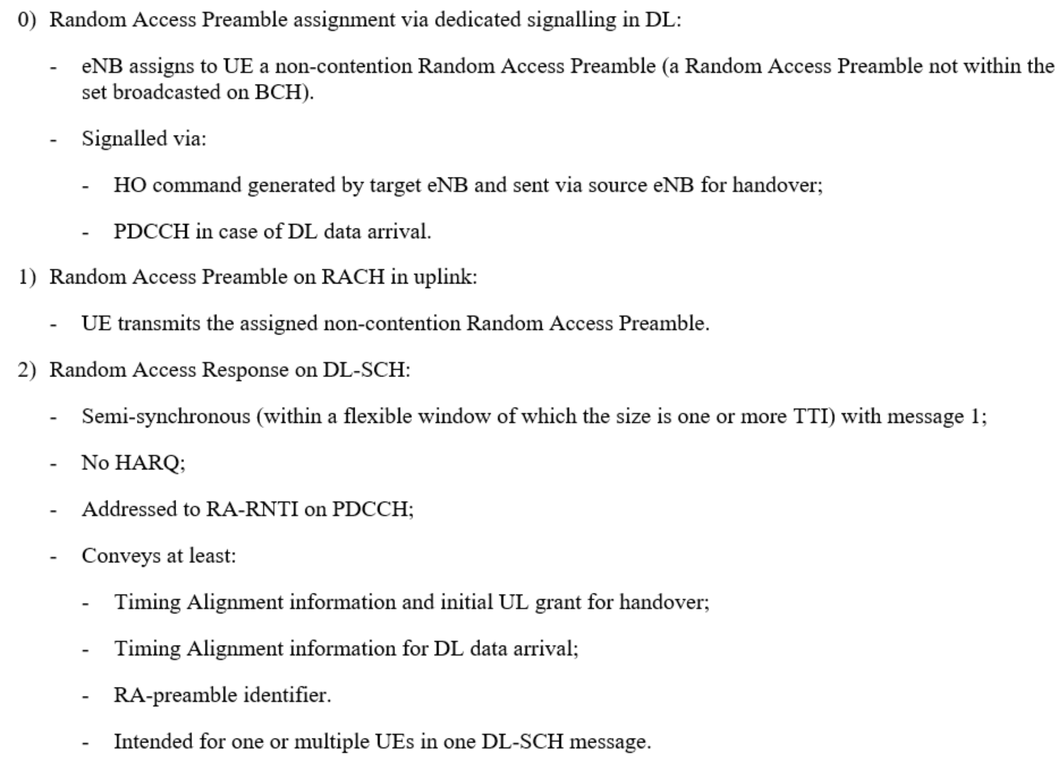
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

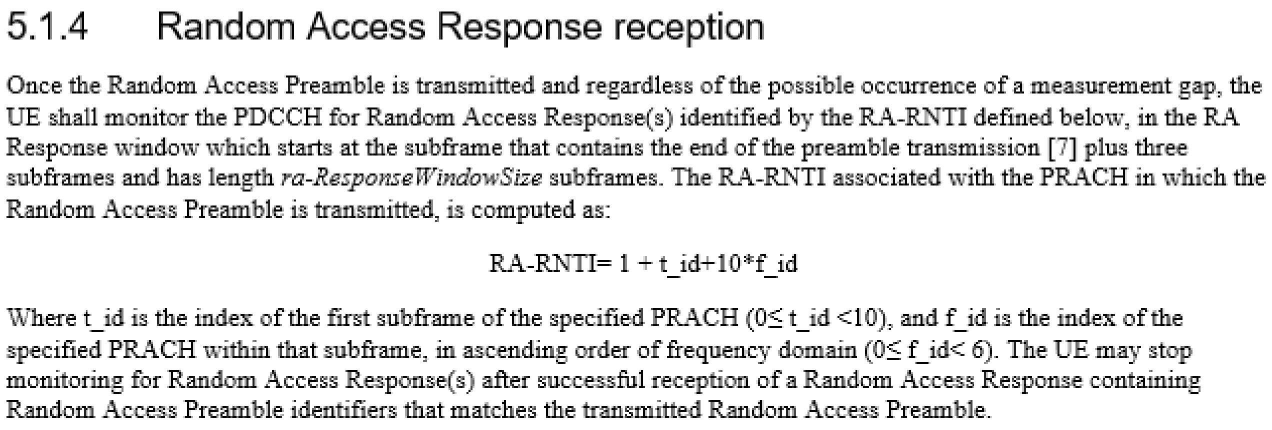


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
   - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



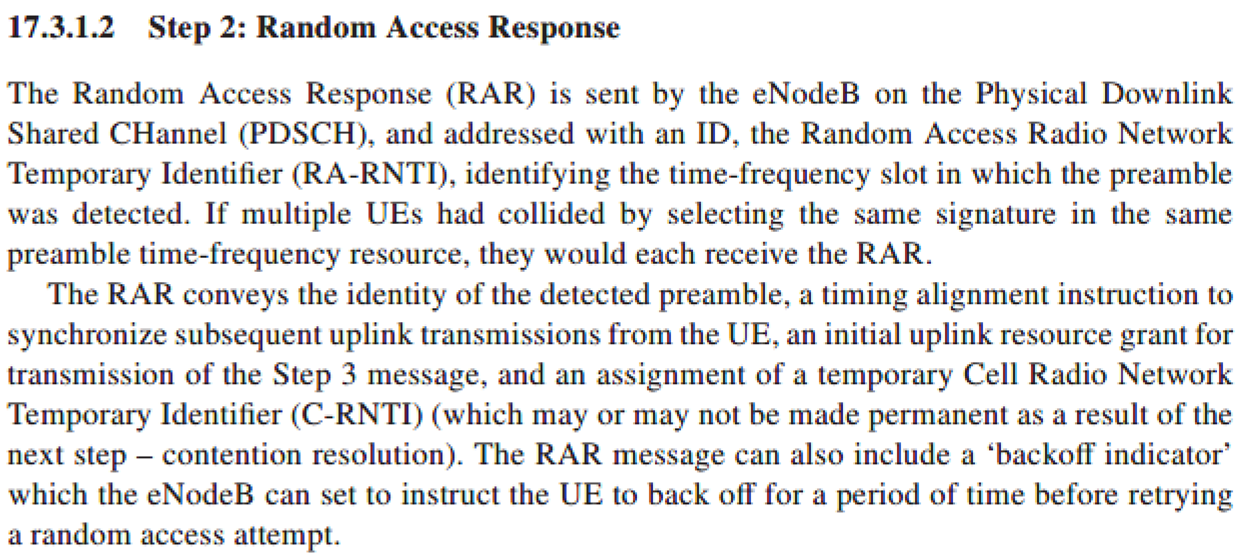
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

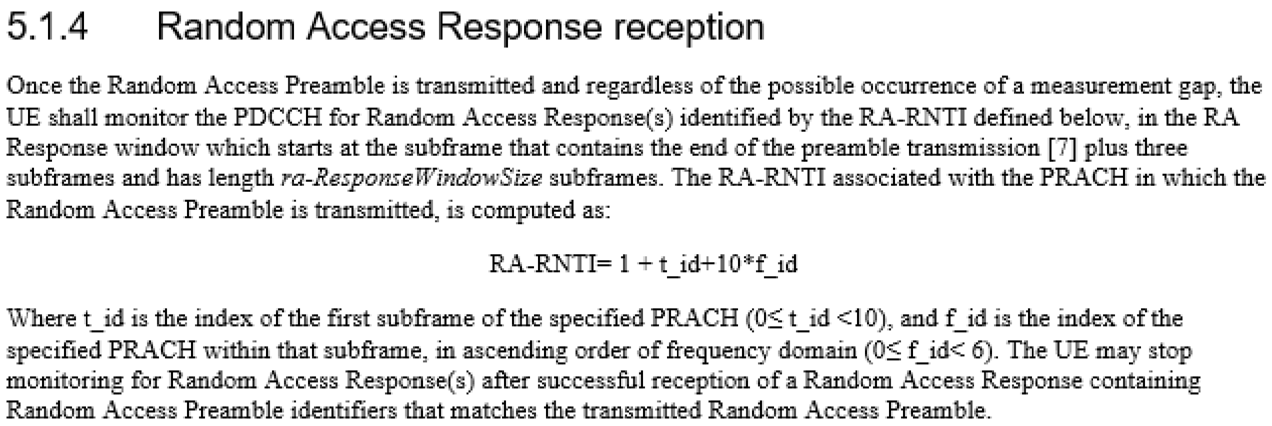
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

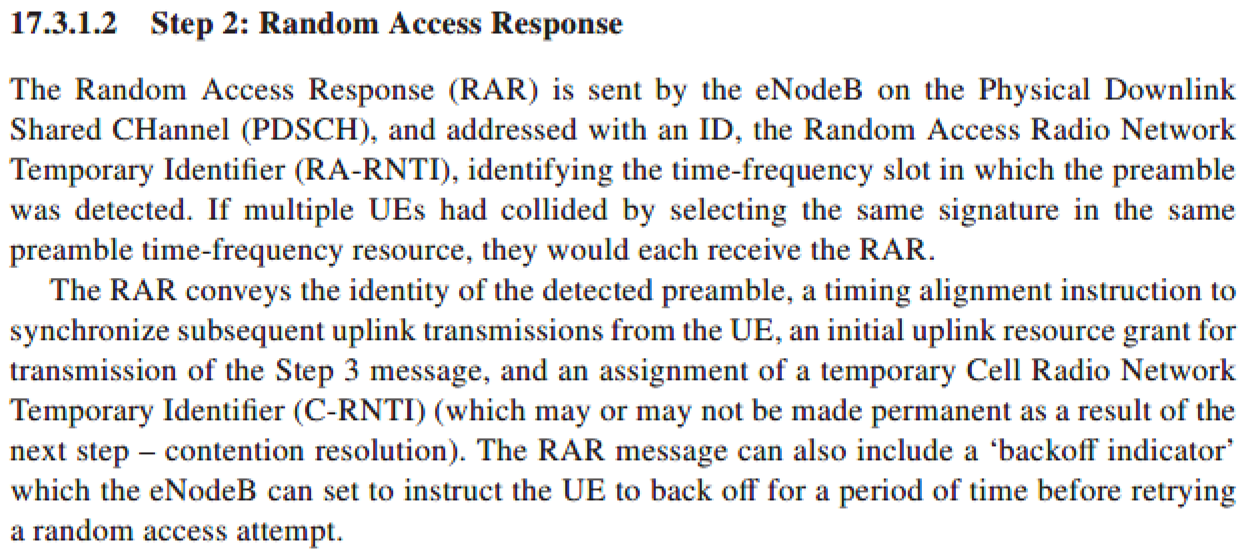
US Patent No. 10,833,908: Claim 2(a)
“The mobile station of claim 1, wherein:”

2. The mobile station of claim 1, wherein:	*See* Claim 1.

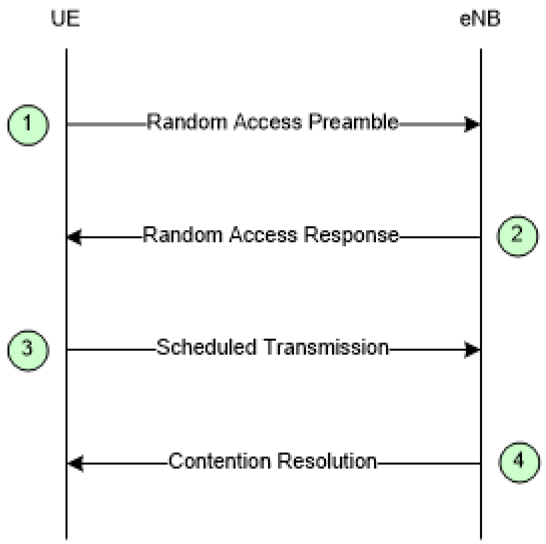
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of Volkswagen’s Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

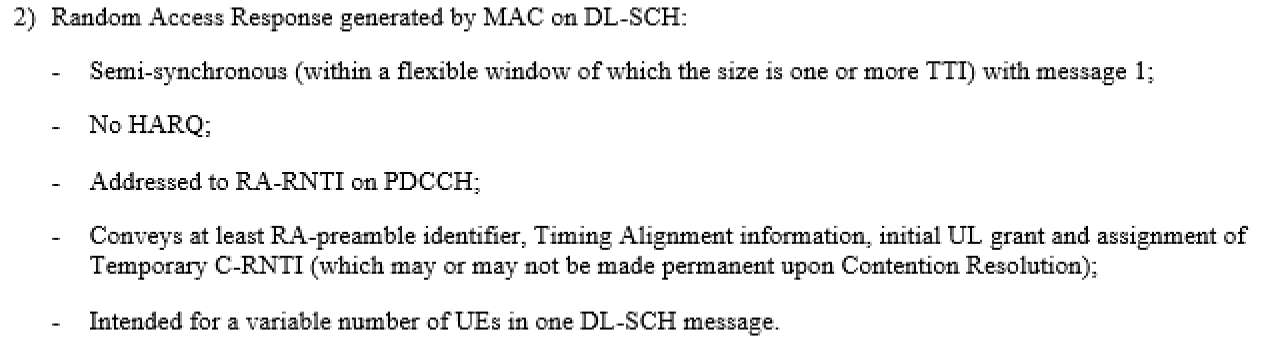
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in Volkswagen's Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.*, When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:  **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

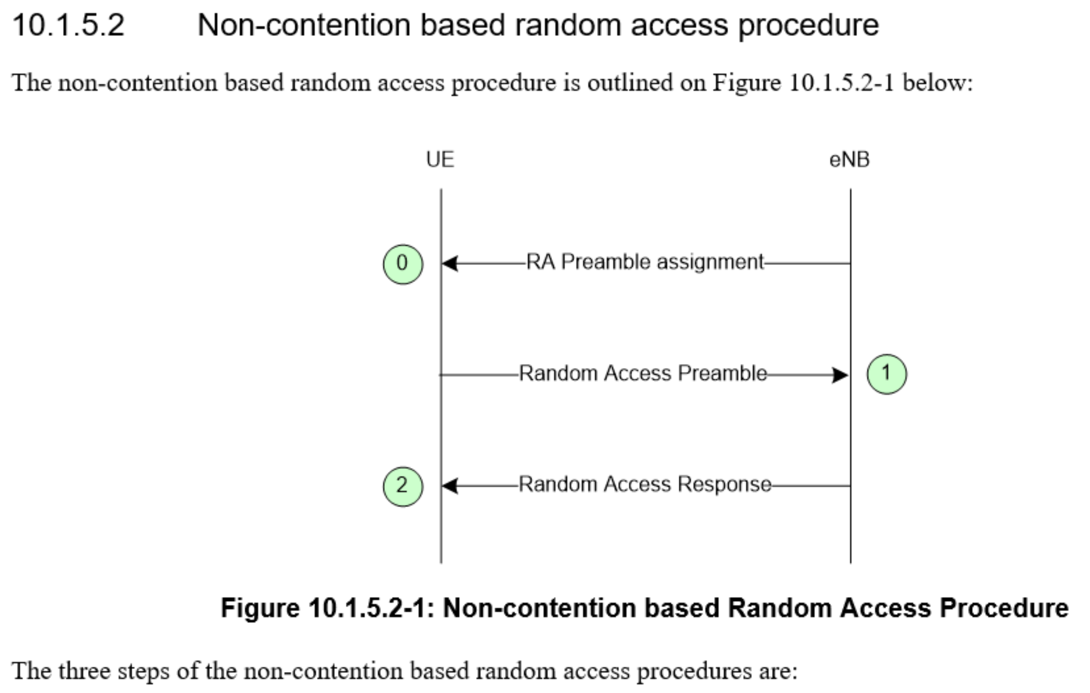
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



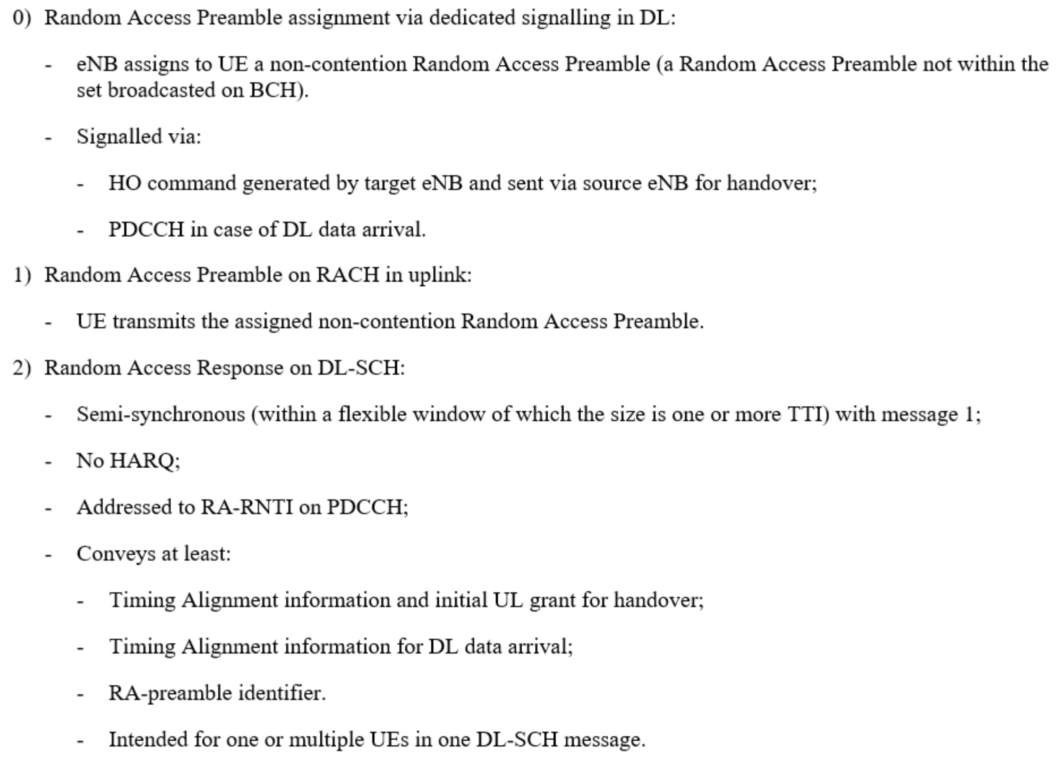
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

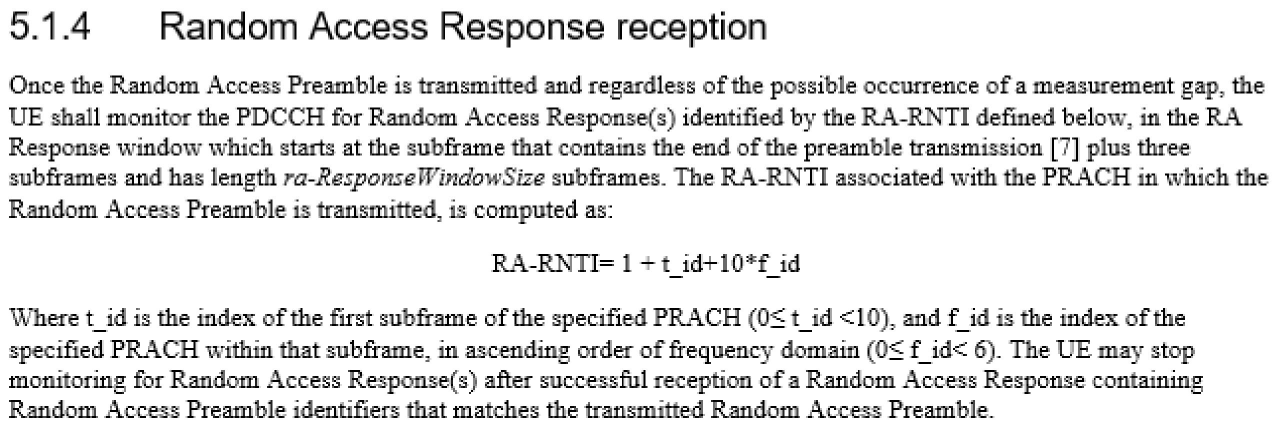


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

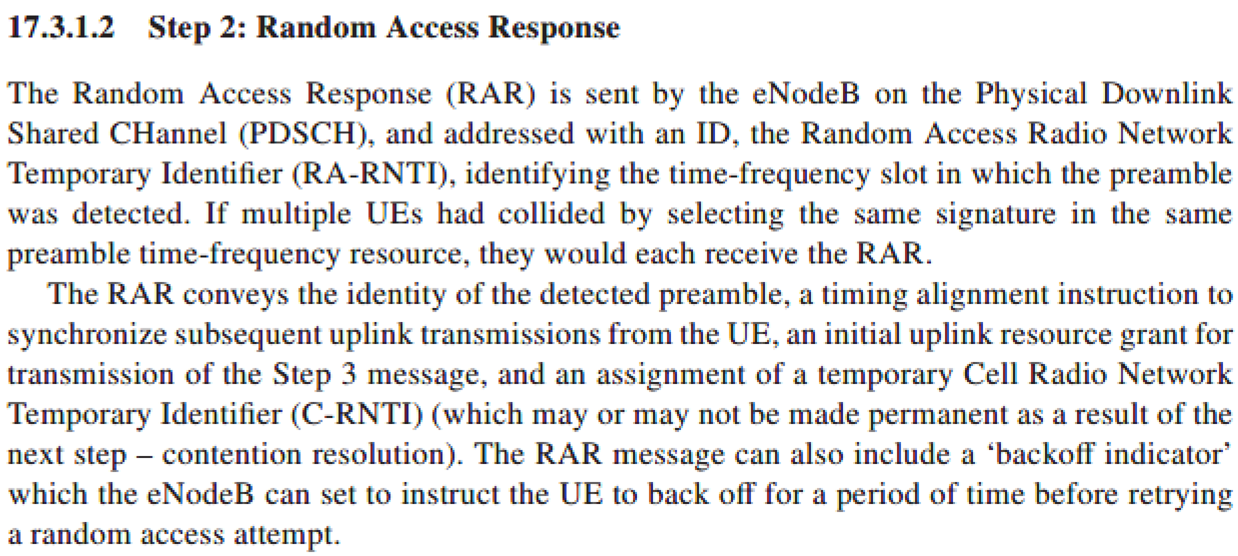
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + \text{t\_id}+10*\text{f\_id}$$

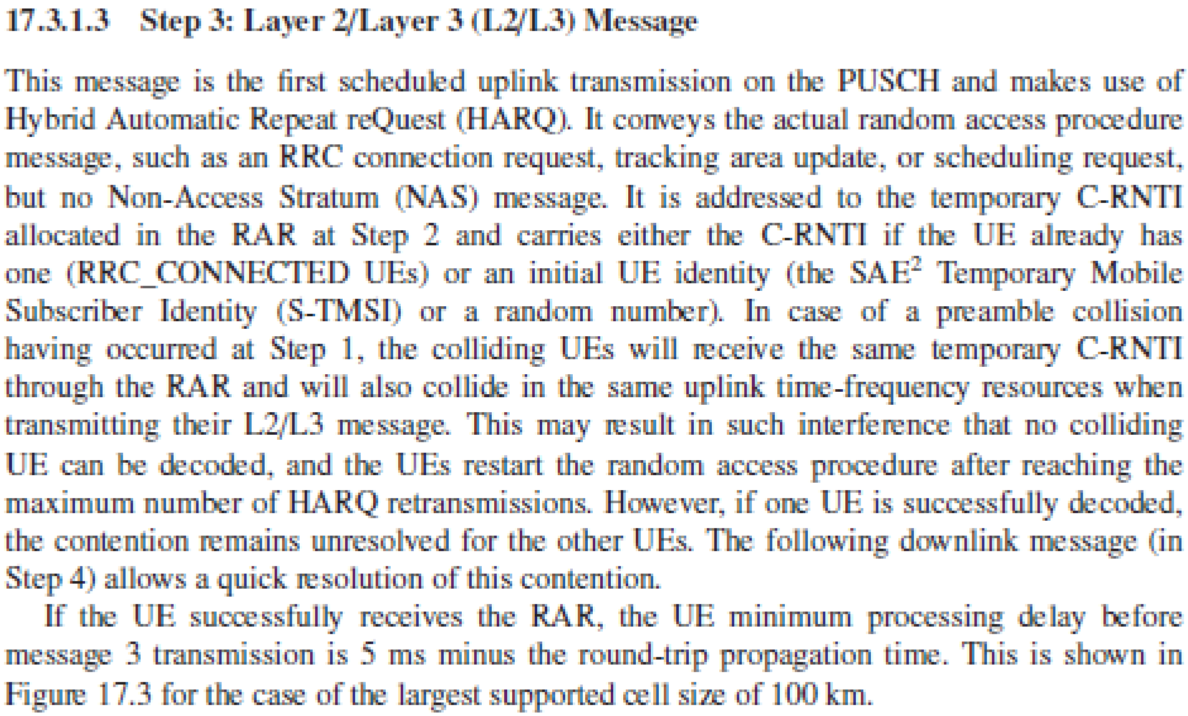
Where t_id is the index of the first subframe of the specified PRACH ($0\leq$ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq$ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

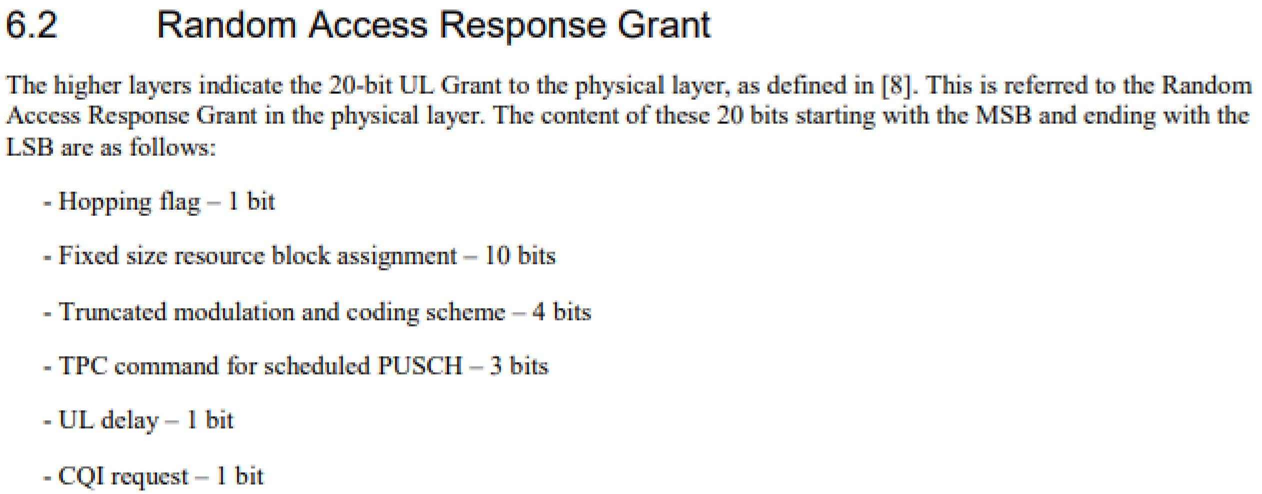
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

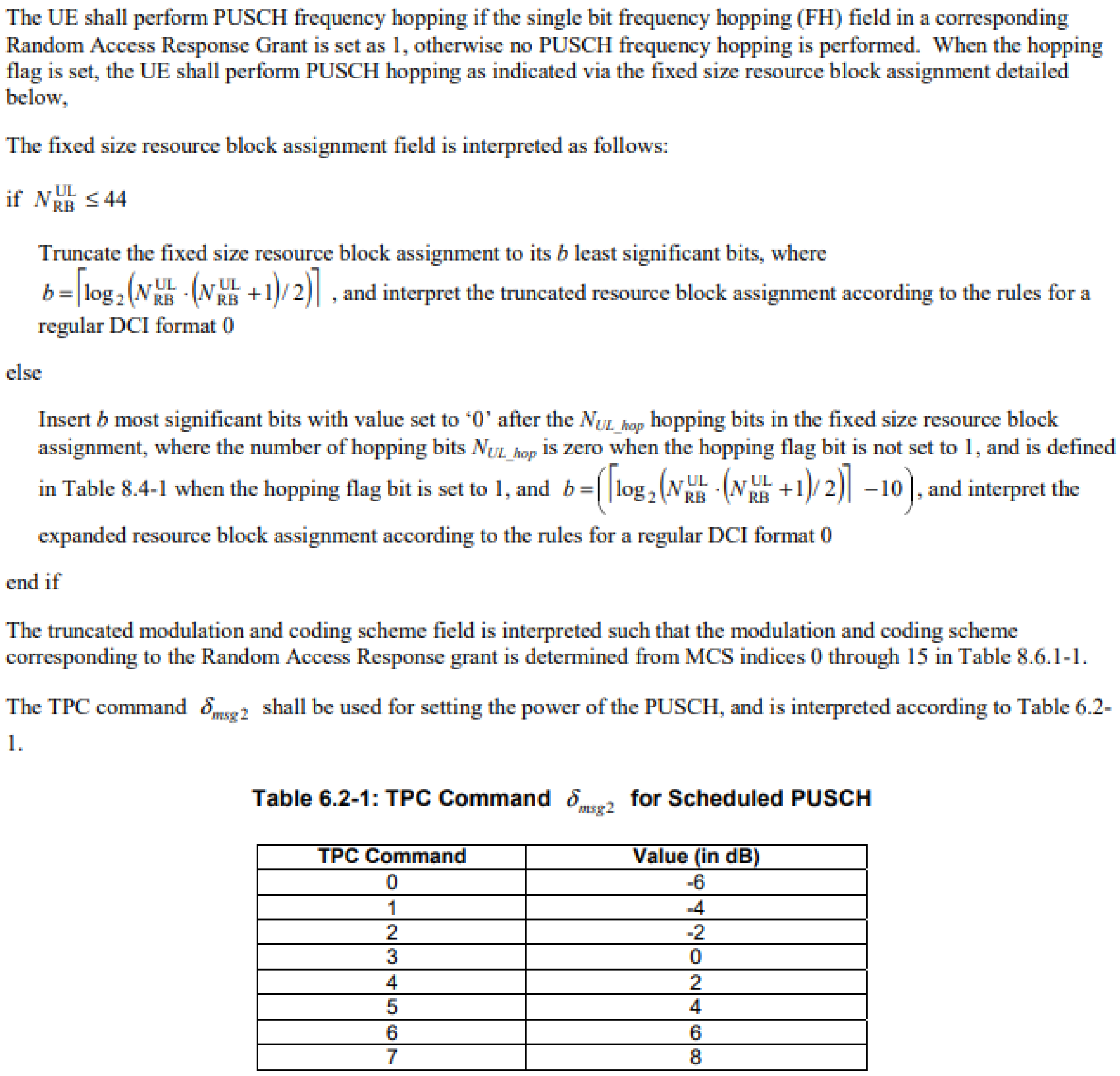
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of Volkswagen's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

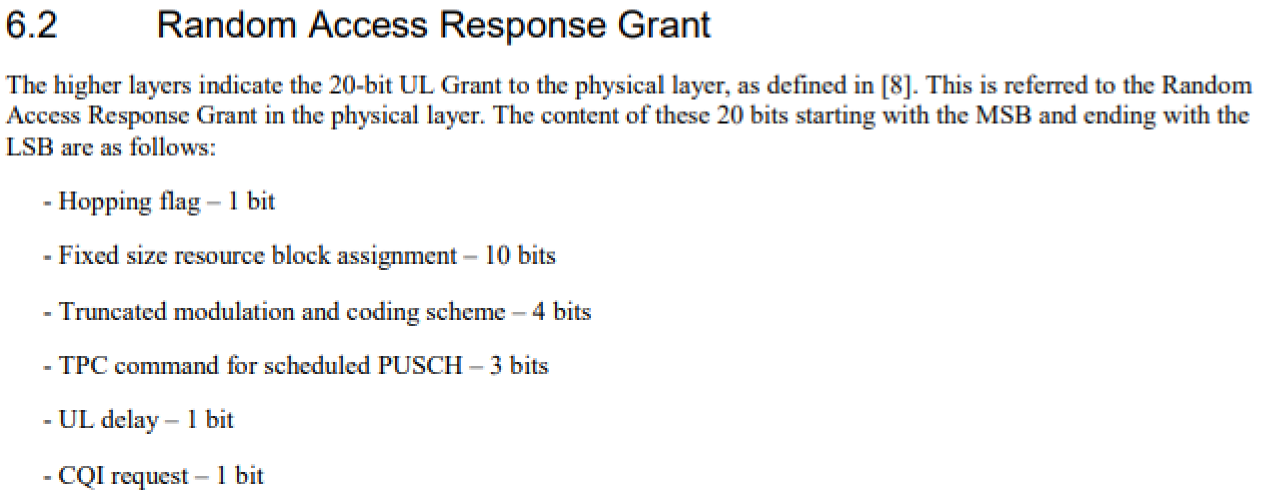
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

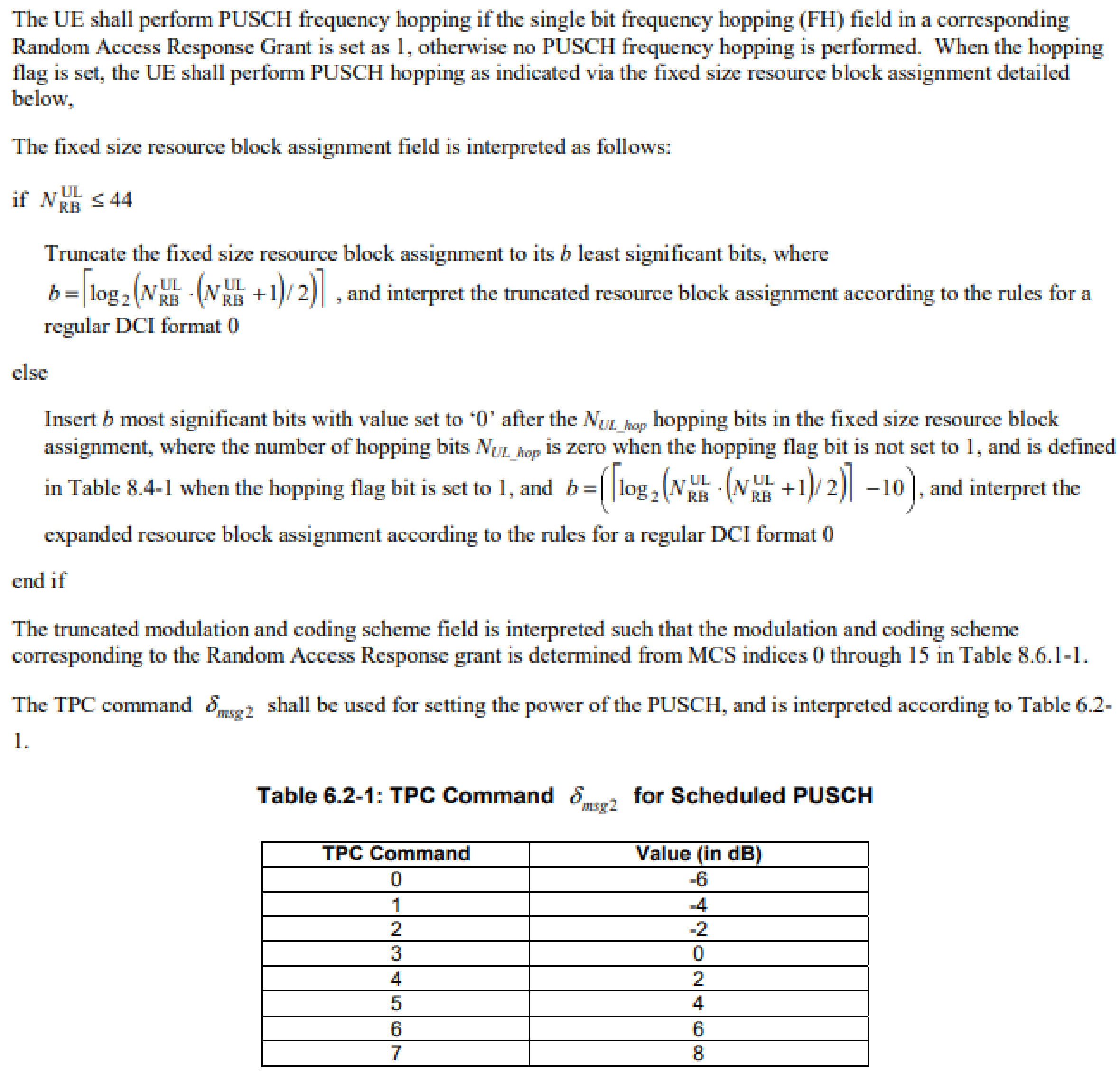
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of Volkswagen’s Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

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TPC Command	Value (in dB)
0	-6
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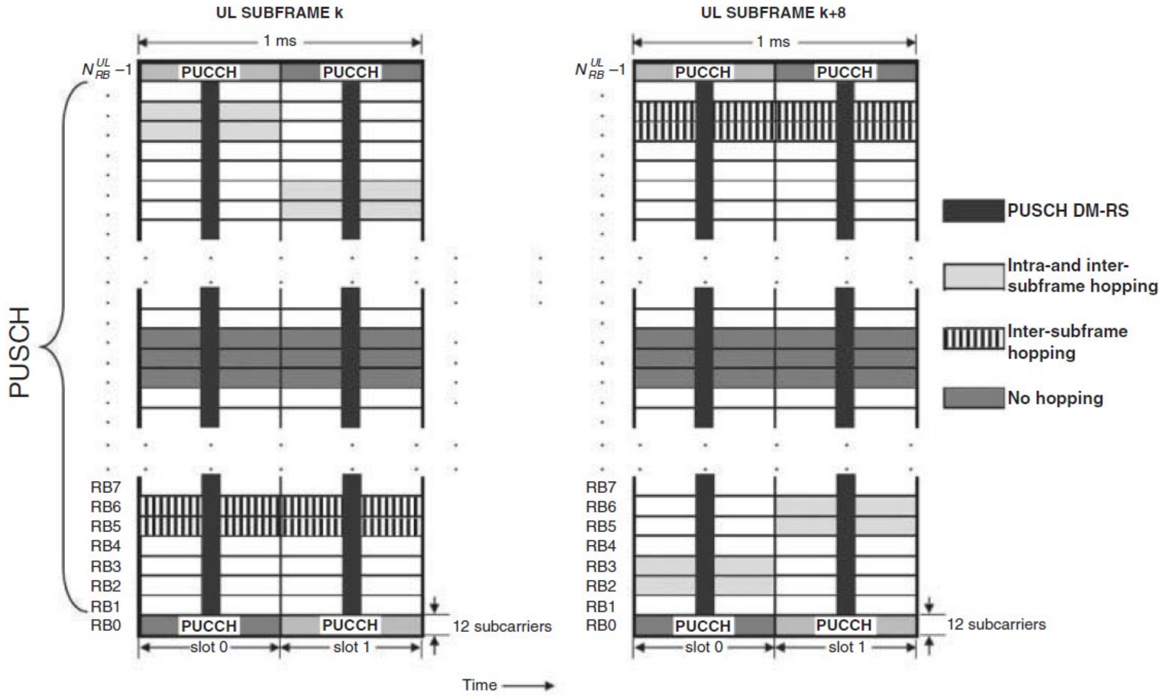
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

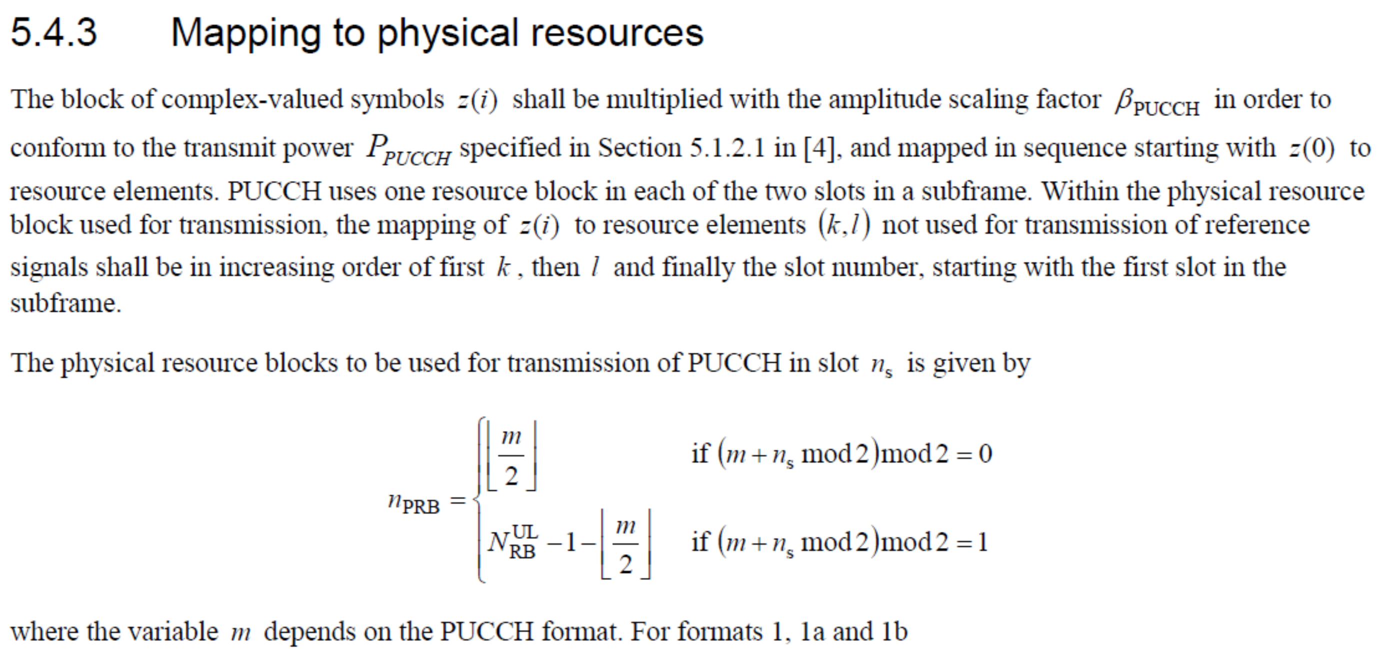
US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of Volkswagen’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



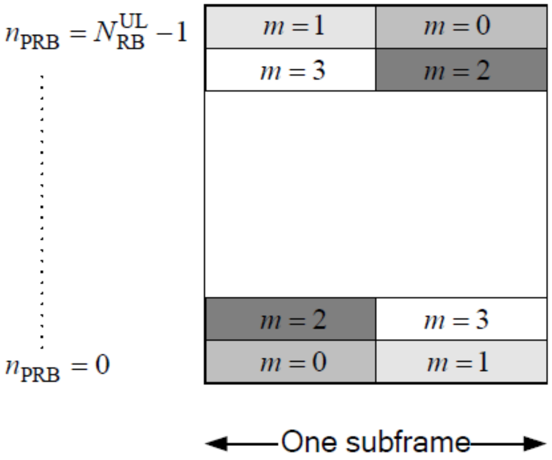
5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

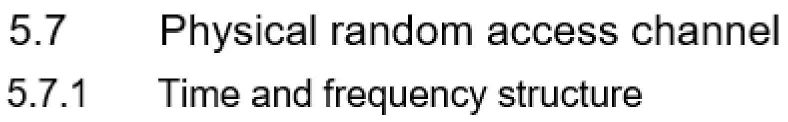
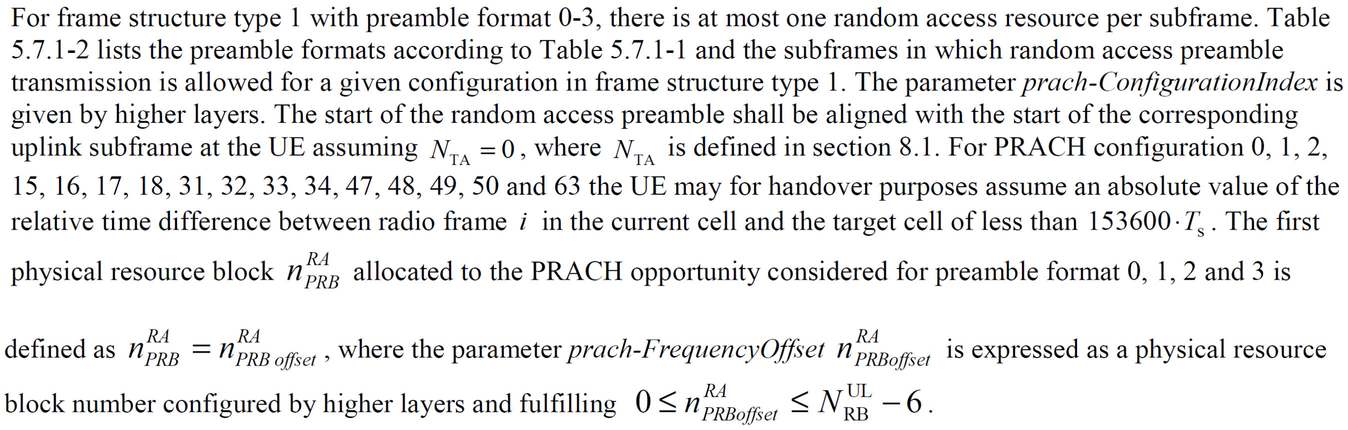
The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

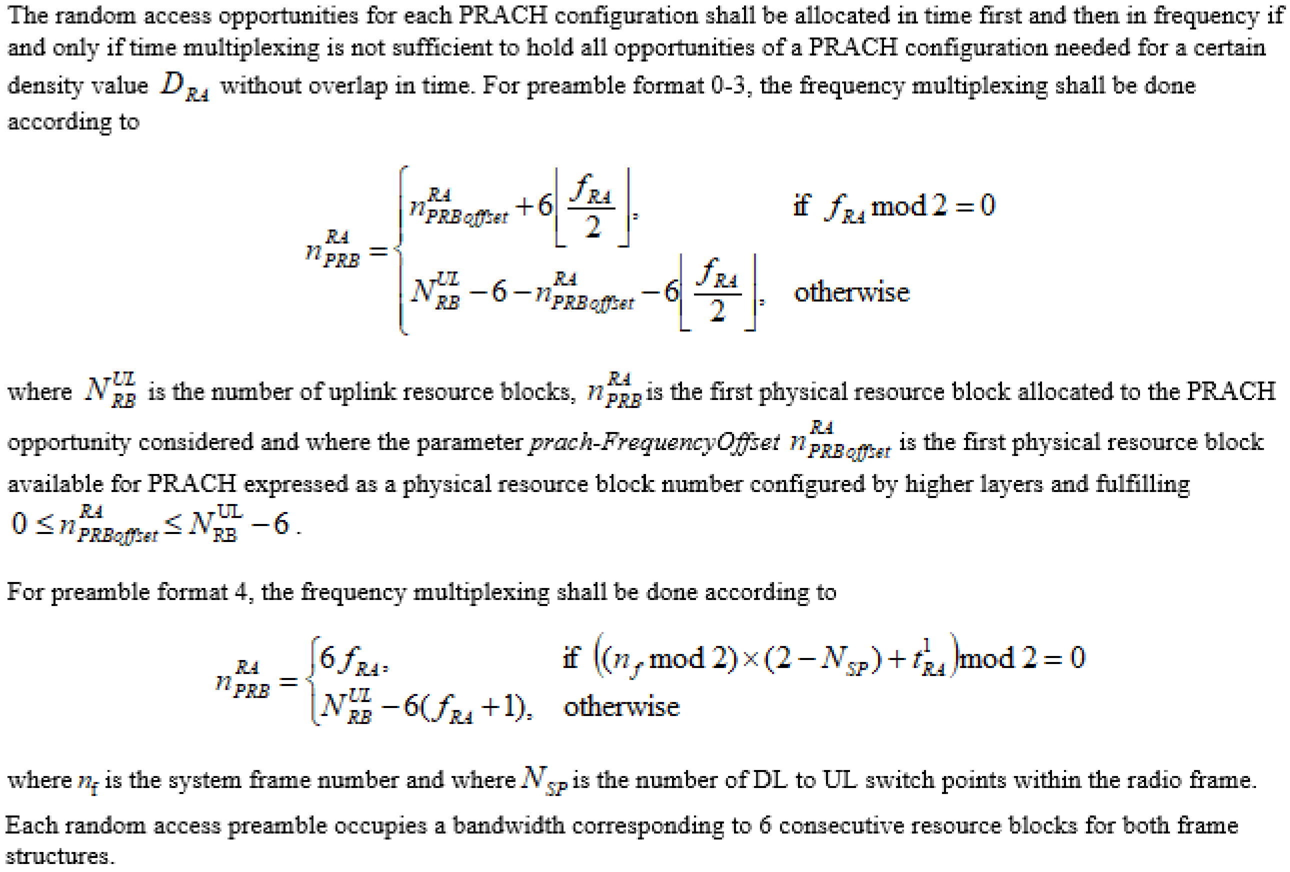
where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

	$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \frac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \frac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$ $c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$ and for formats 2, 2a and 2b $m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$ Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1. In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.  **Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21. The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure …  For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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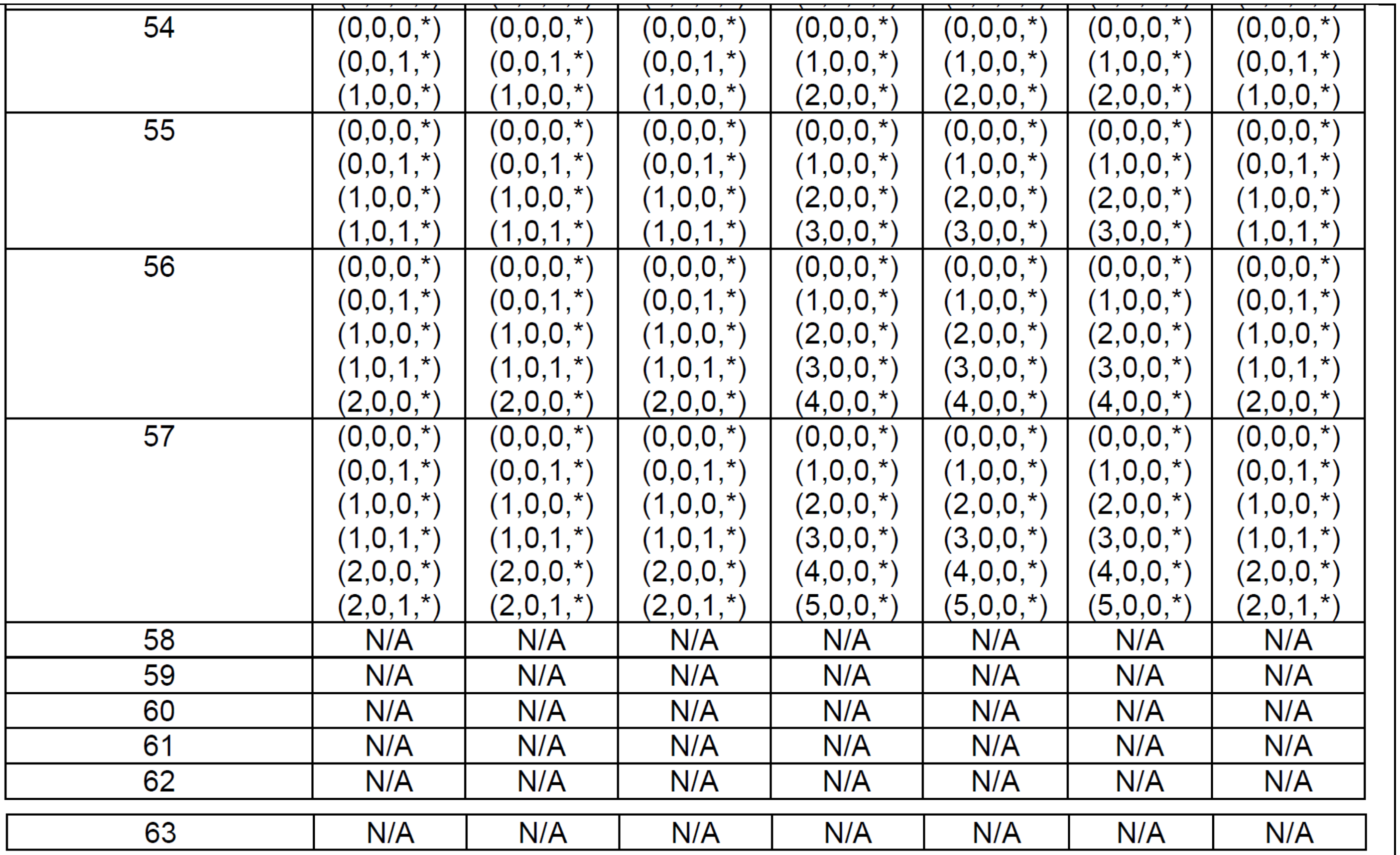
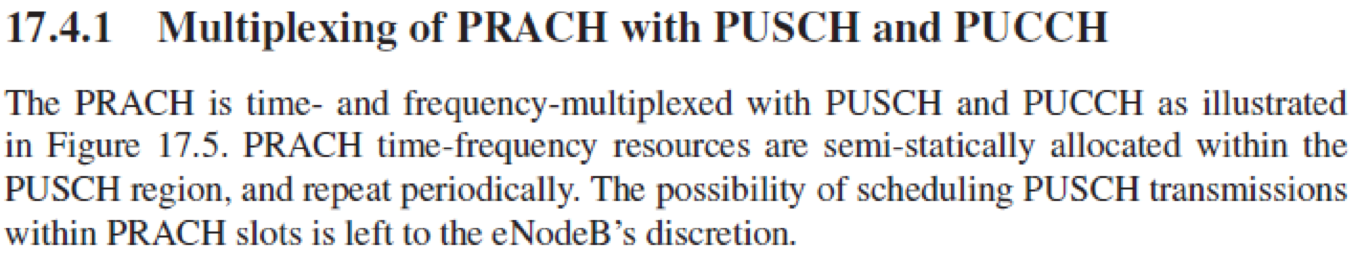
US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

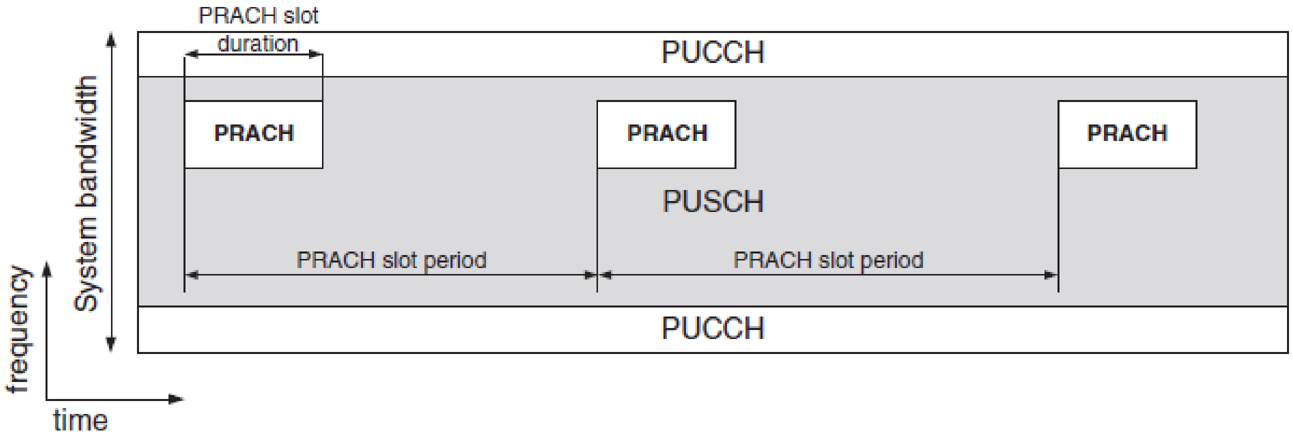


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

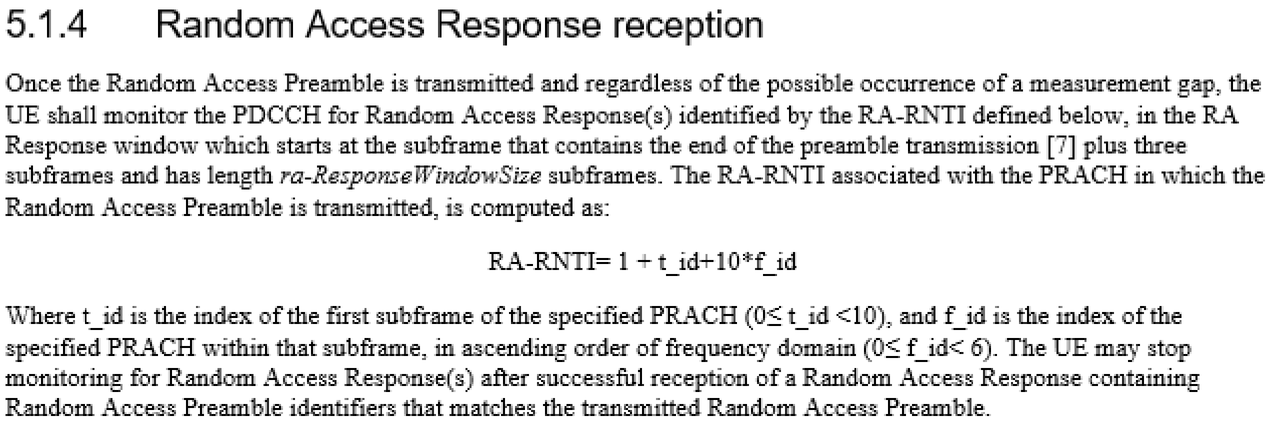
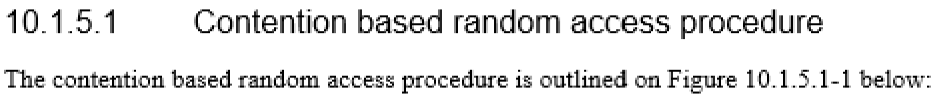
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 4

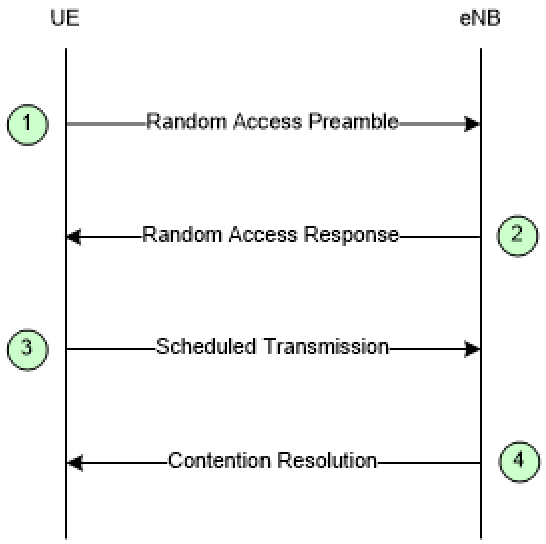
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

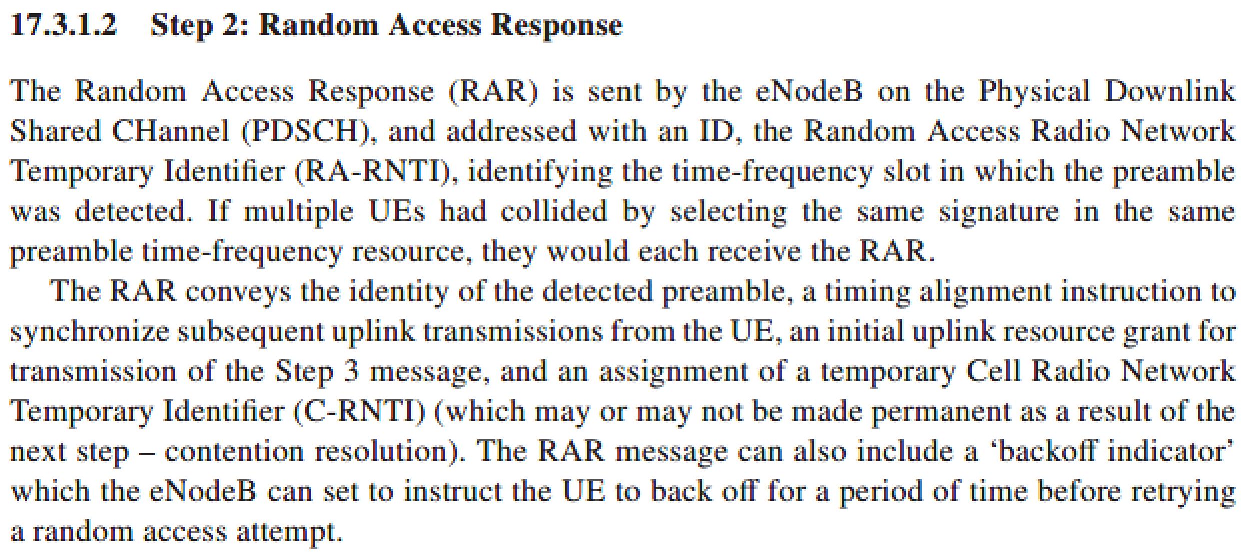
US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Volkswagen’s Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

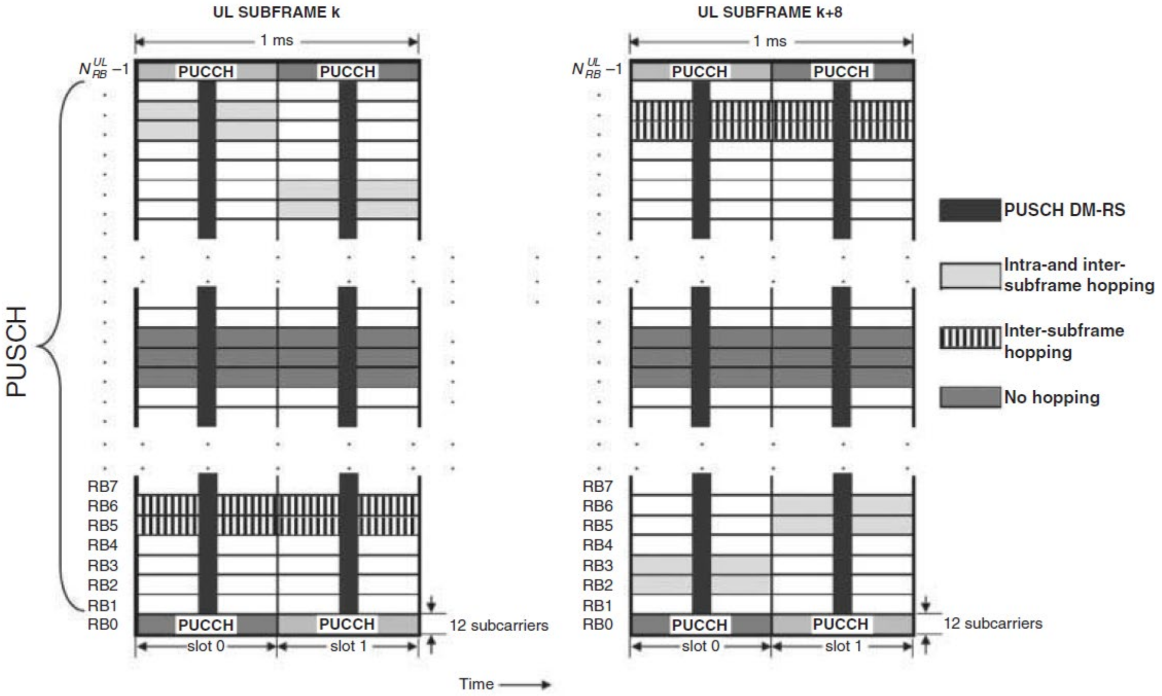
US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

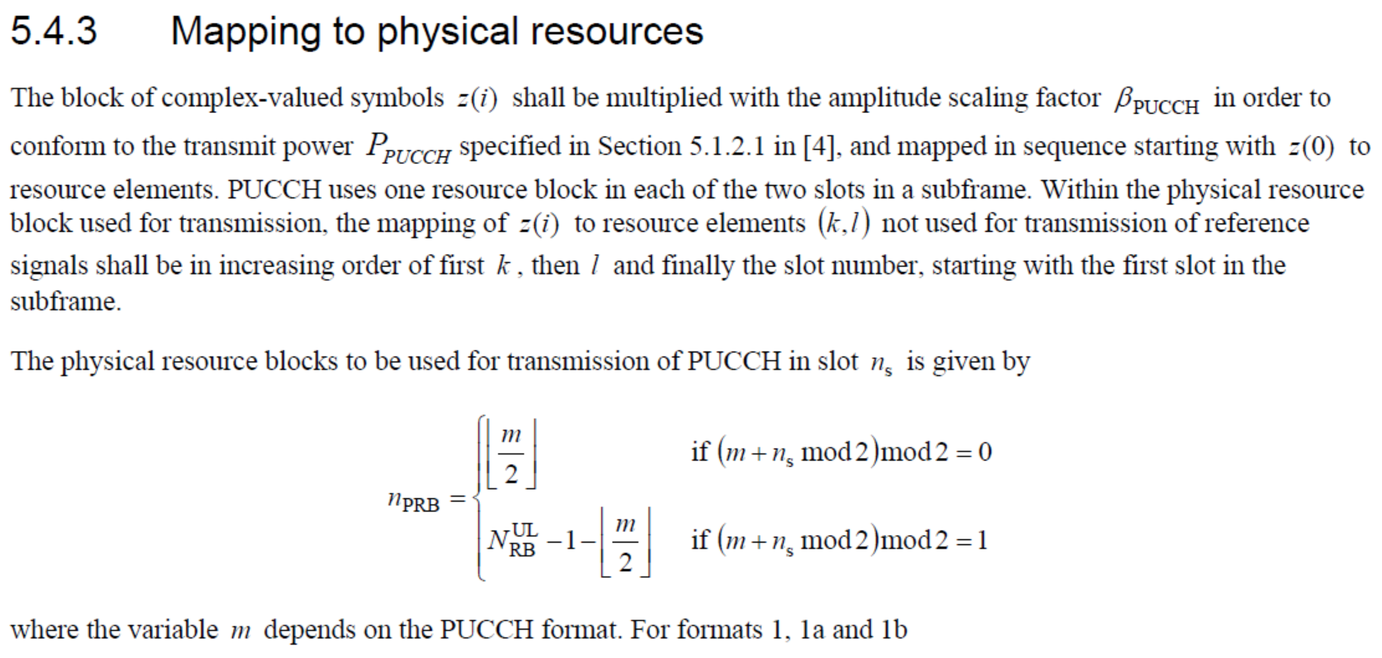
US Patent No. 10,833,908: Claim 6
"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Volkswagen's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

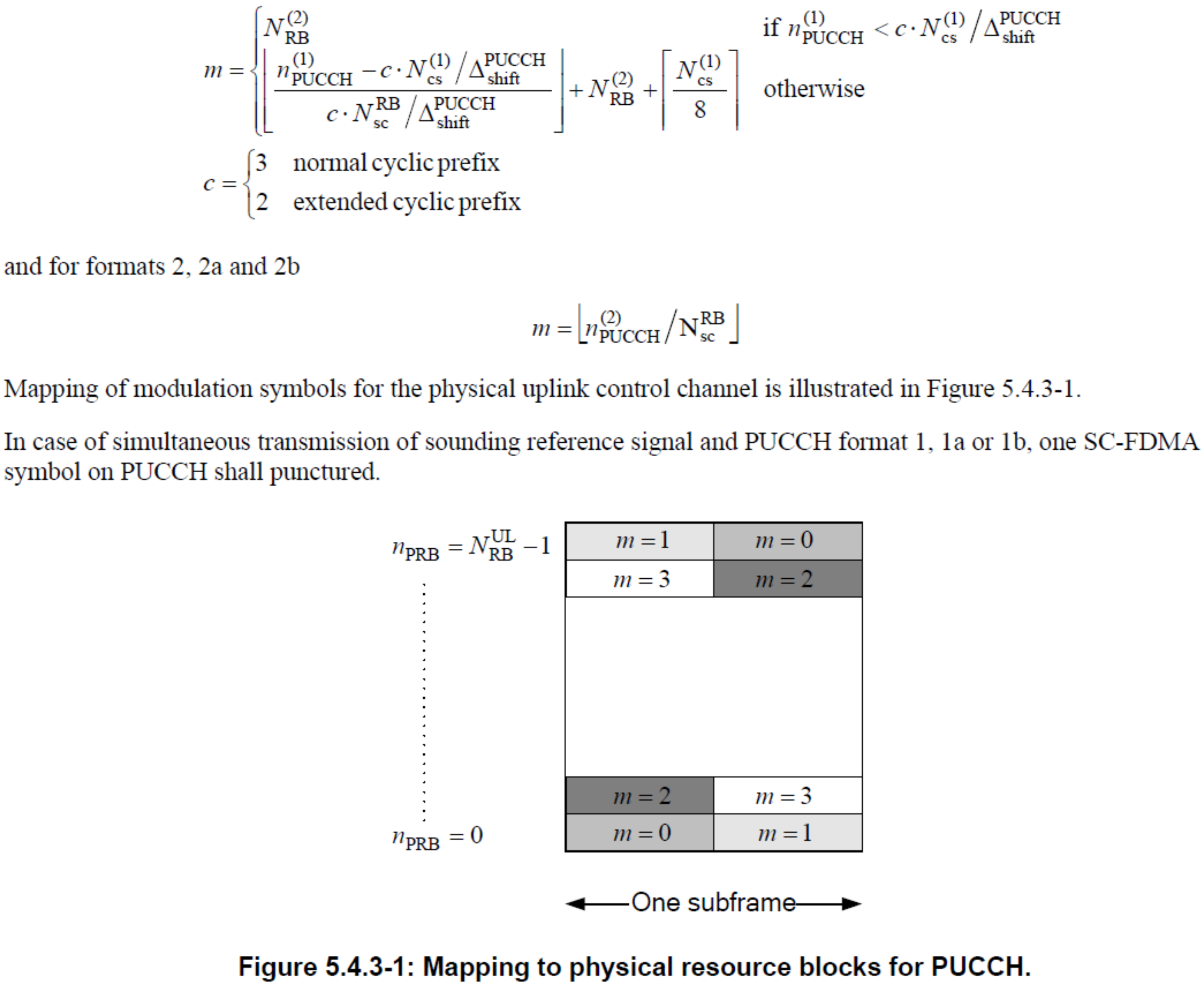
US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Volkswagen's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7
“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

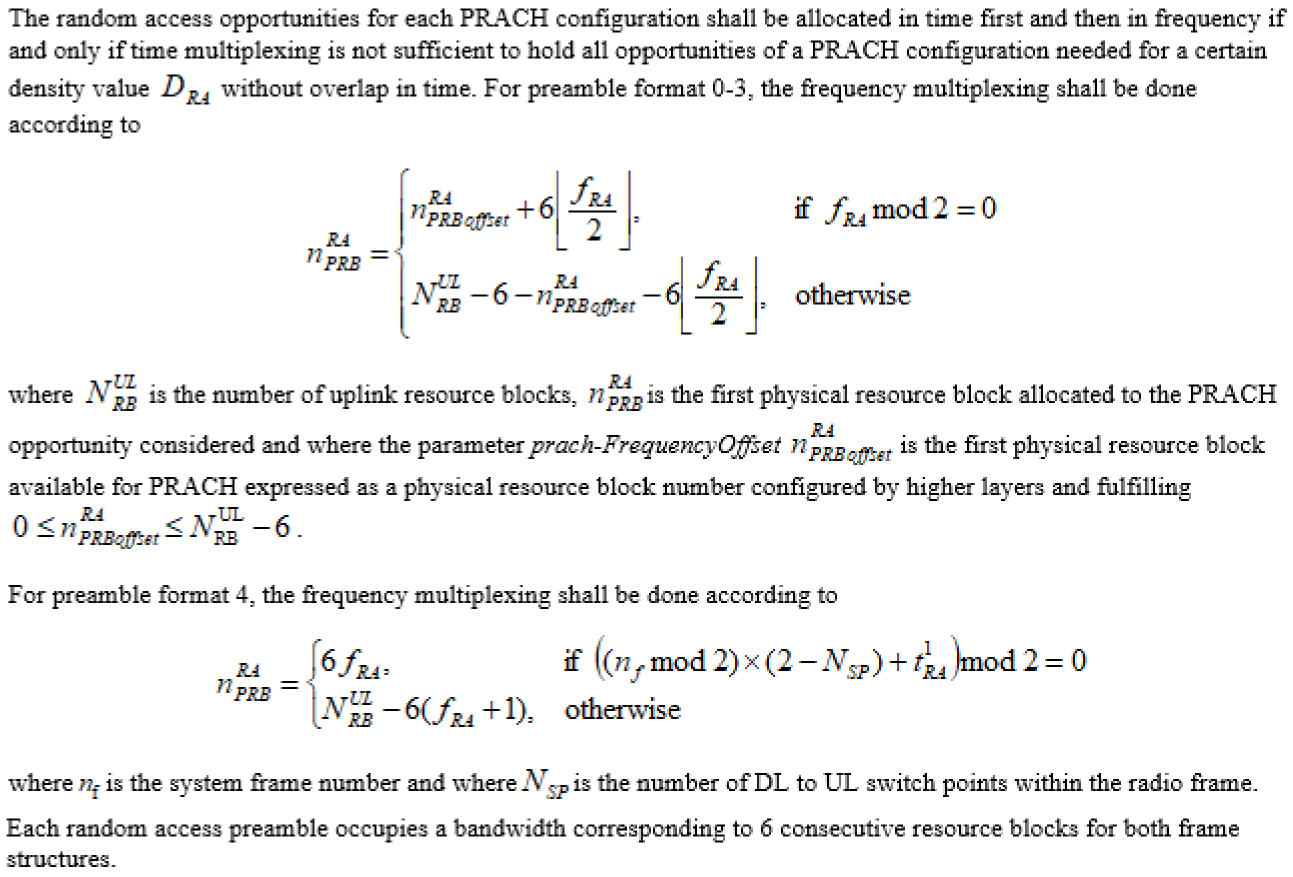
5.7.1 Time and frequency structure

...

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

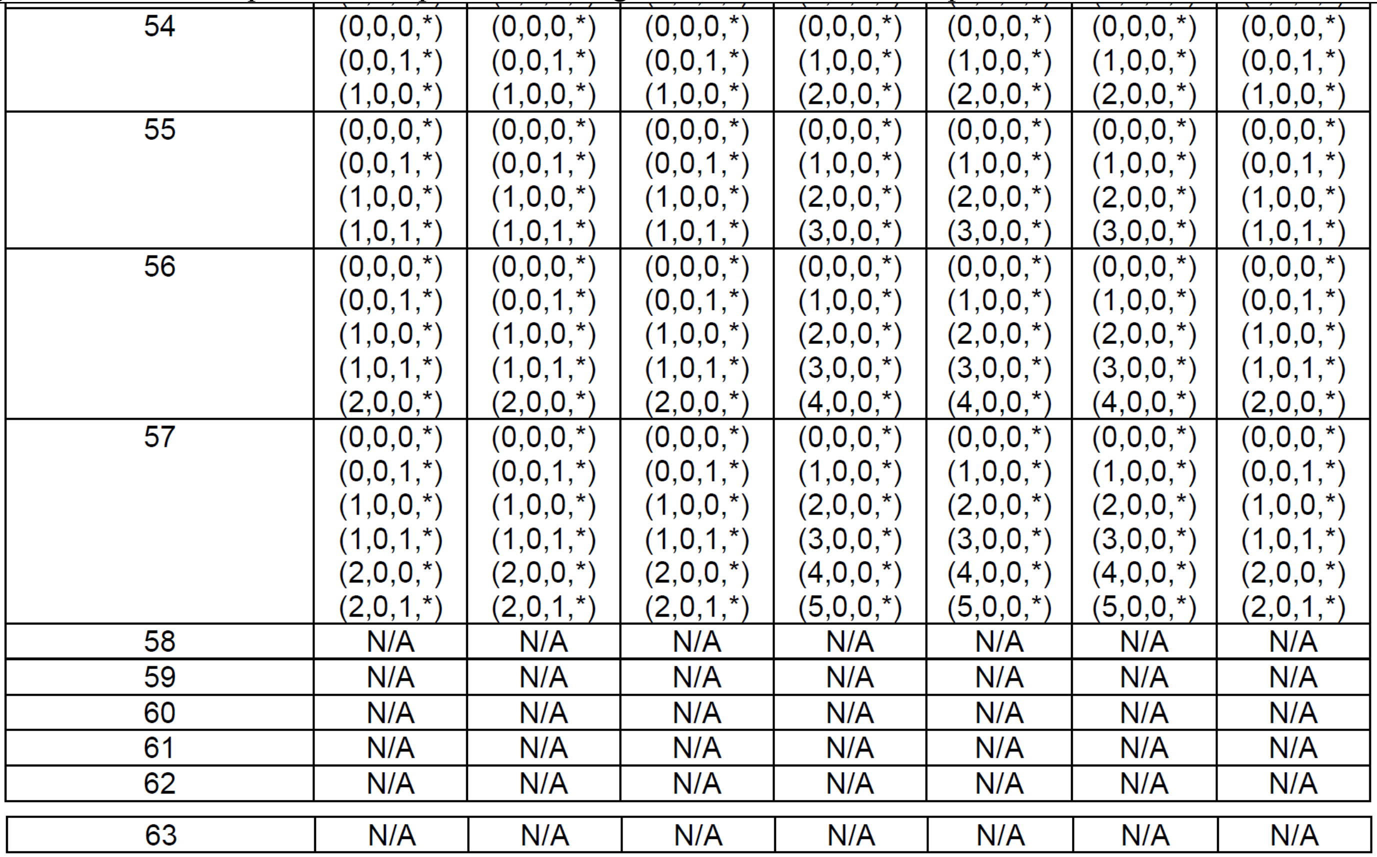
Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.
.
.

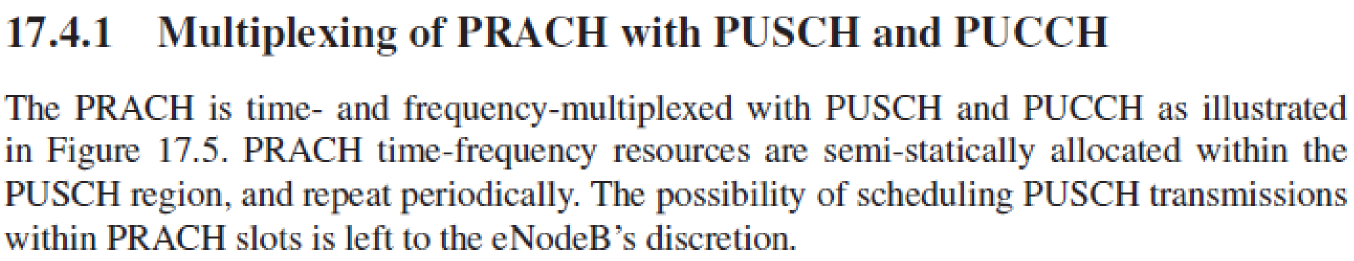
US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

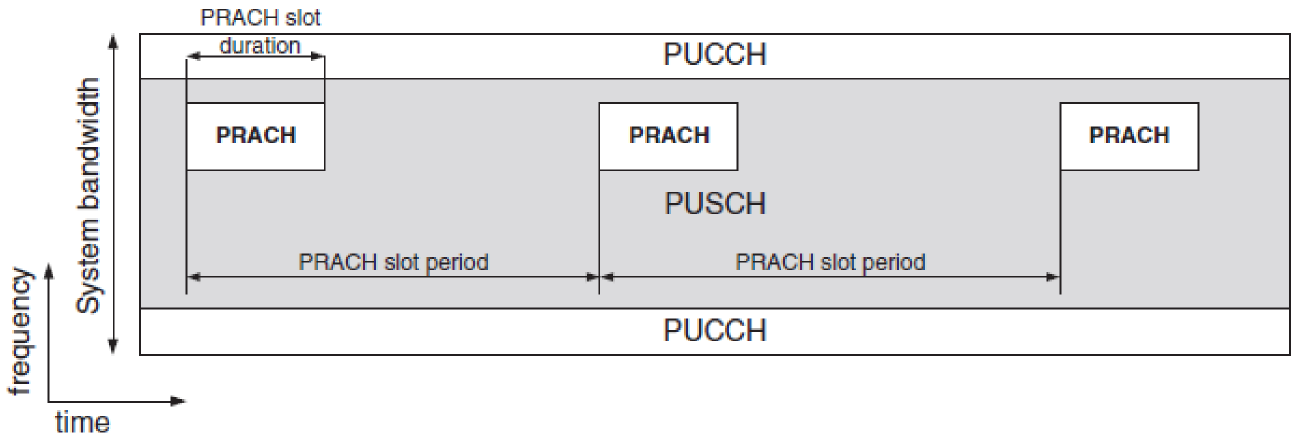


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

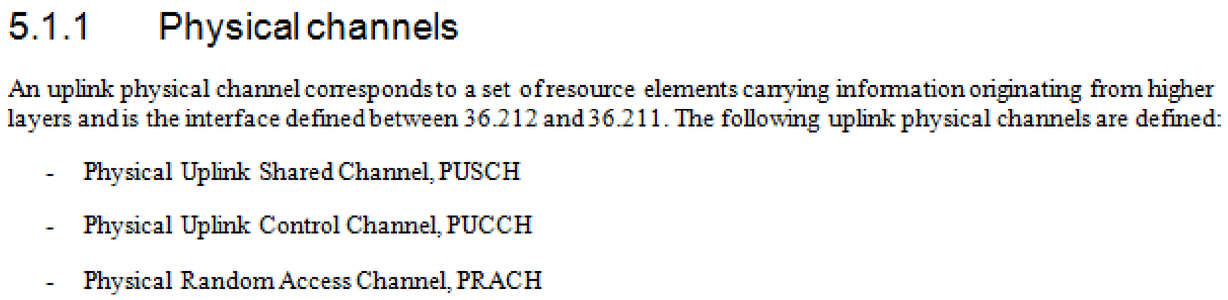
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 7

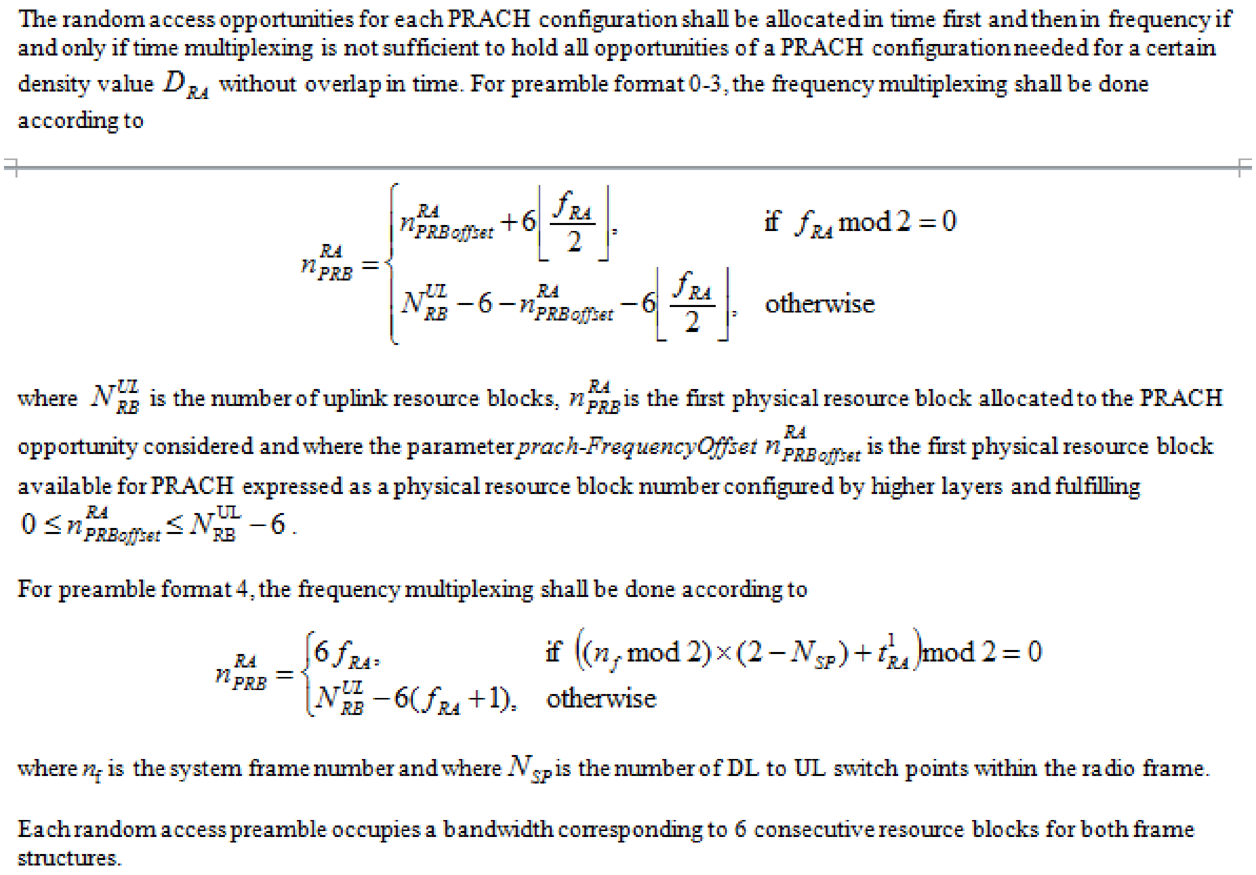
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Volkswagen's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

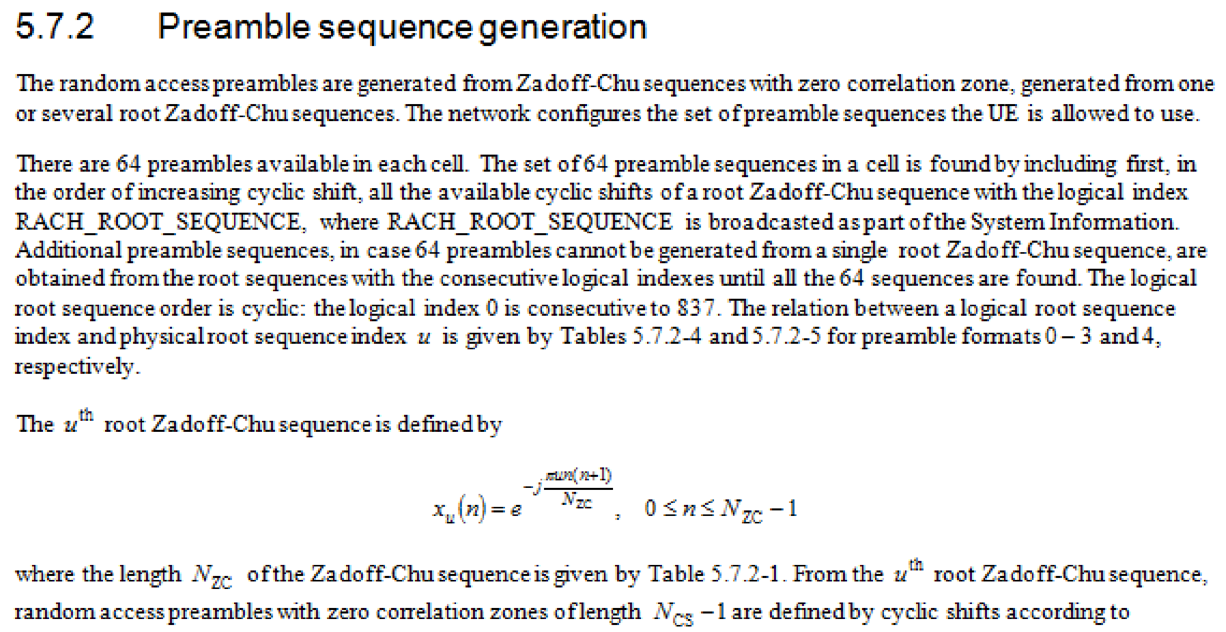
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

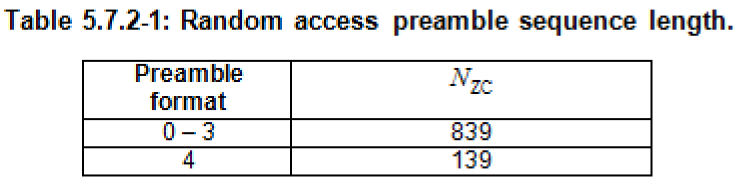
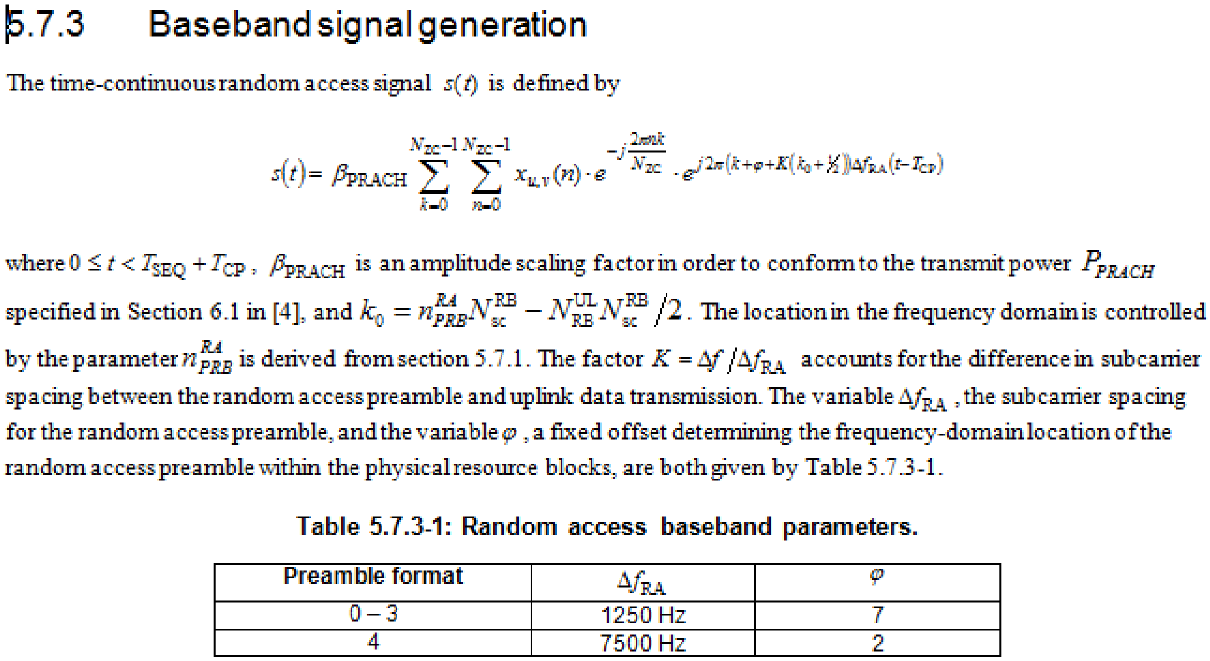


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

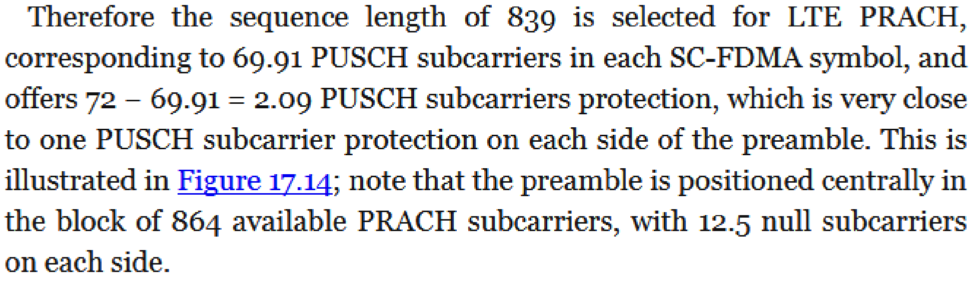
$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

where $0\le t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

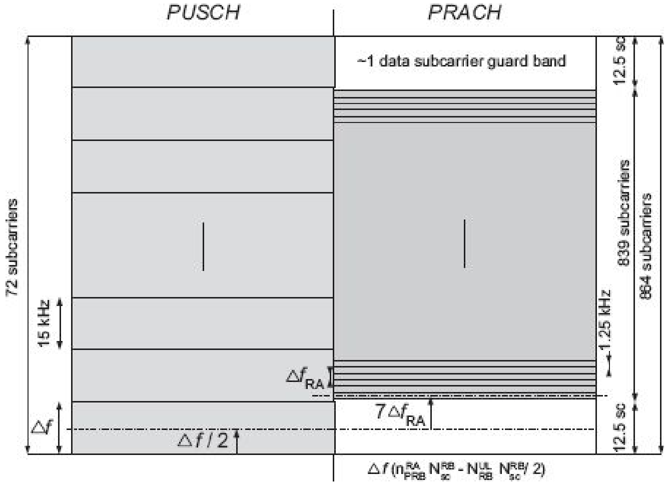
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.



Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

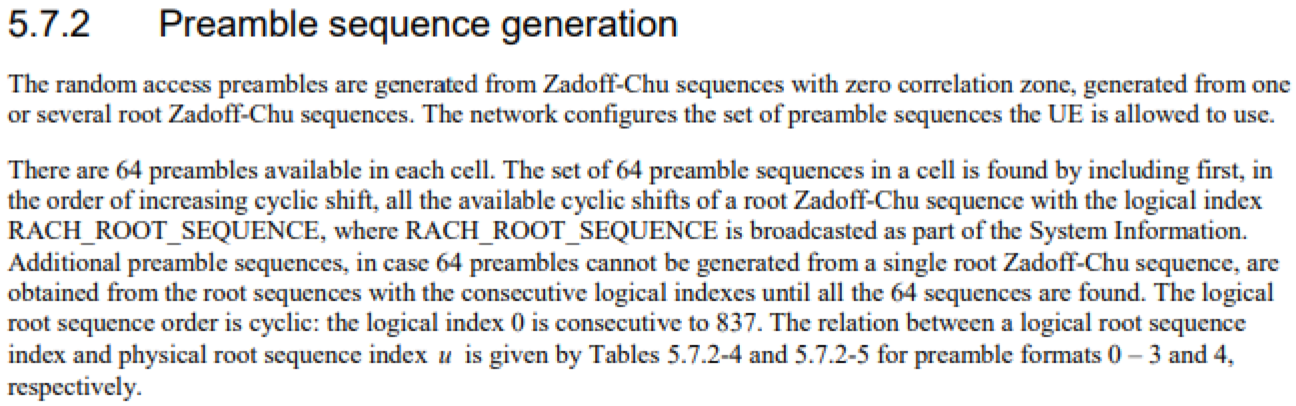
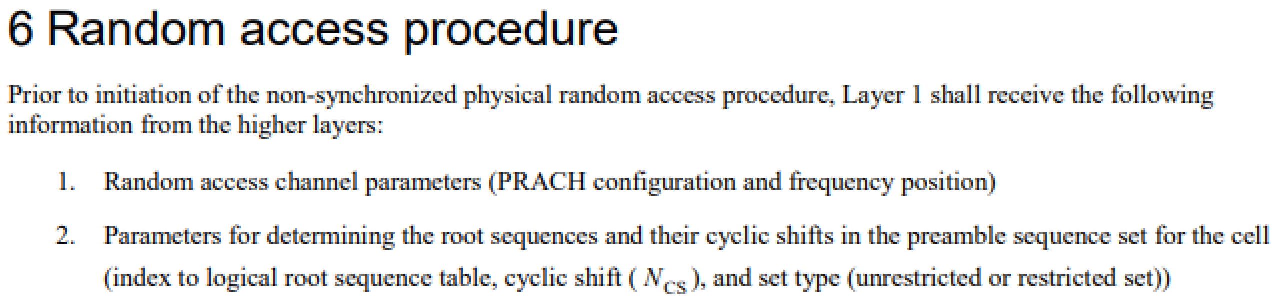
Figure 17.14: PRACH preamble mapping onto allocated subcarriers.



See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Volkswagen's Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

US Patent No. 10,833,908: Claim 9

“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

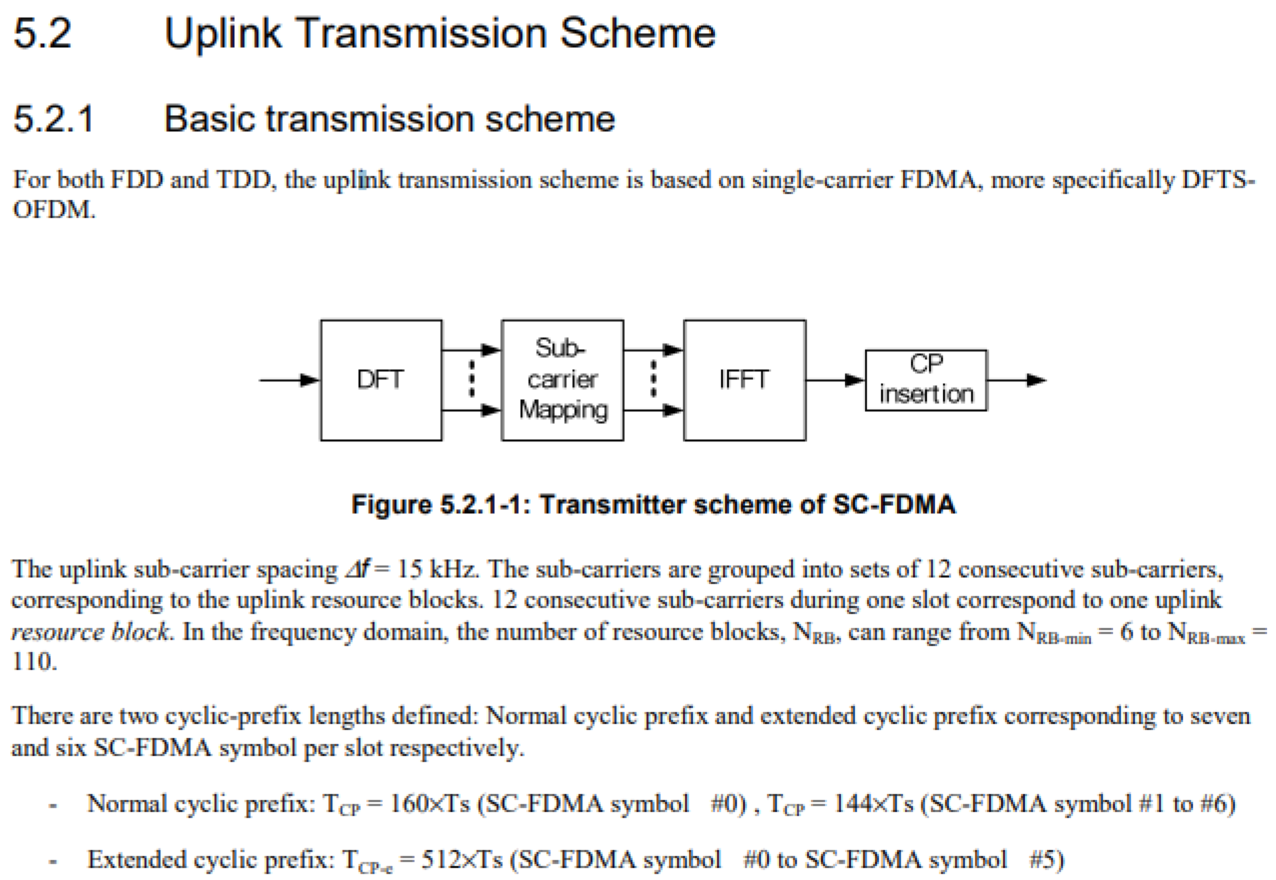
```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 1. Volkswagen's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Volkswagen's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 10

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

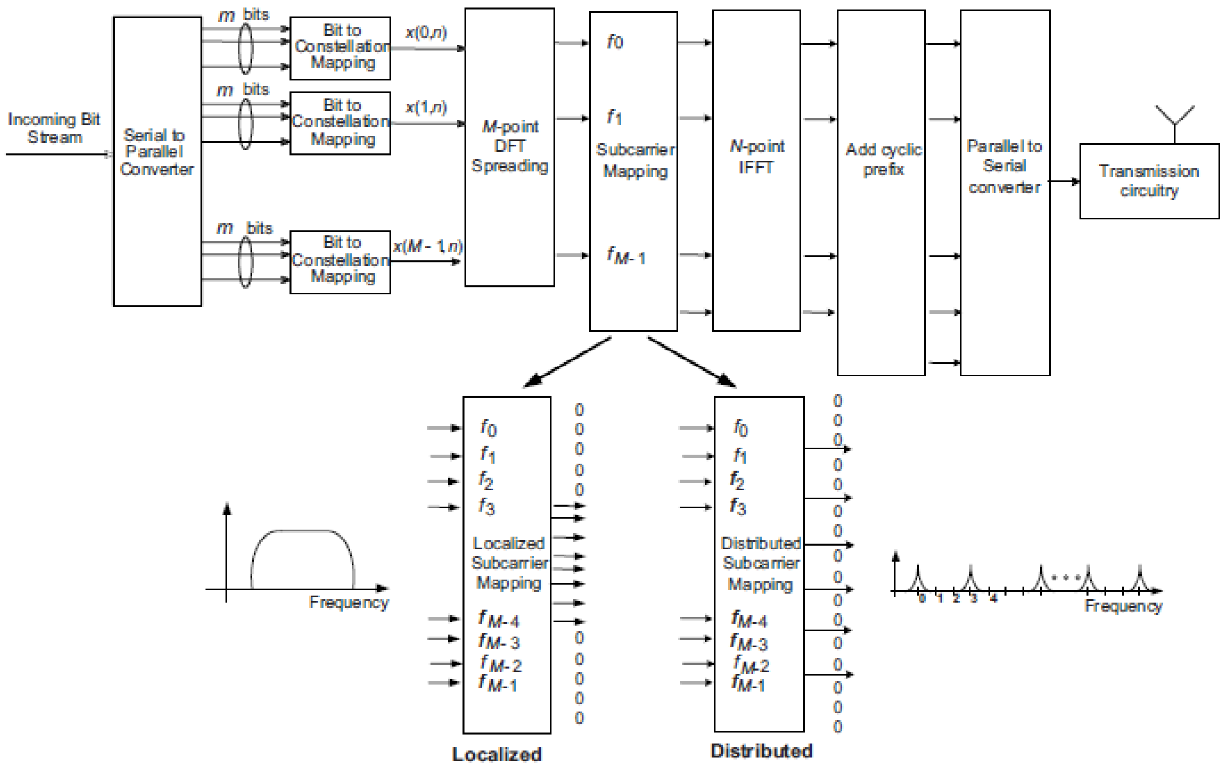
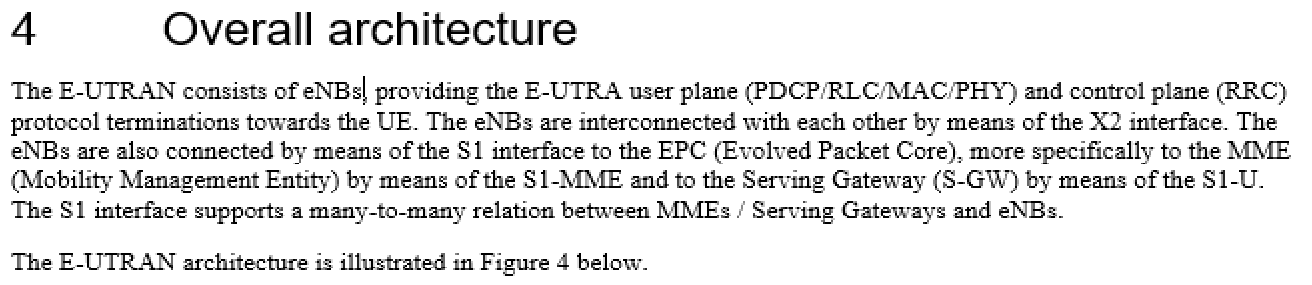


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, Volkswagen's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* Volkswagen's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Volkswagen offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

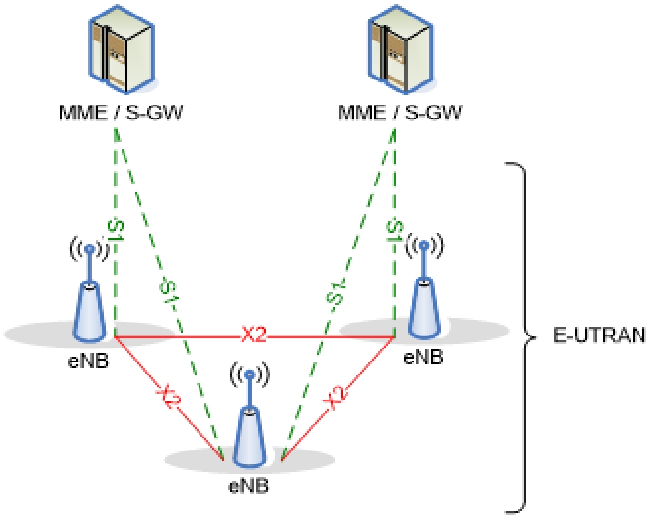
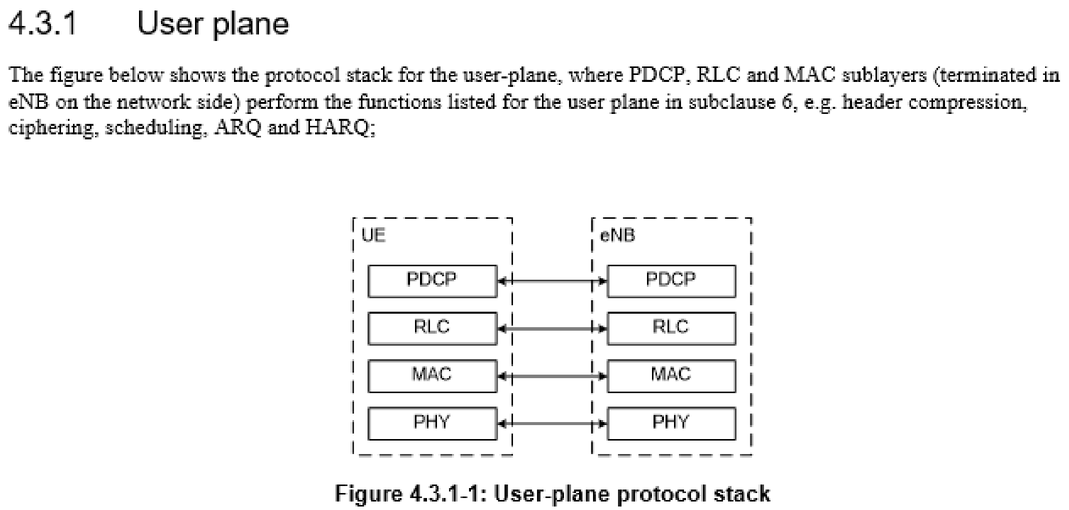


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

Figure 4.3.1-1: User-plane protocol stack

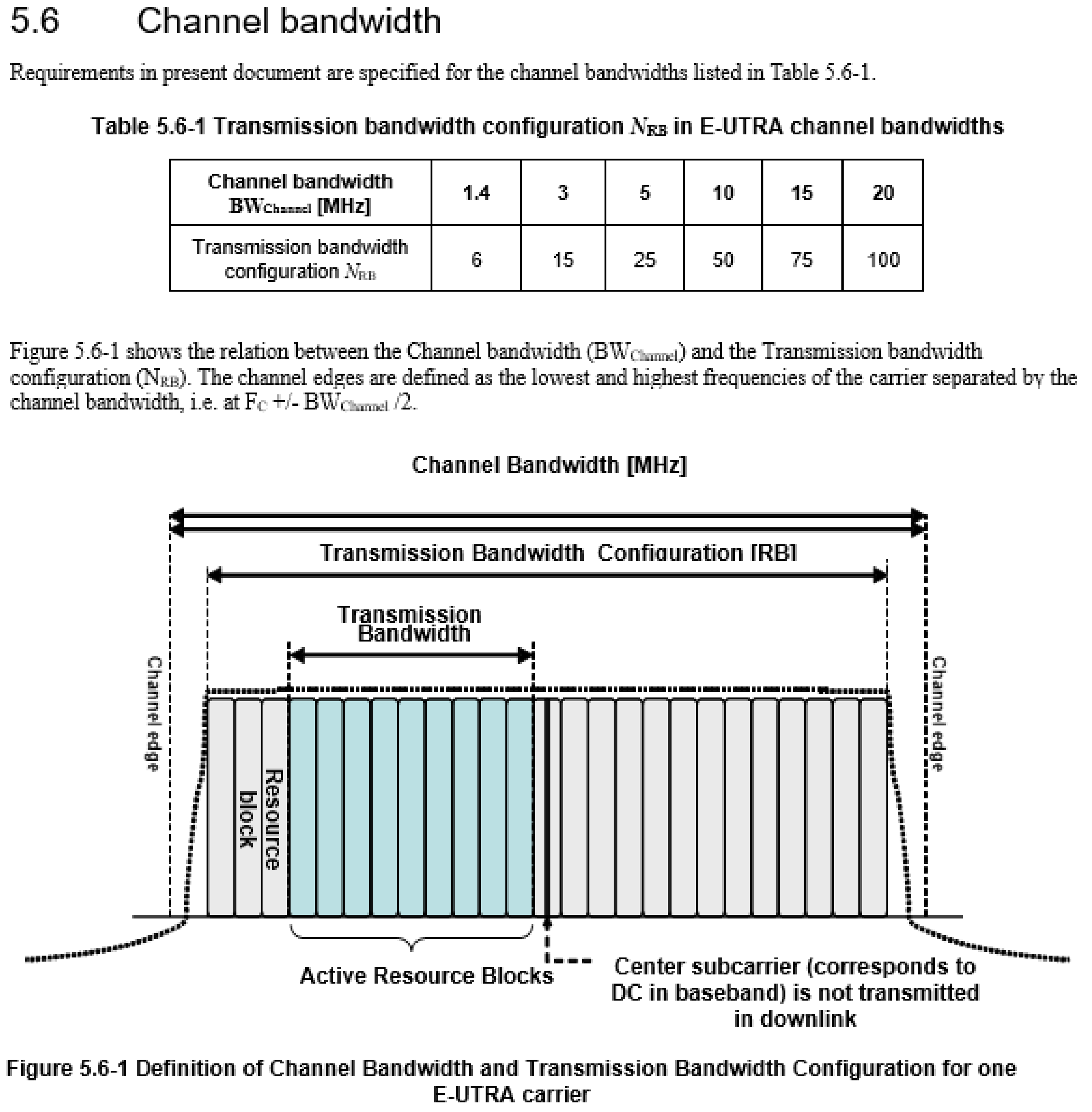
See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Volkswagen’s Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

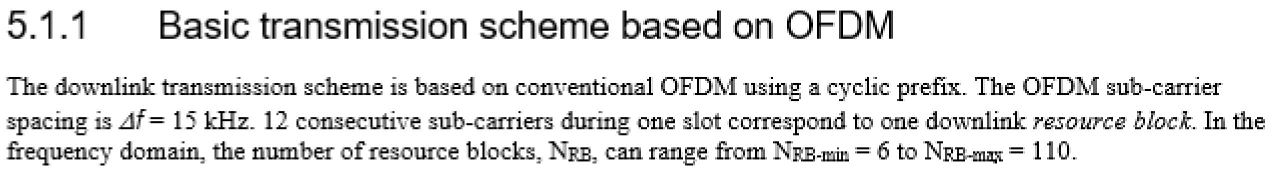
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

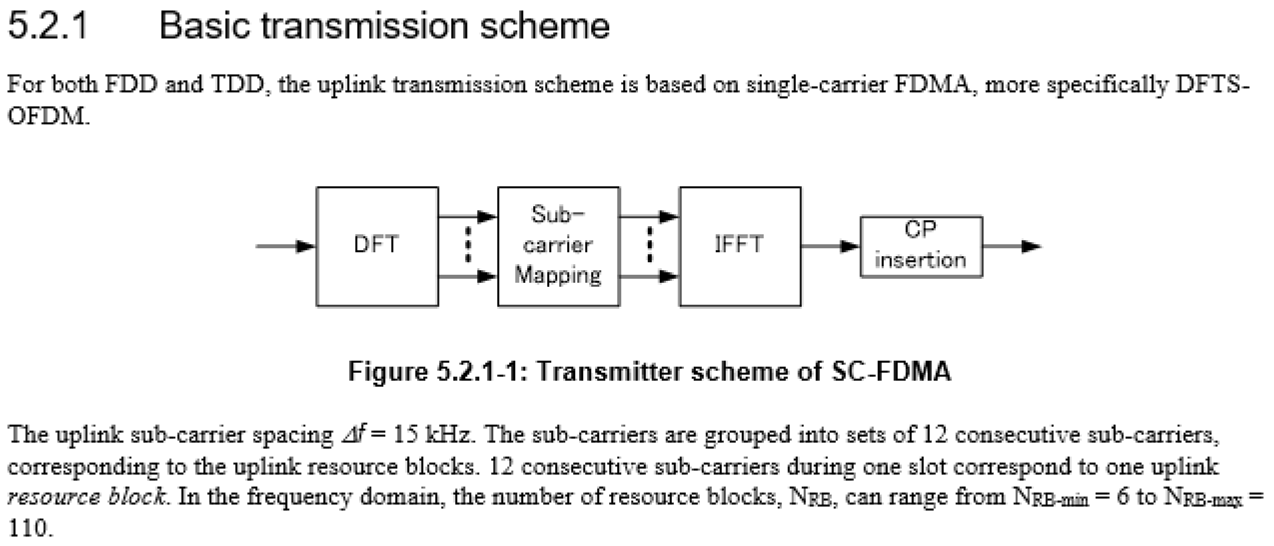
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

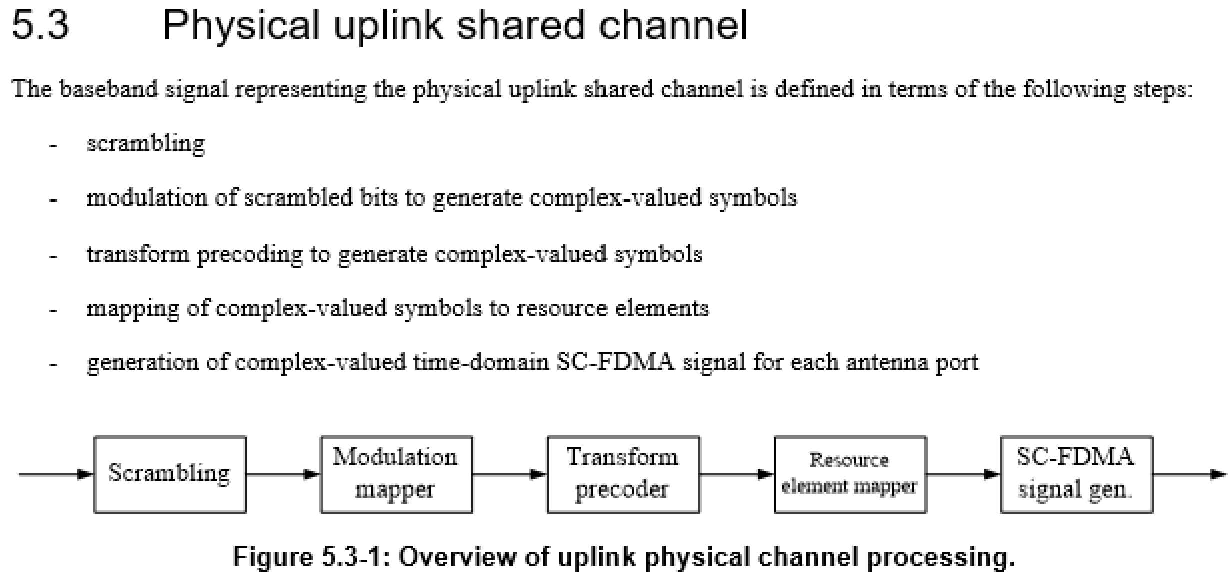
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

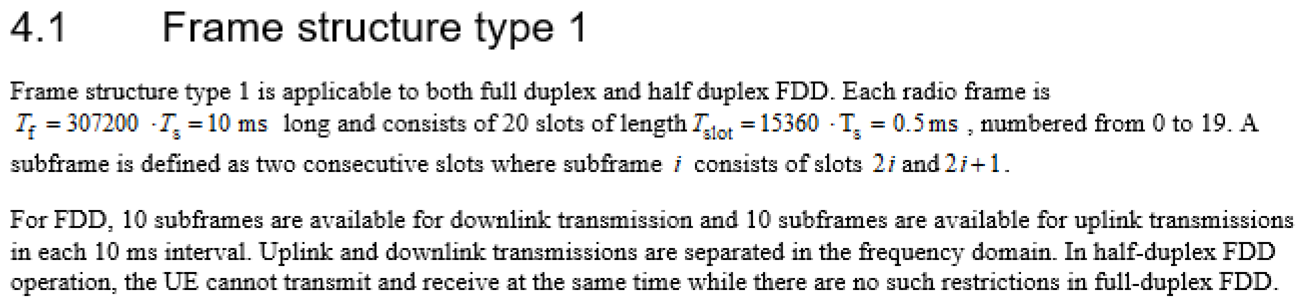
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

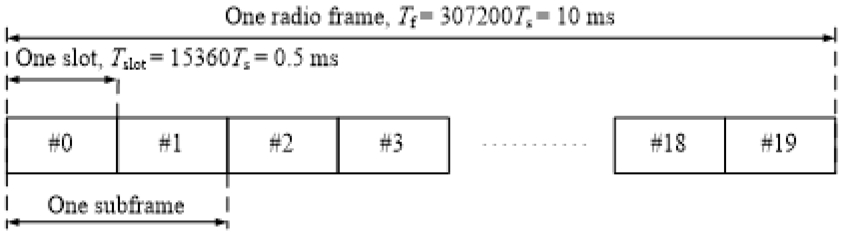
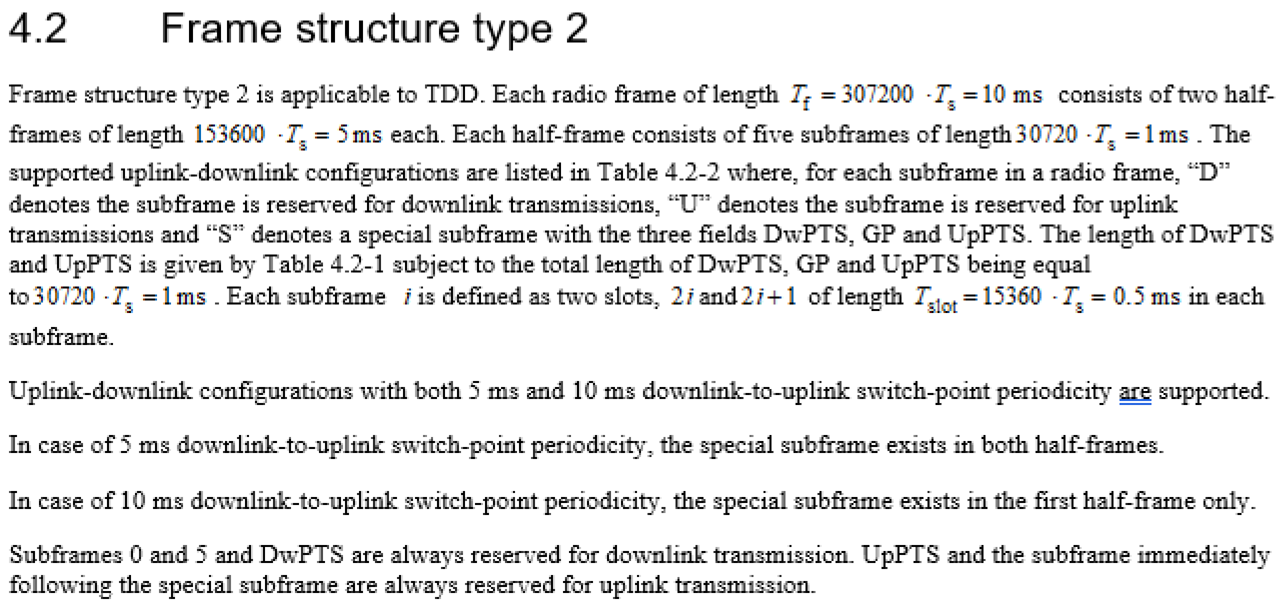


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

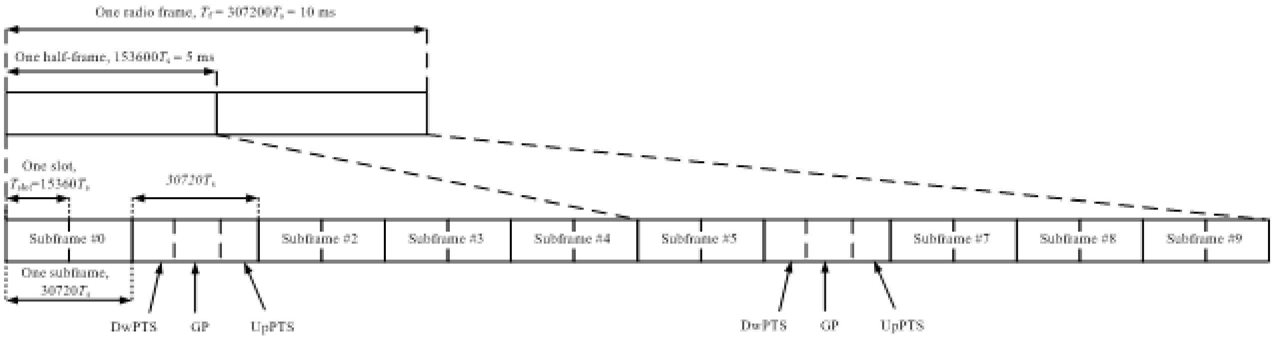
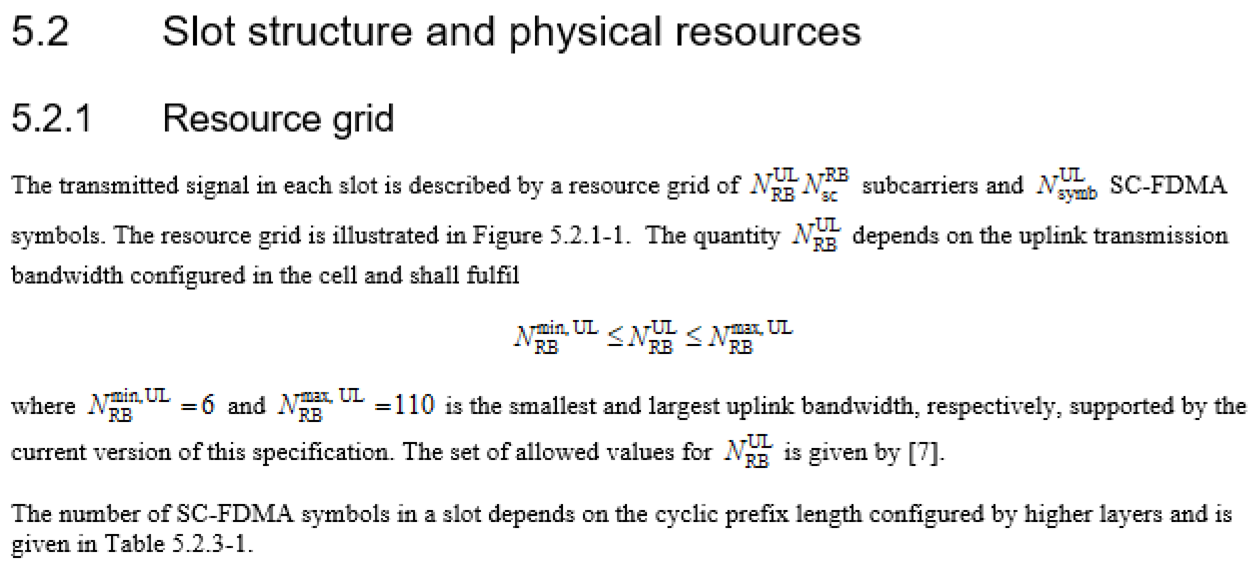


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

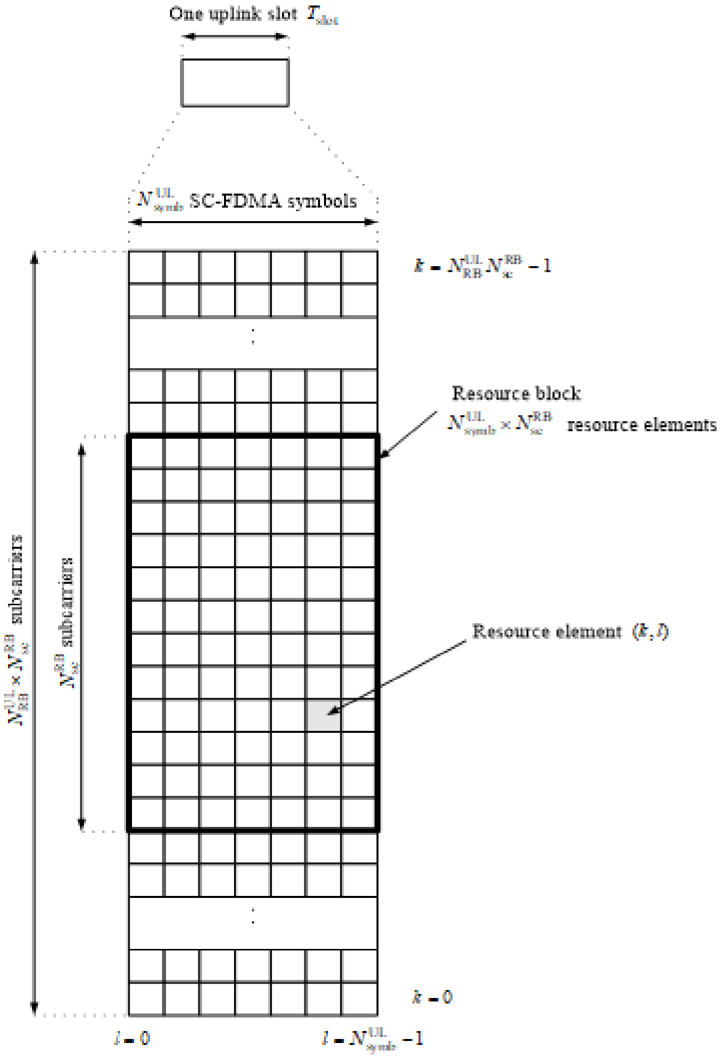
$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \leq N_{\mathrm{RB}}^{\mathrm{UL}} \leq N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

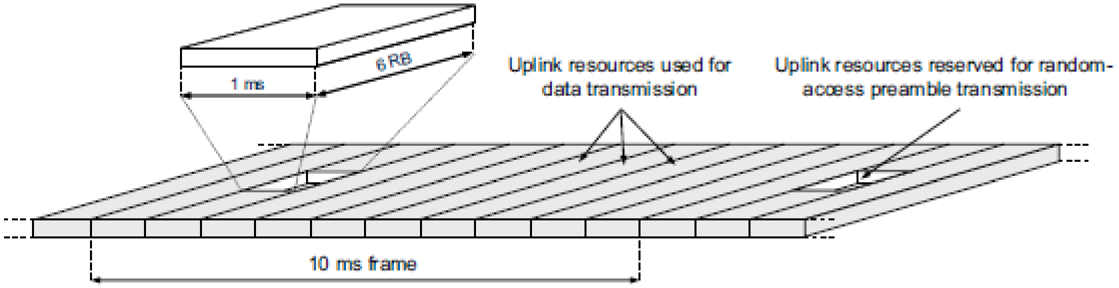
The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	Volkswagen's Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

<table>
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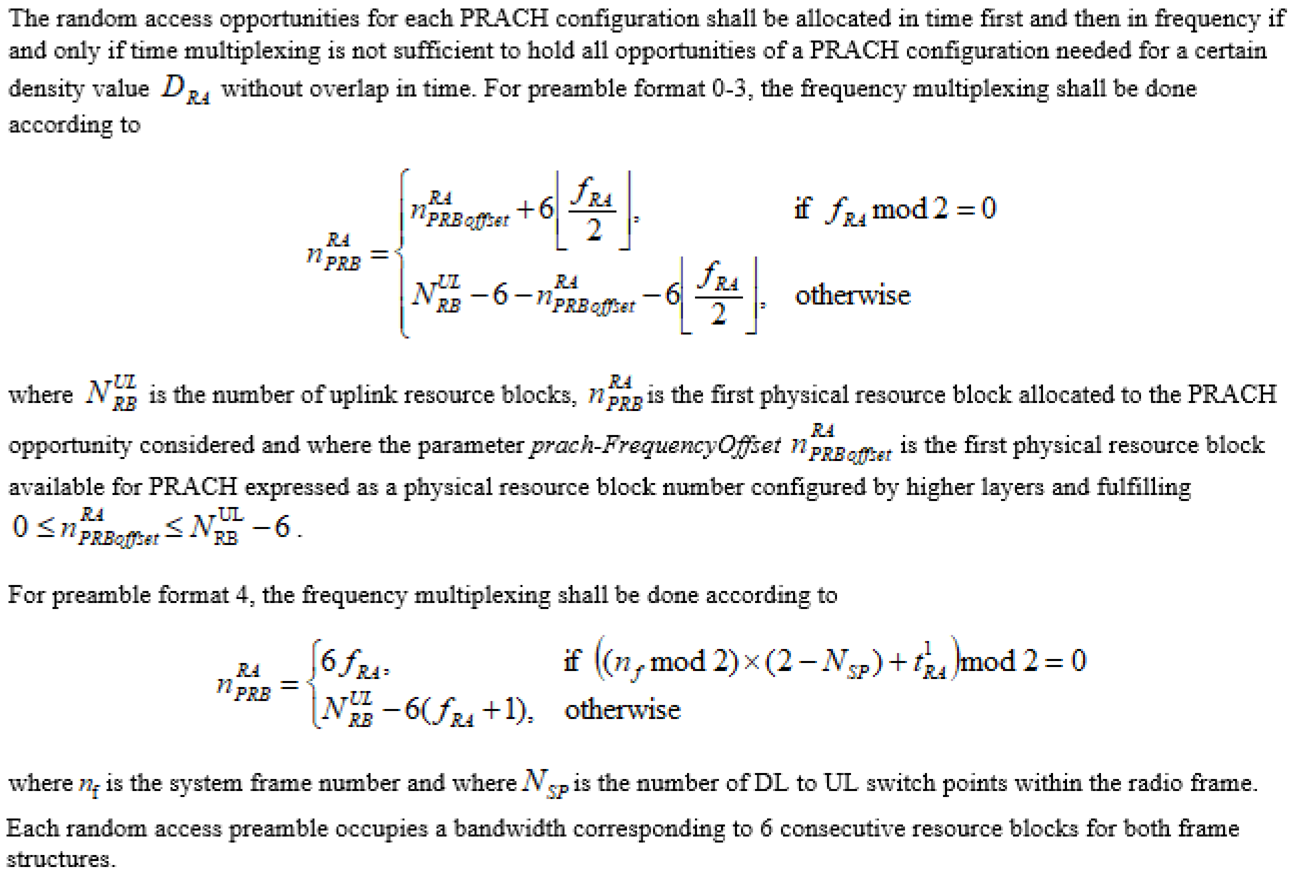


The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

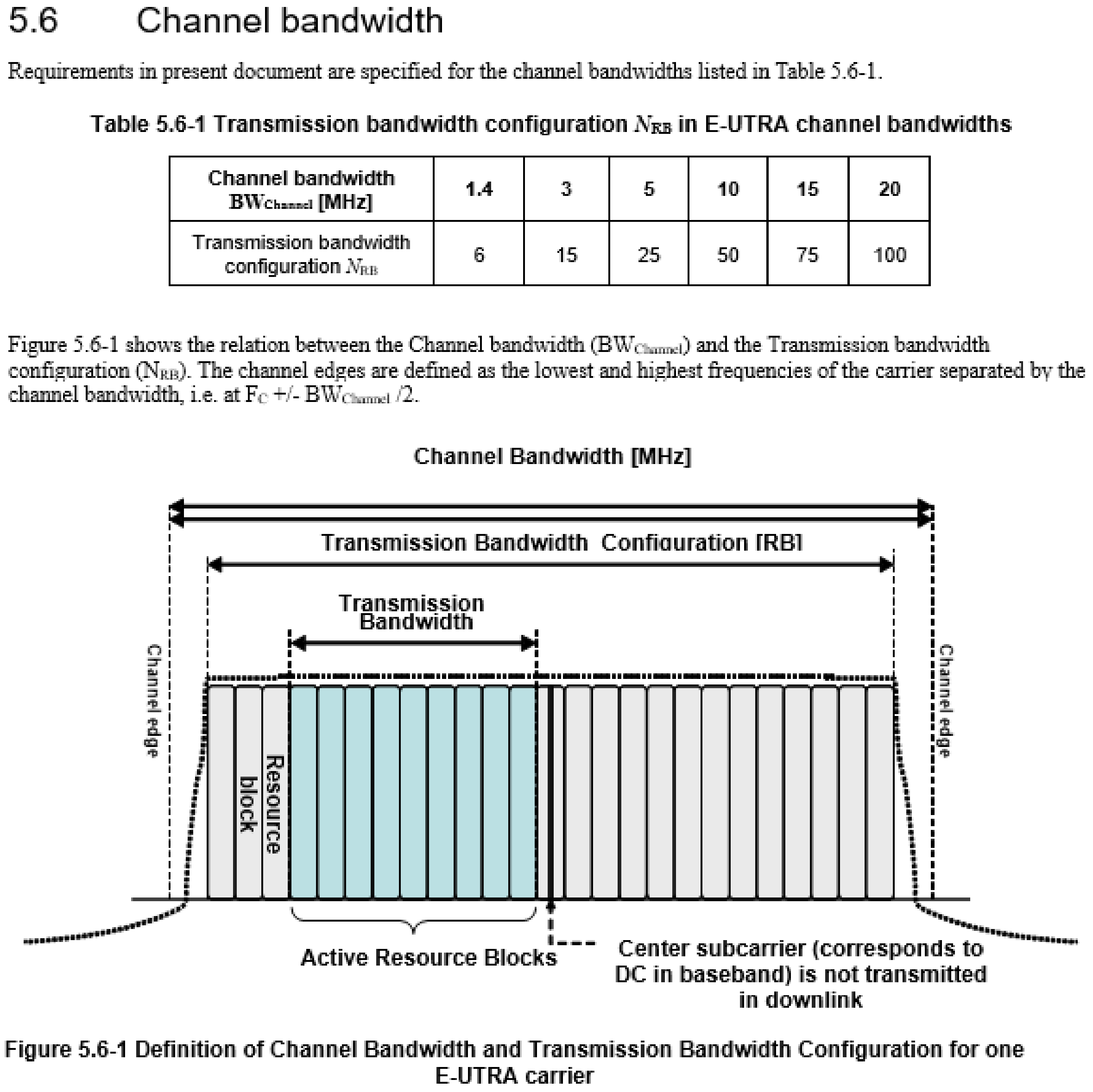
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

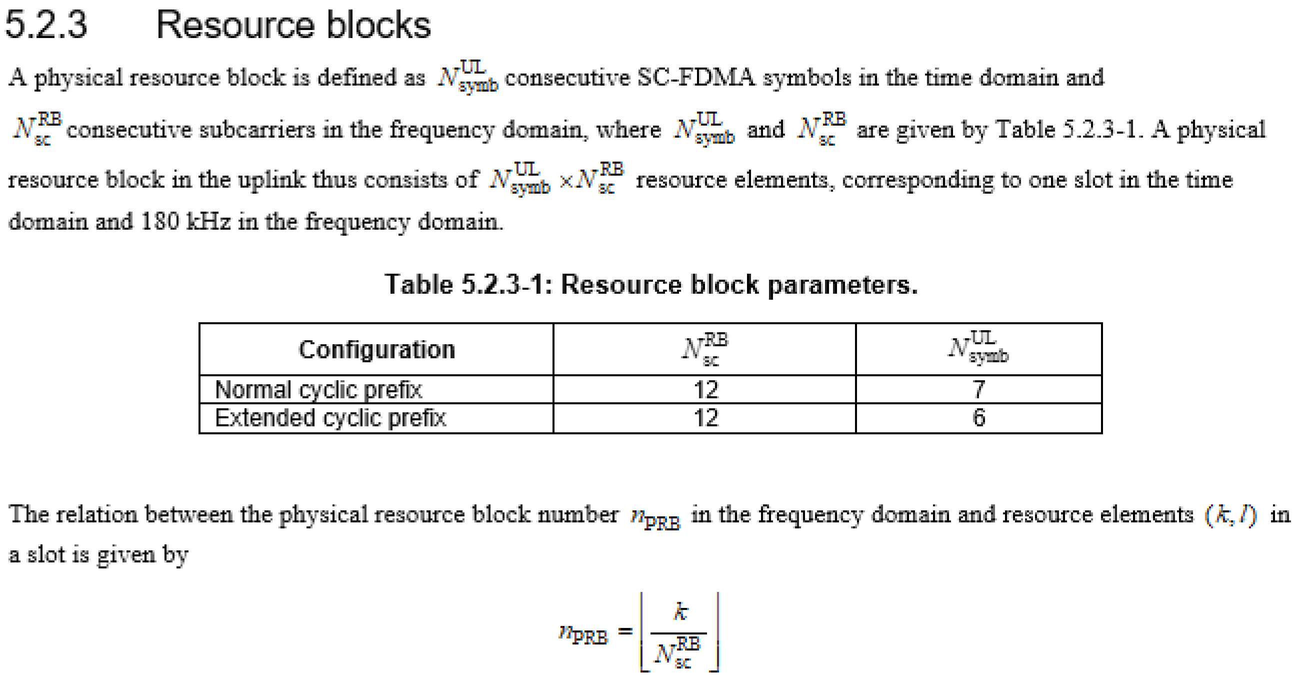
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

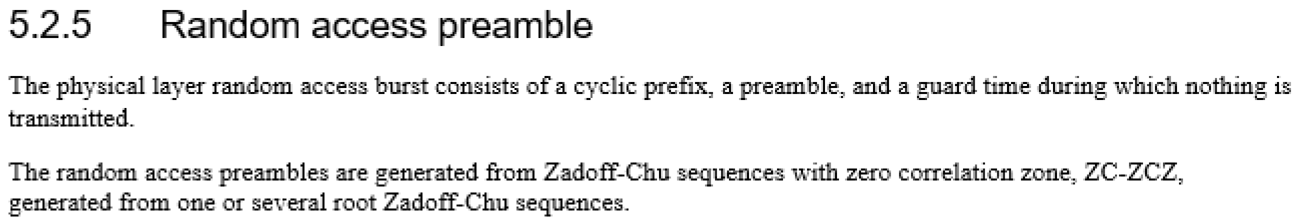
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

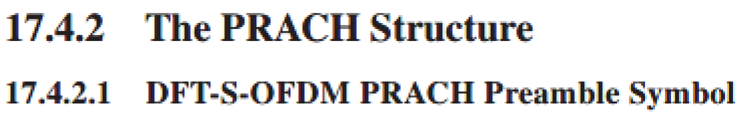


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

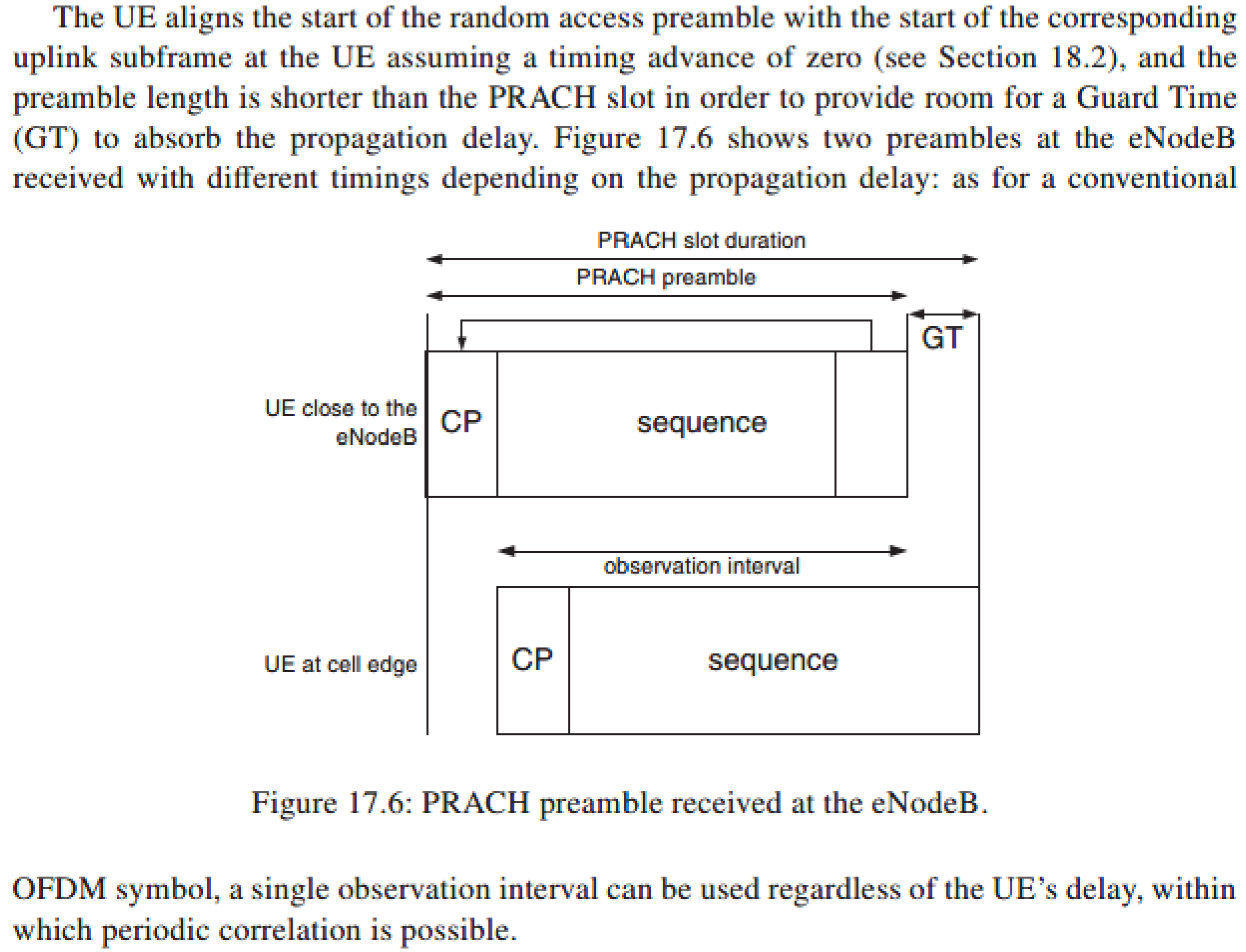


17.4.2 The PRACH Structure

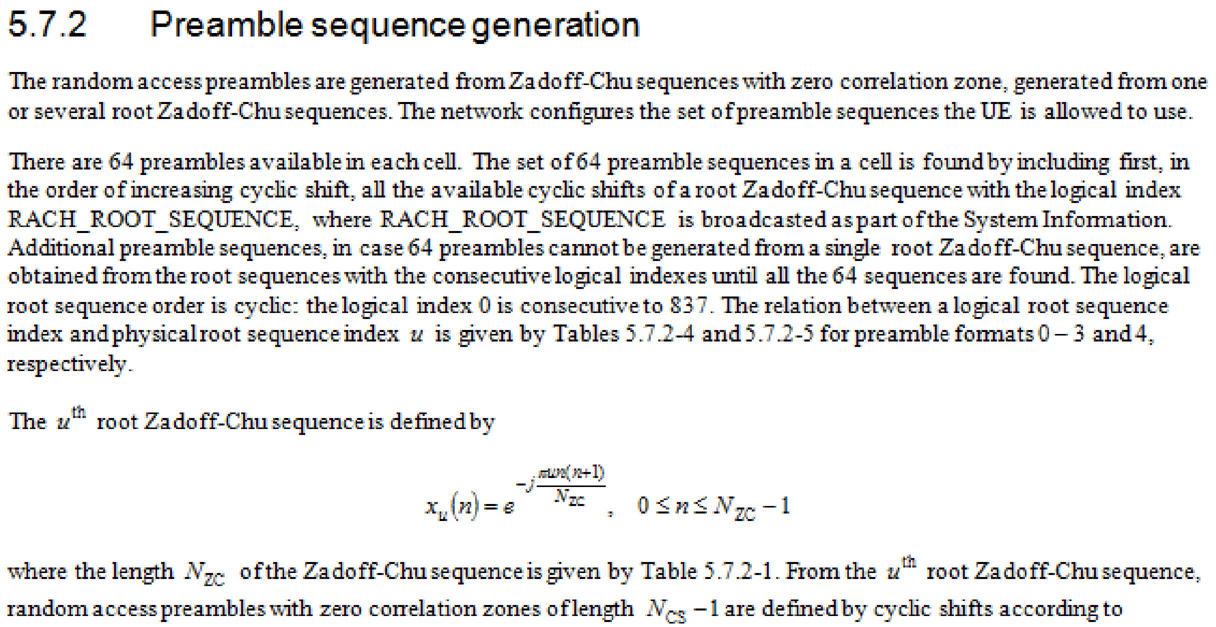
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

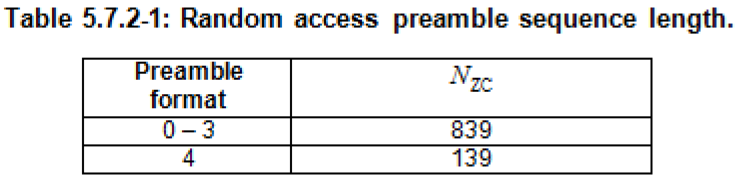
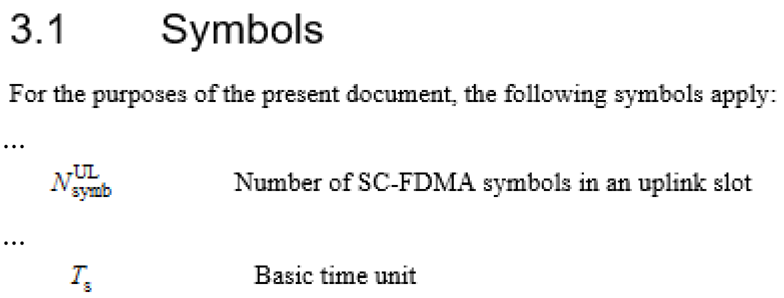
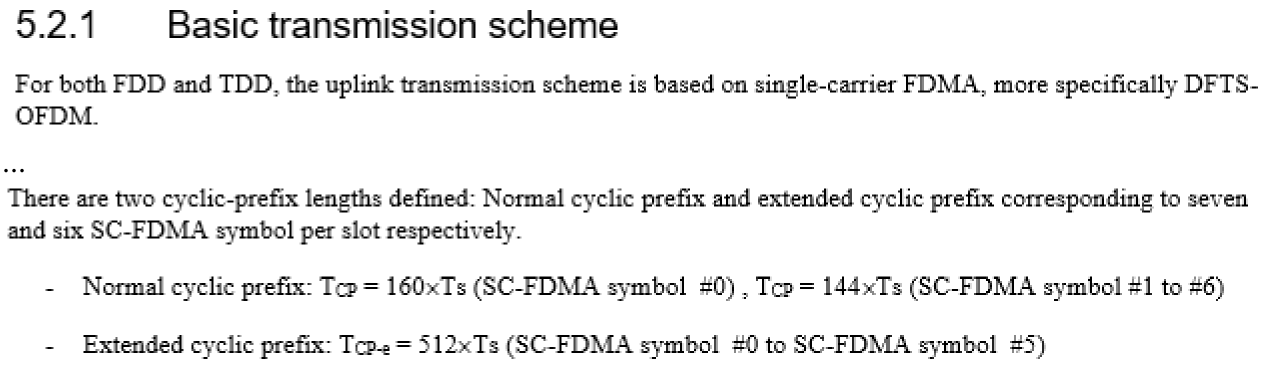


Table 5.7.2-1: Random access preamble sequence length.

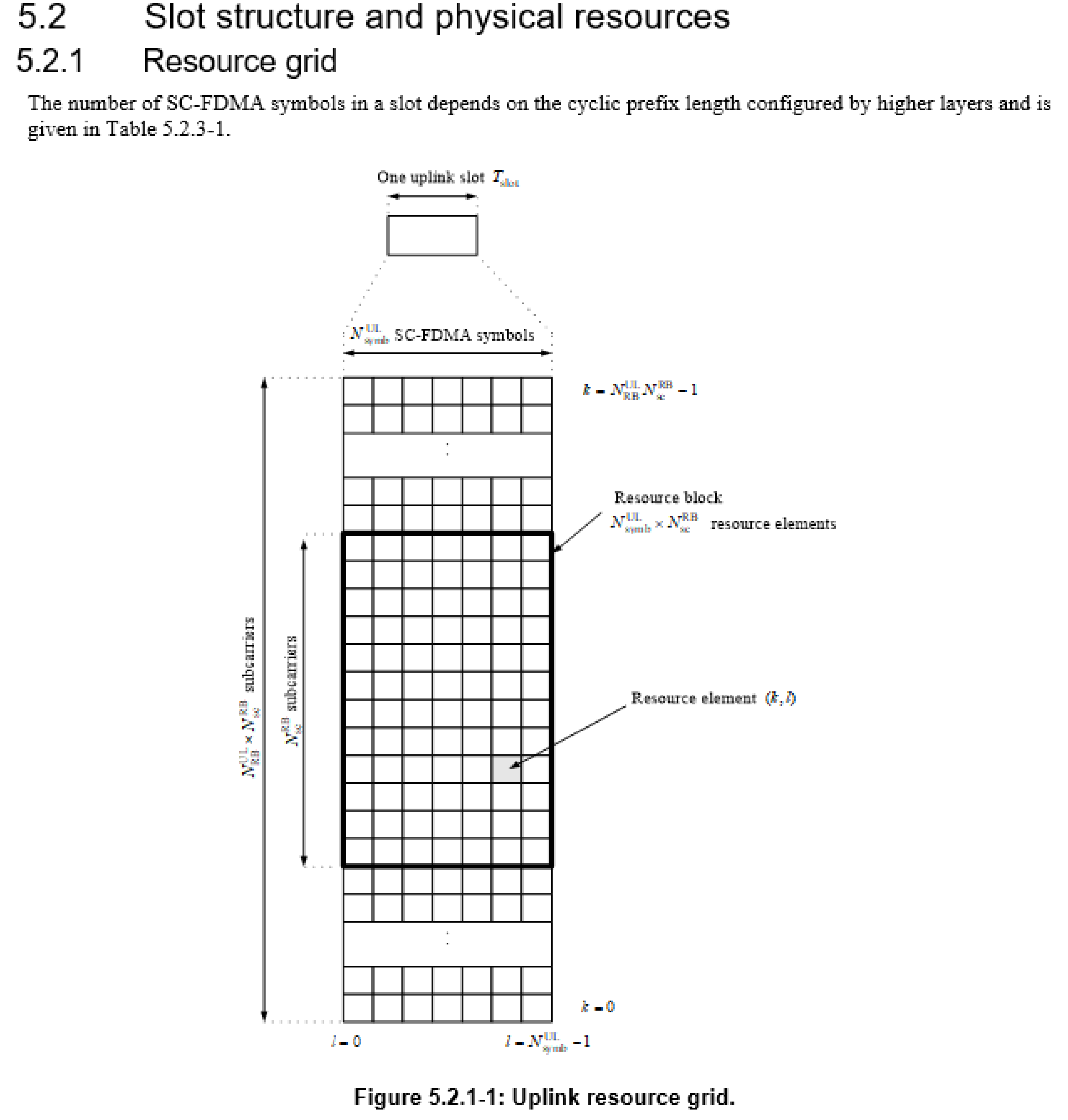
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Volkswagen’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{\text{CP}} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{\text{CP}} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{\text{CP-e}} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”



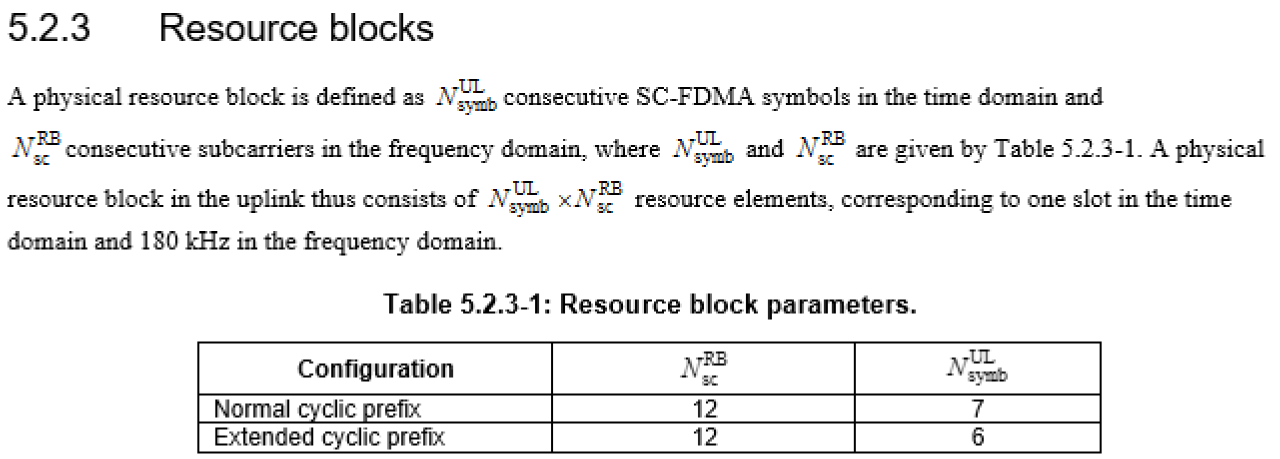
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

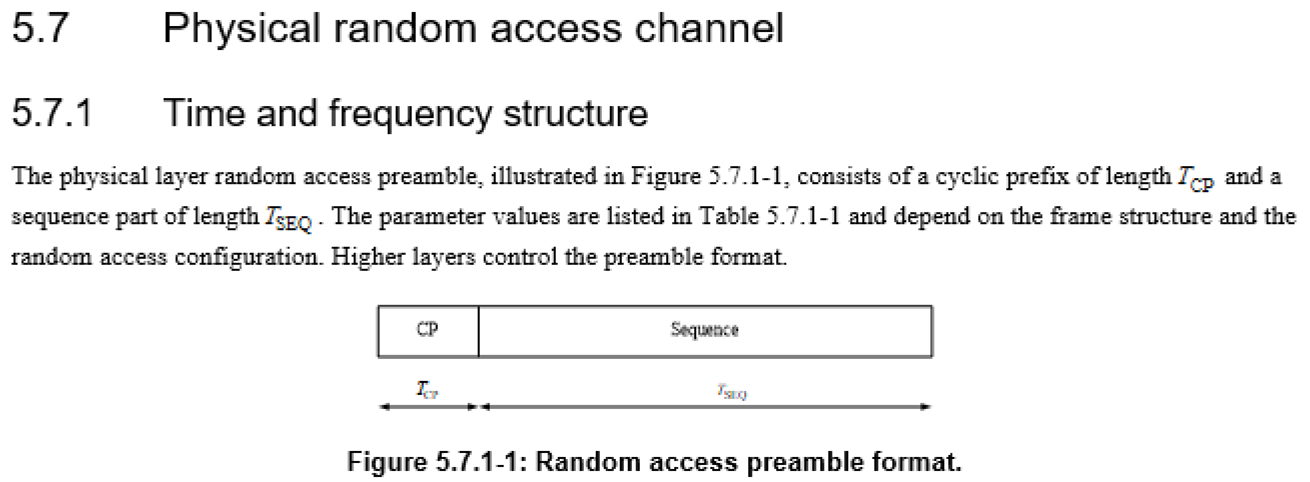
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

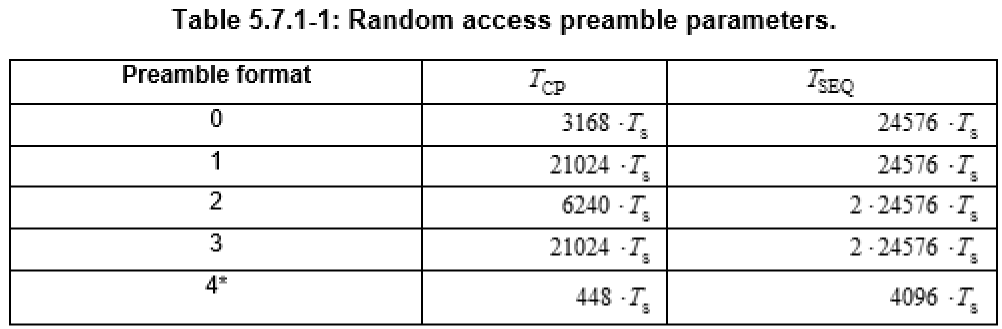
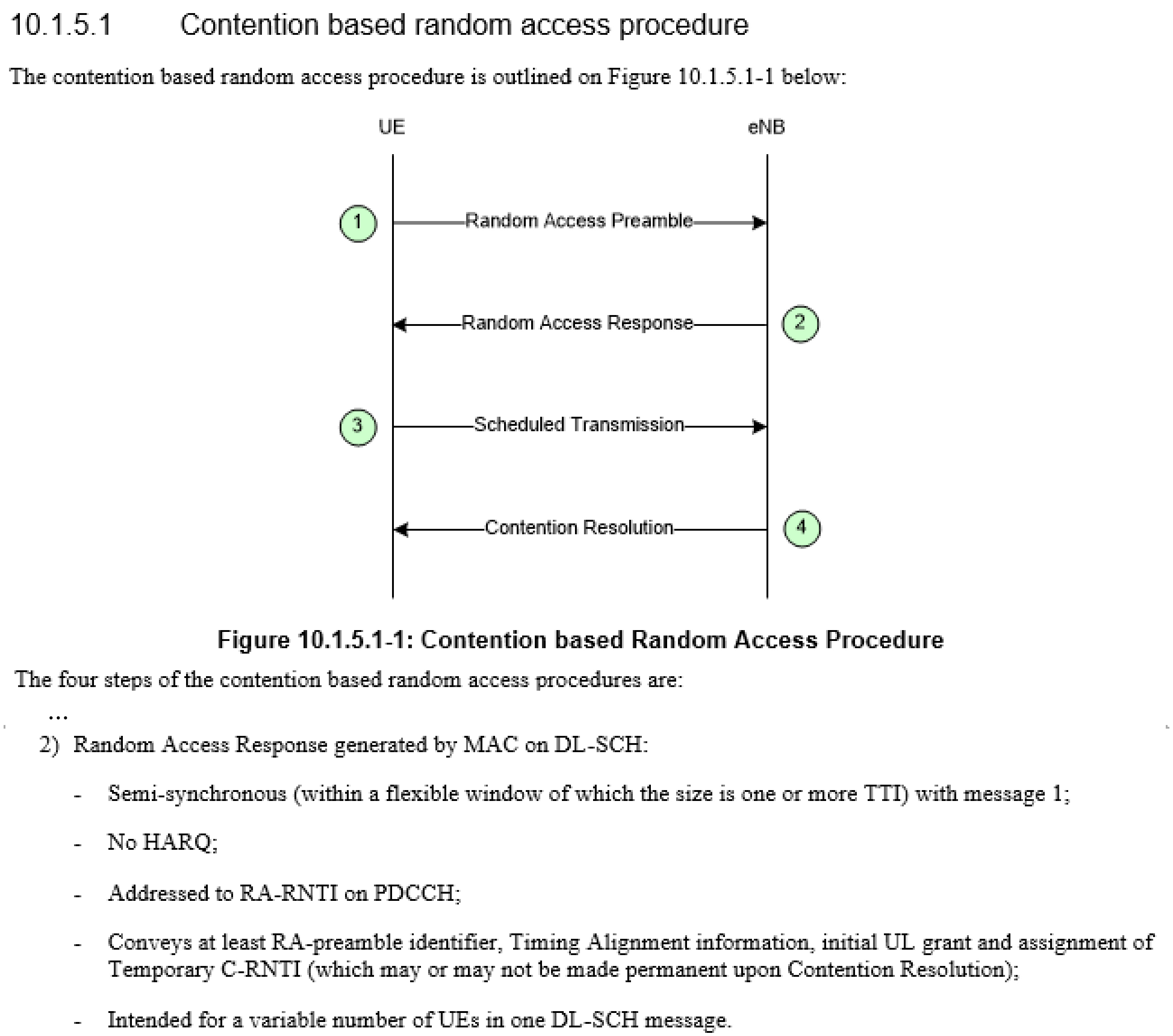


Table 5.7.1-1: Random access preamble parameters.

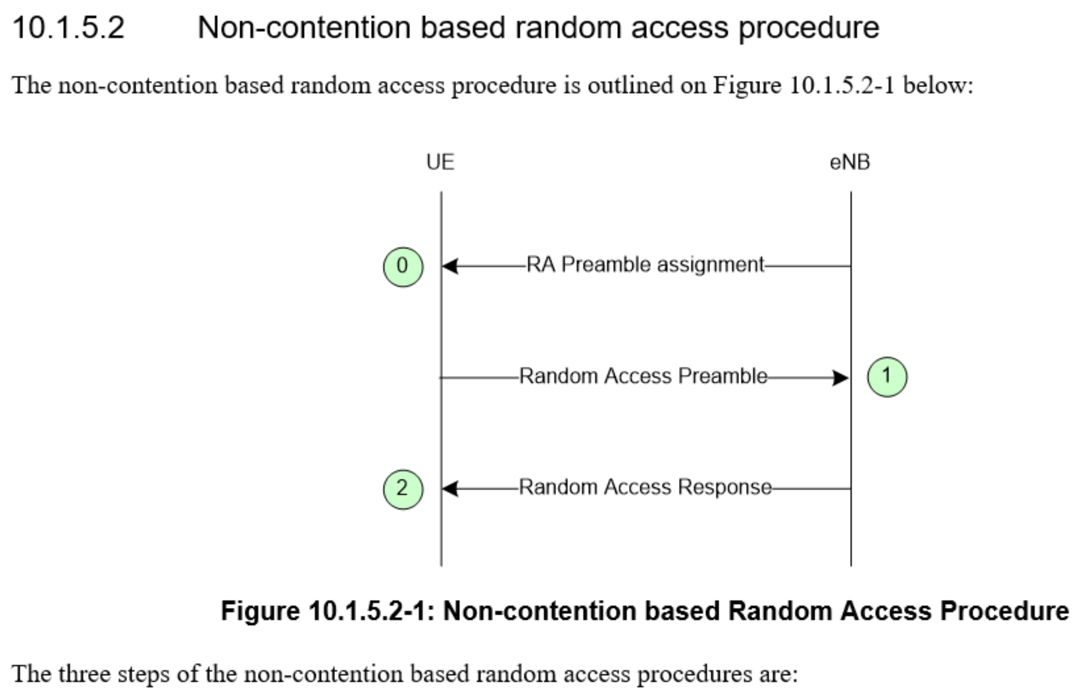
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

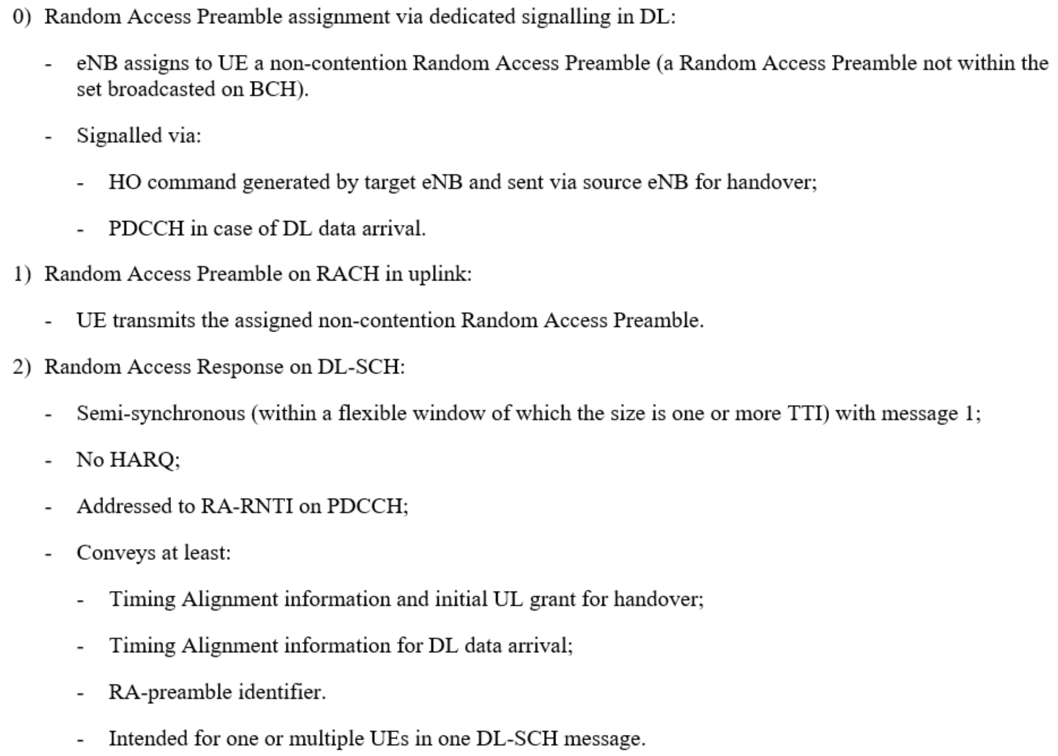
US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

receiving, from the base station, a response message. ;	Volkswagen’s Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

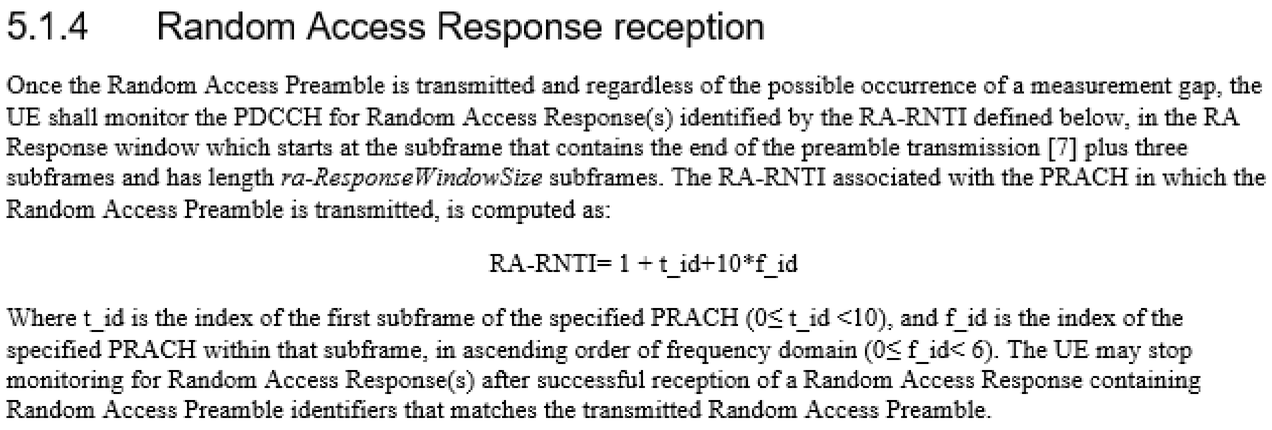
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

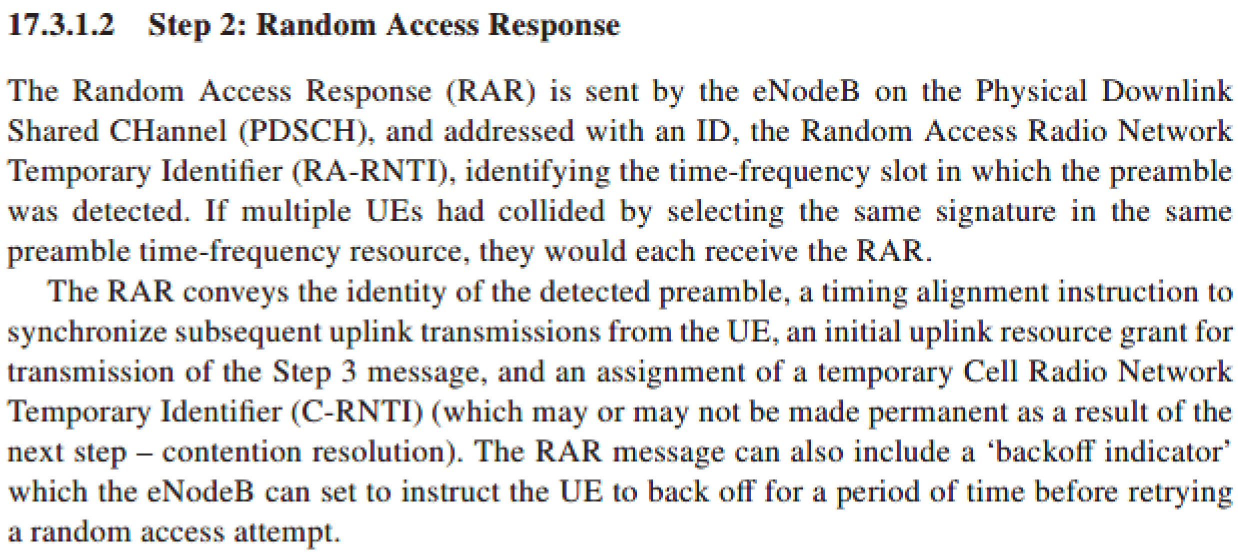
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

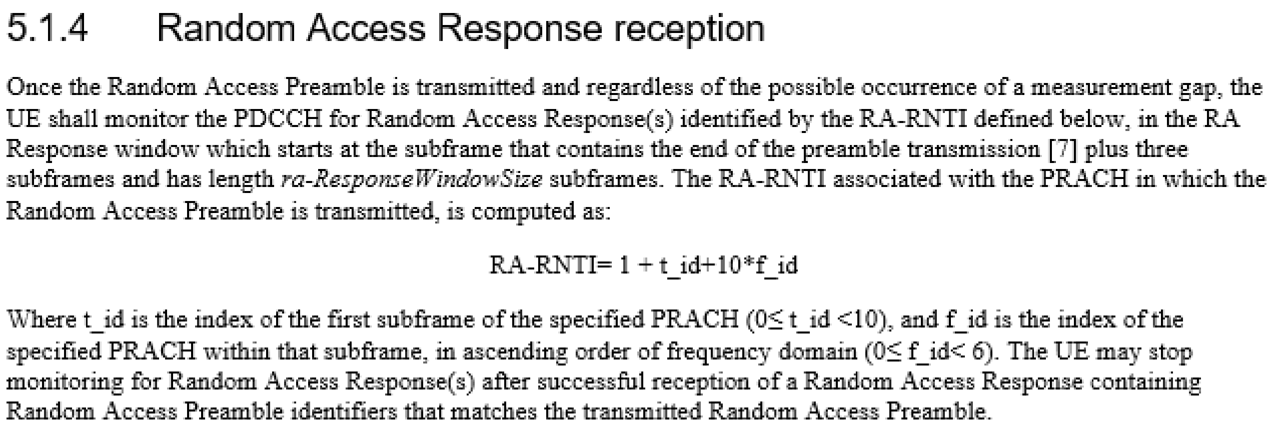
US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

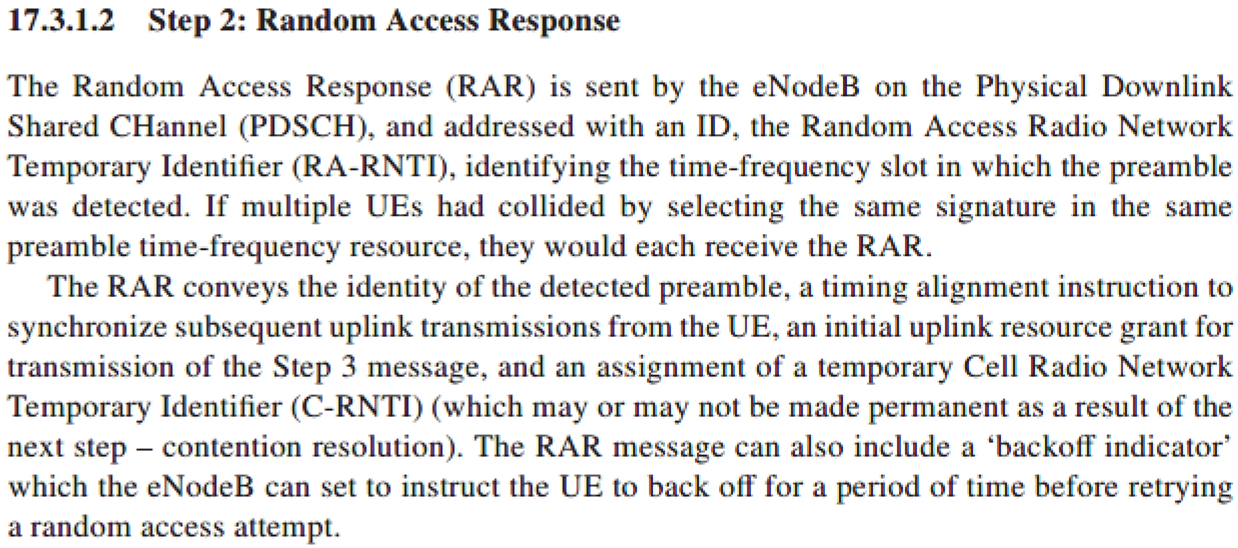
US Patent No. 10,833,908: Claim 12(a)
"The method claim 11, further comprising:"

12. The method claim 11, further comprising:	*See* Claim 11.

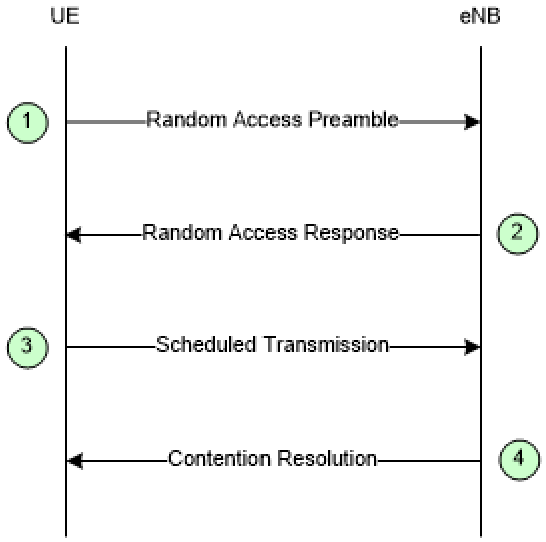
US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

determining if the response message identifies the sequence associated with the base station in the random access signal; and	Volkswagen’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

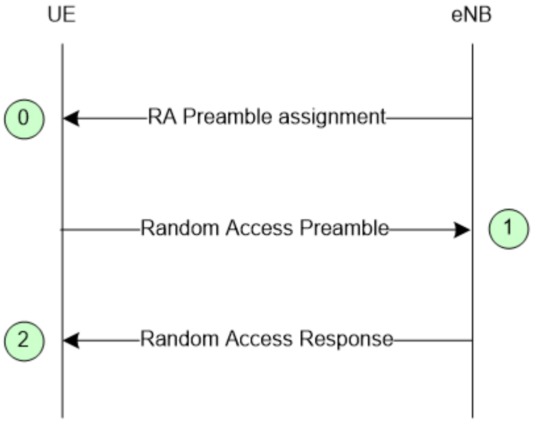
US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

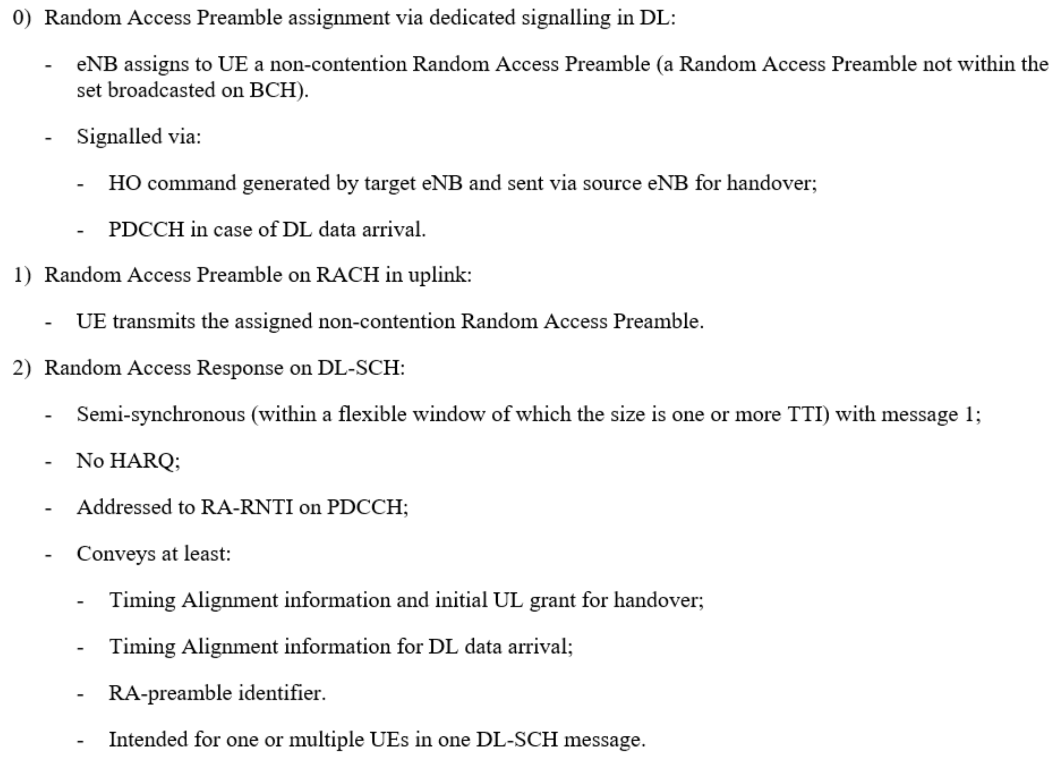
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Volkswagen’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:  **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53. 10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

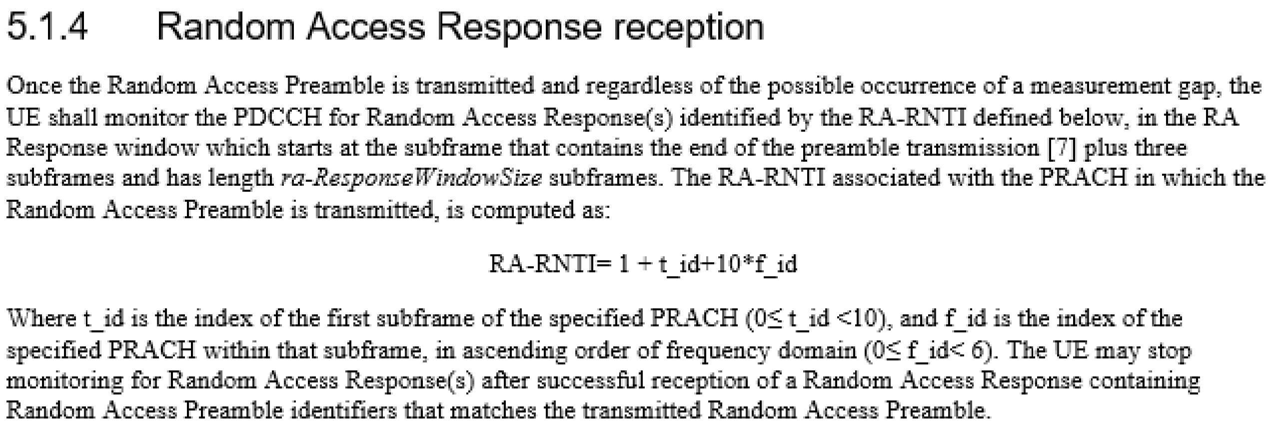
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

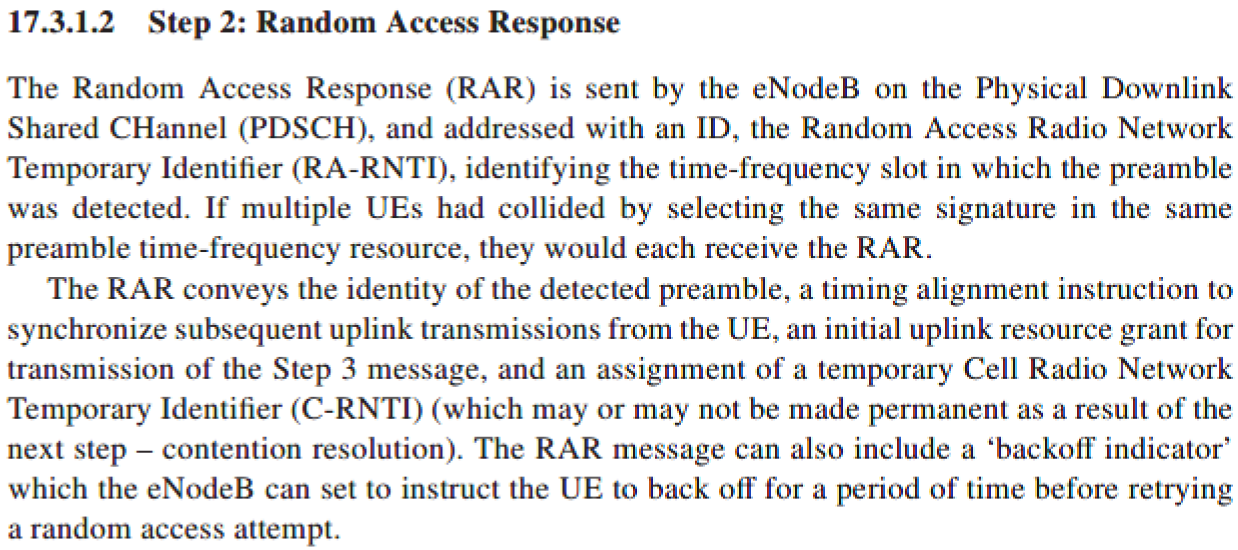
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

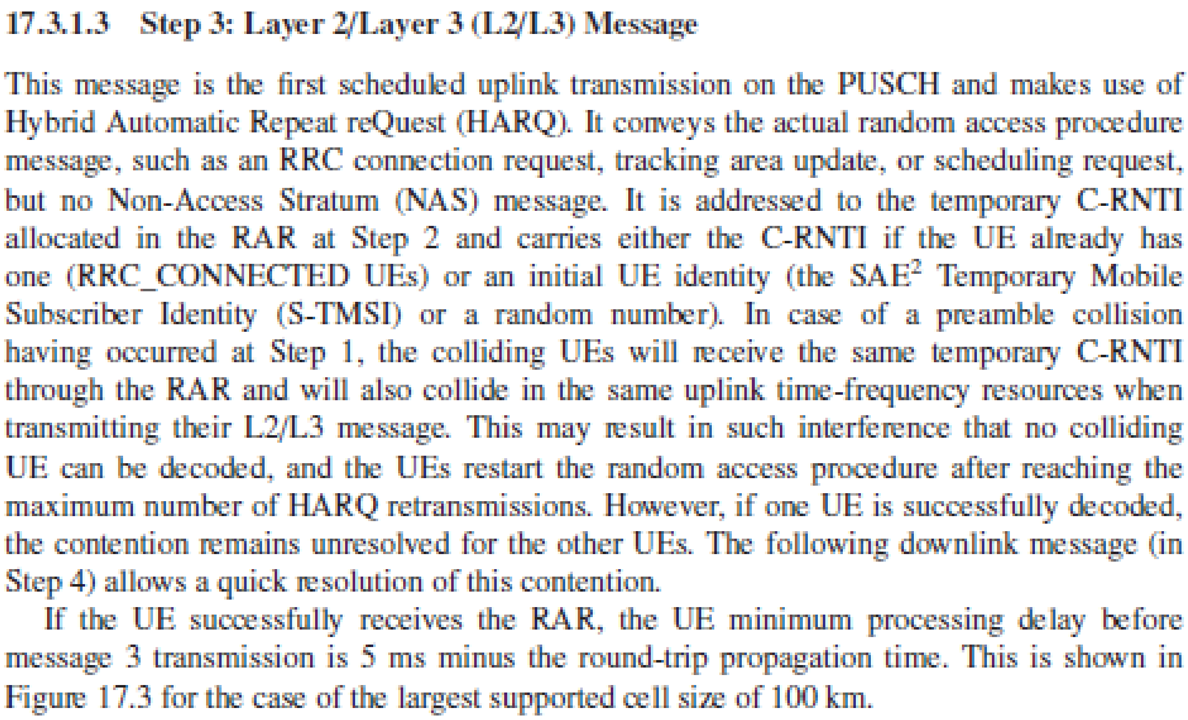
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message

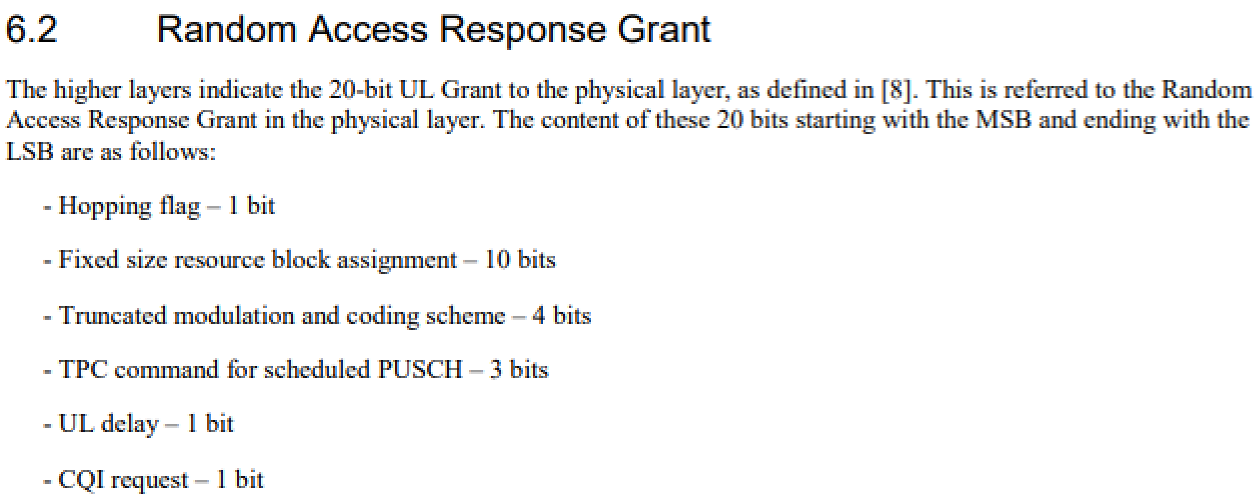
This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention.

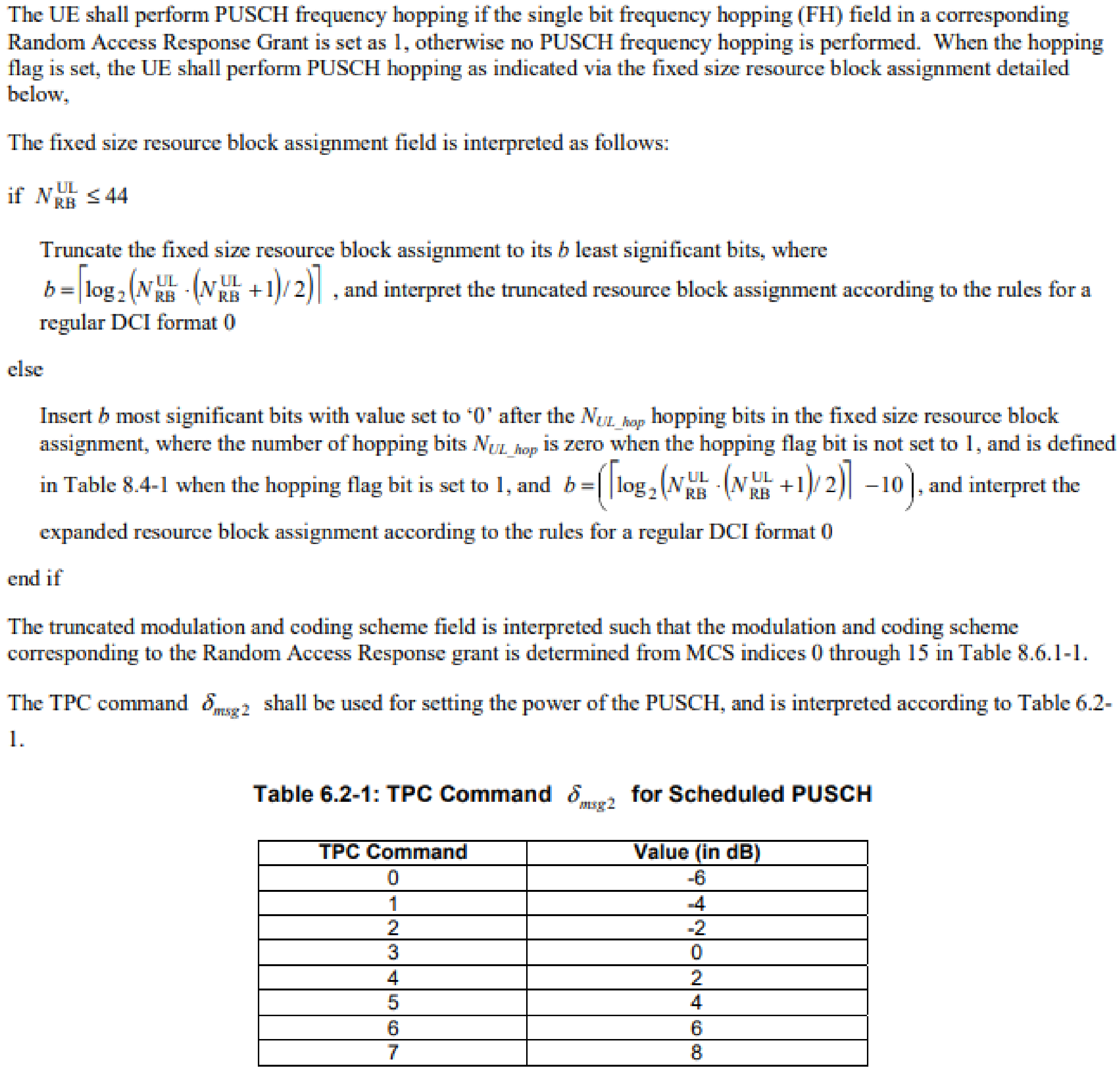
If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

See also Claim 2.

US Patent No. 10,833,908: Claim 13(a)
"The method of claim 12, wherein the response message includes power adjustment information and"

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by Volkswagen's Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

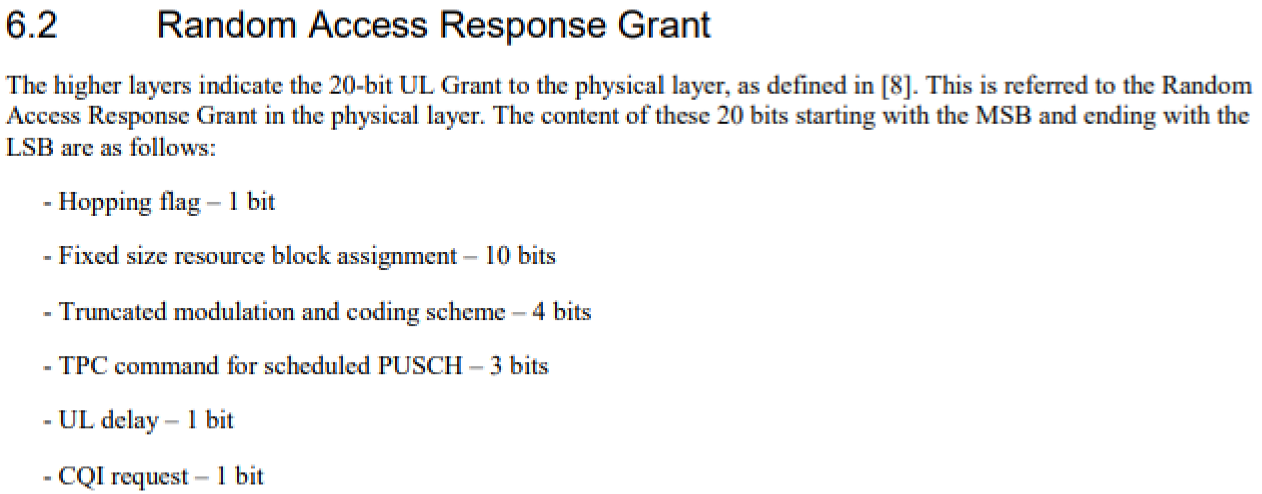
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

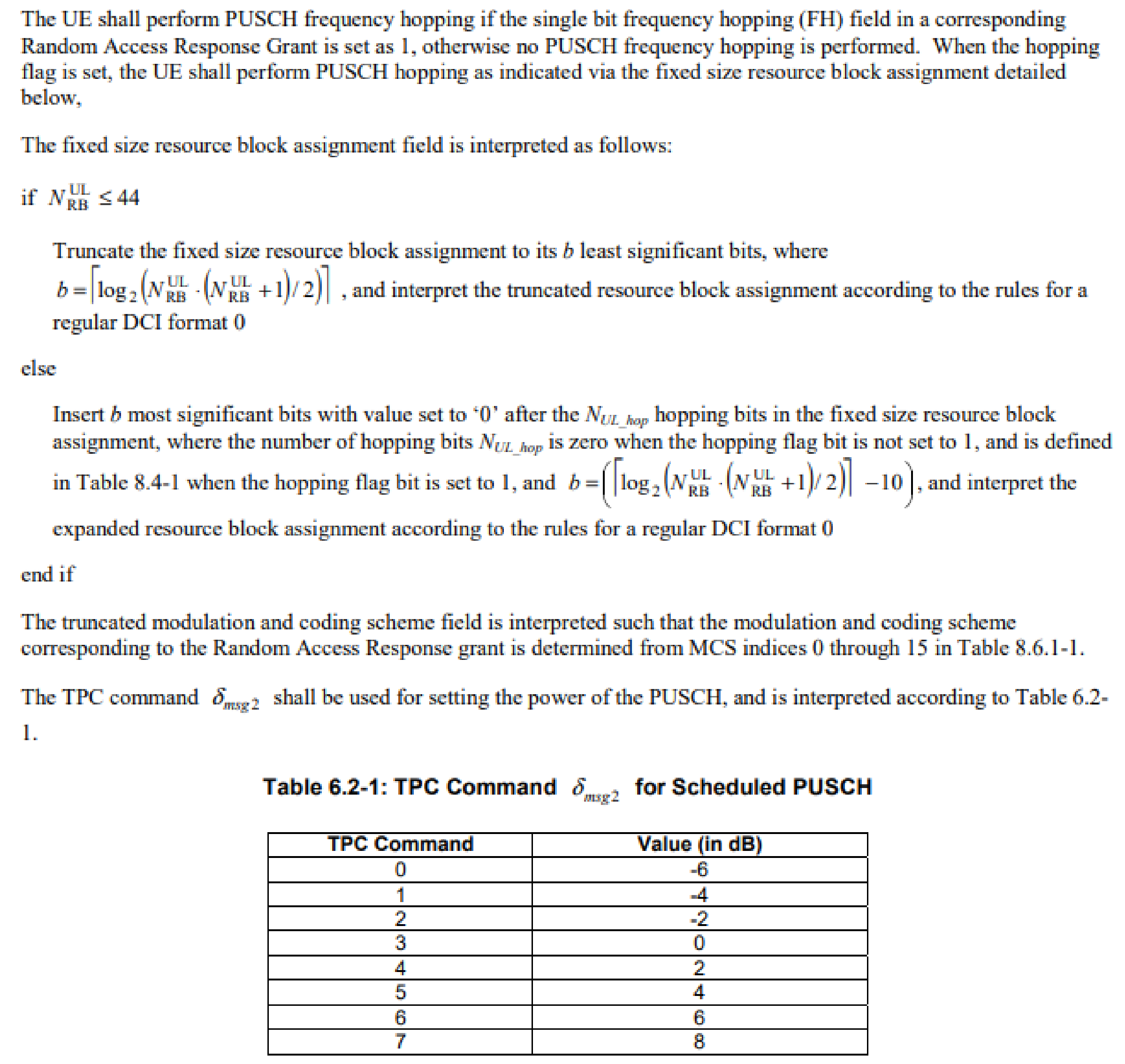
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the second uplink signal is transmitted according to the power adjustment information.	Volkswagen's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

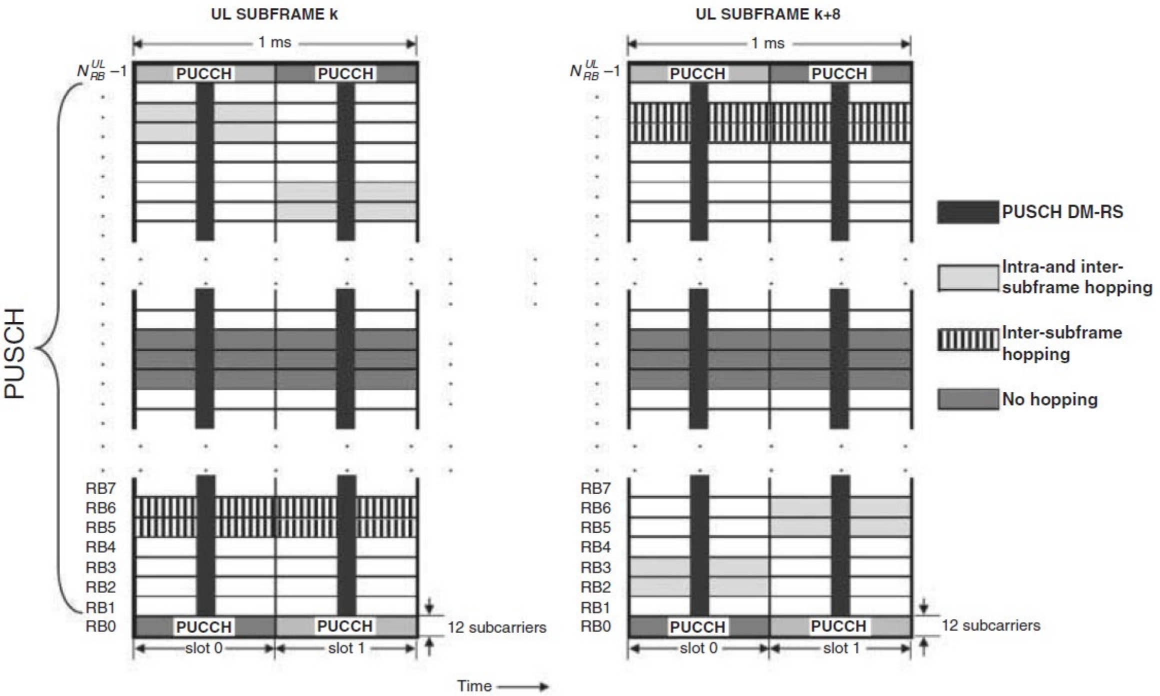
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

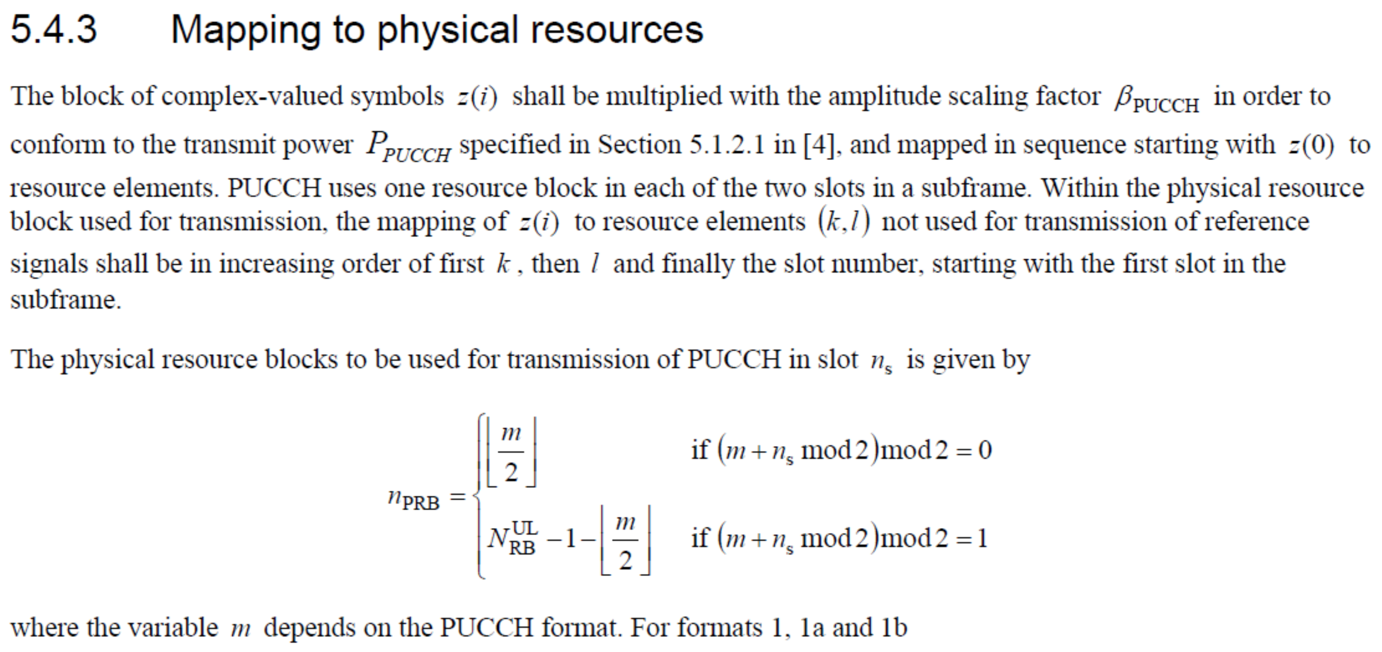
US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Volkswagen's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 11. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

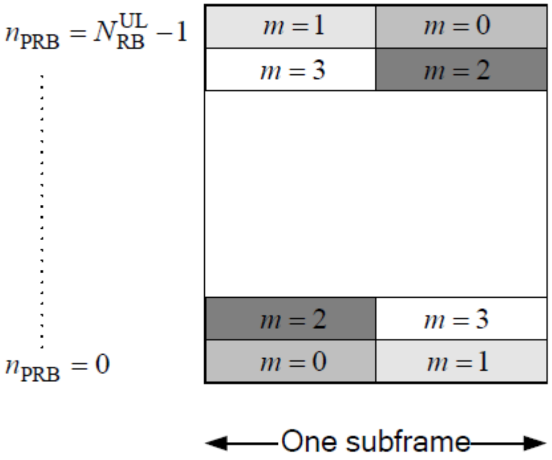


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

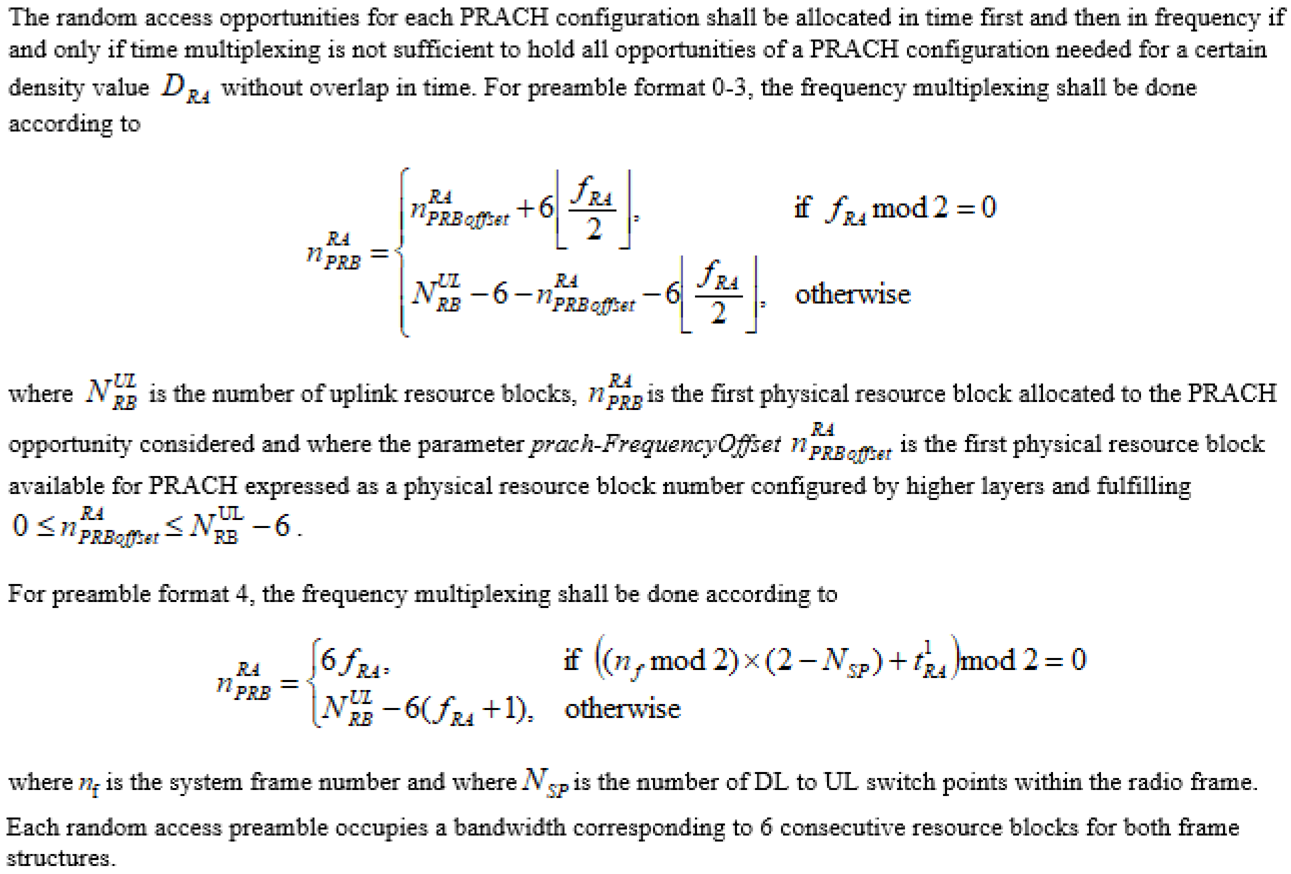
5.7.1 Time and frequency structure

...

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

…

US Patent No. 10,833,908: Claim 14
“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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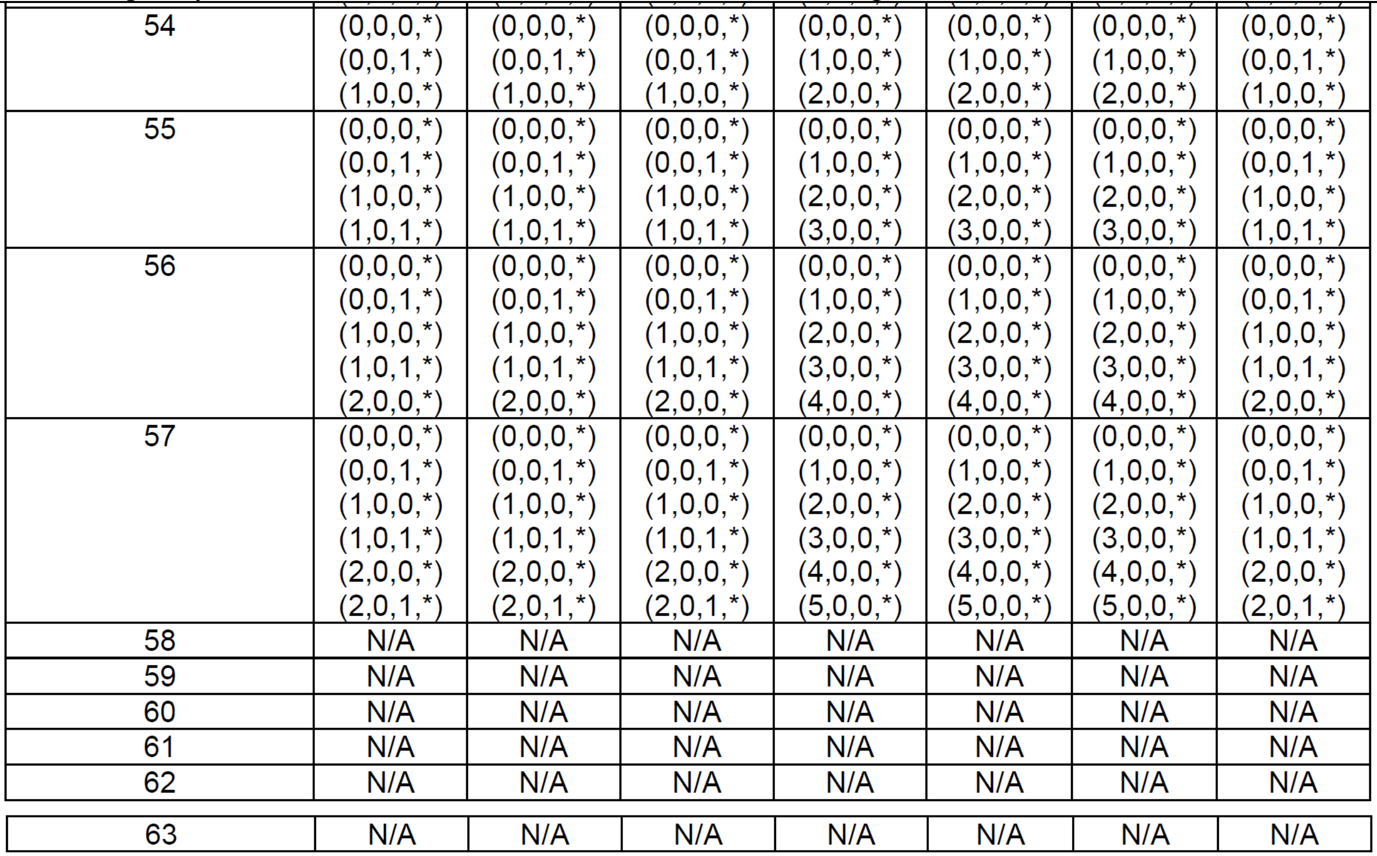
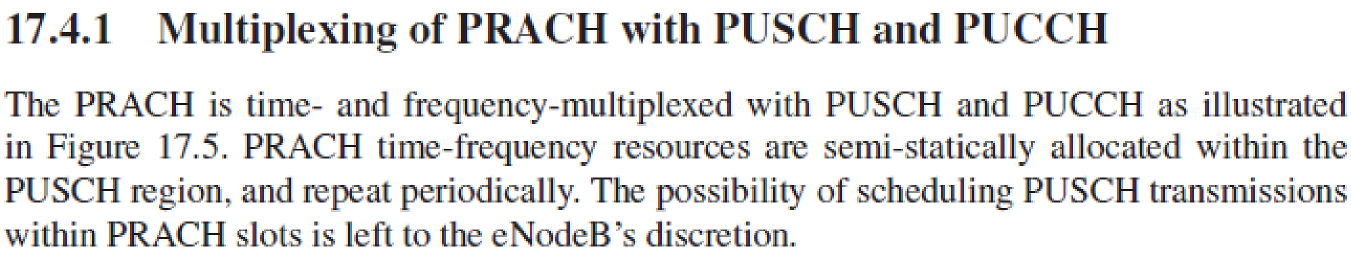


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

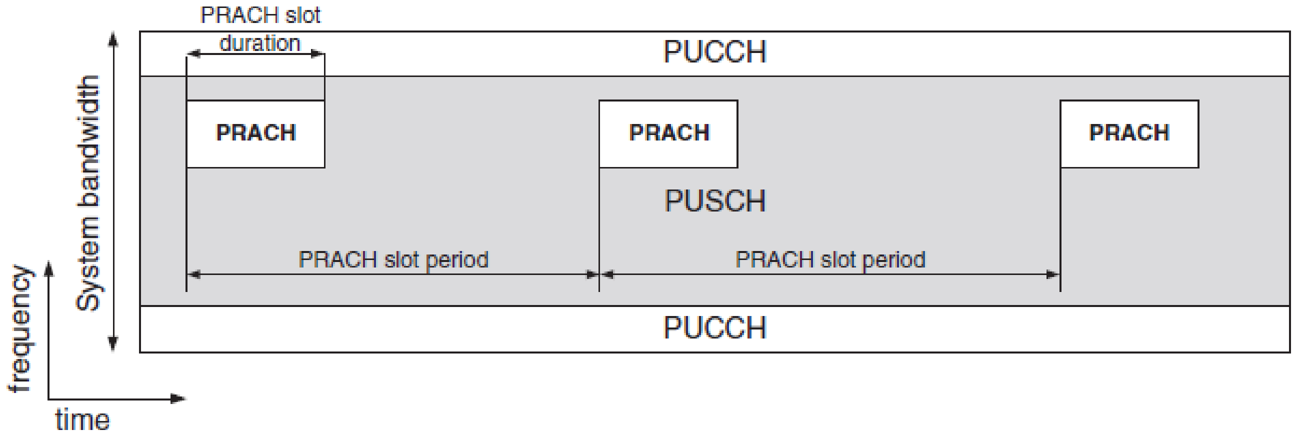


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

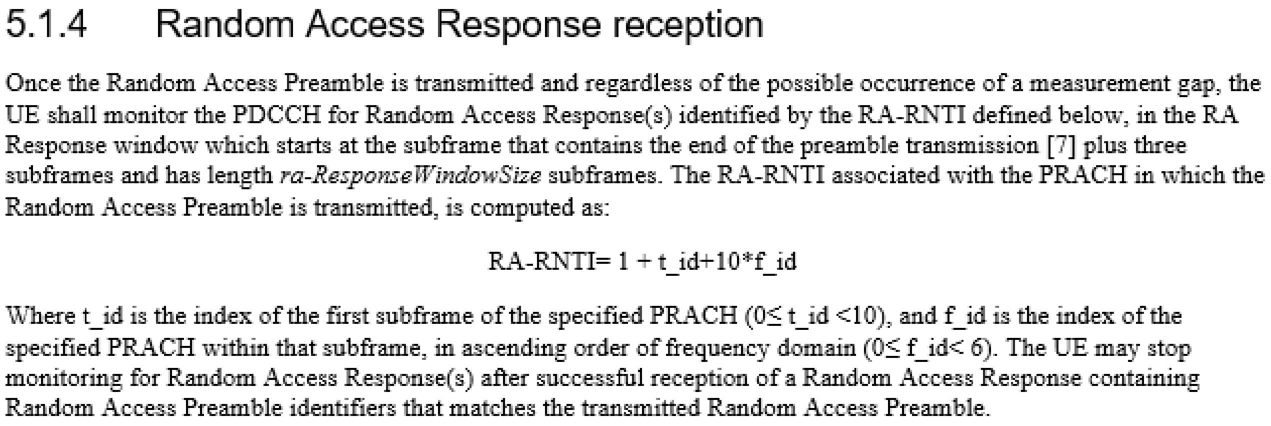
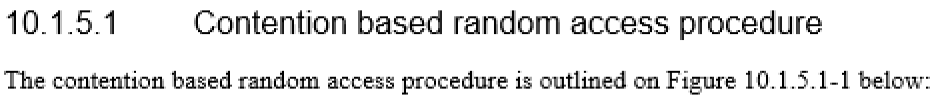
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

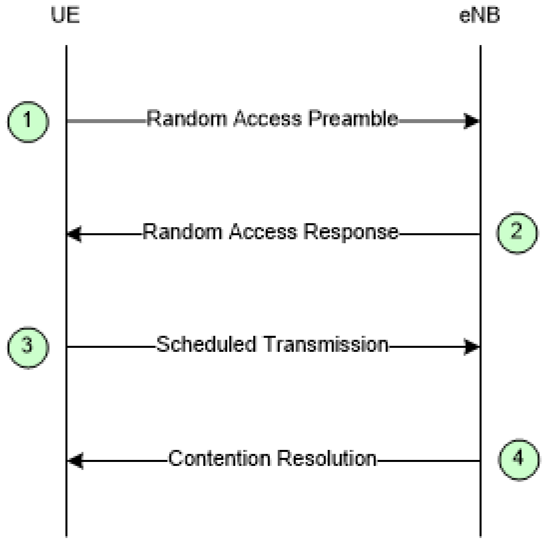
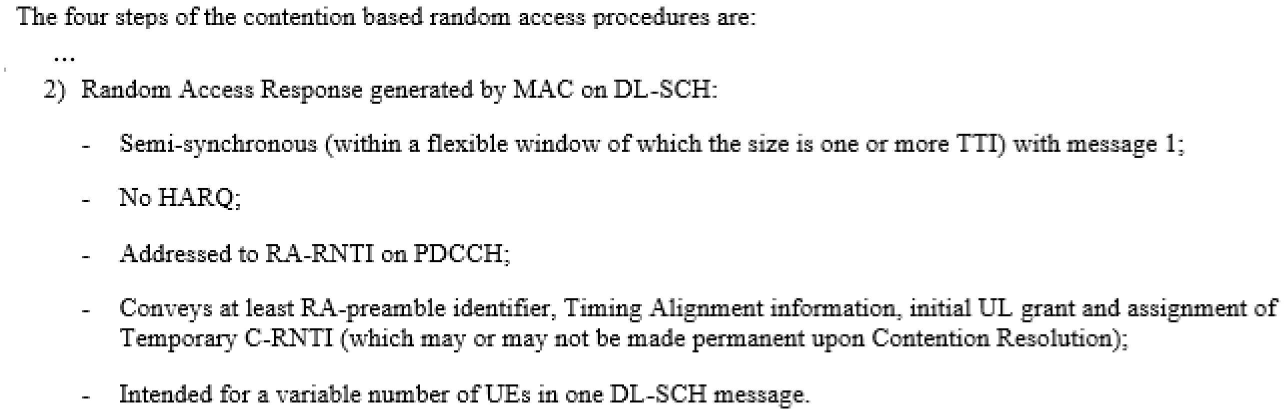
US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

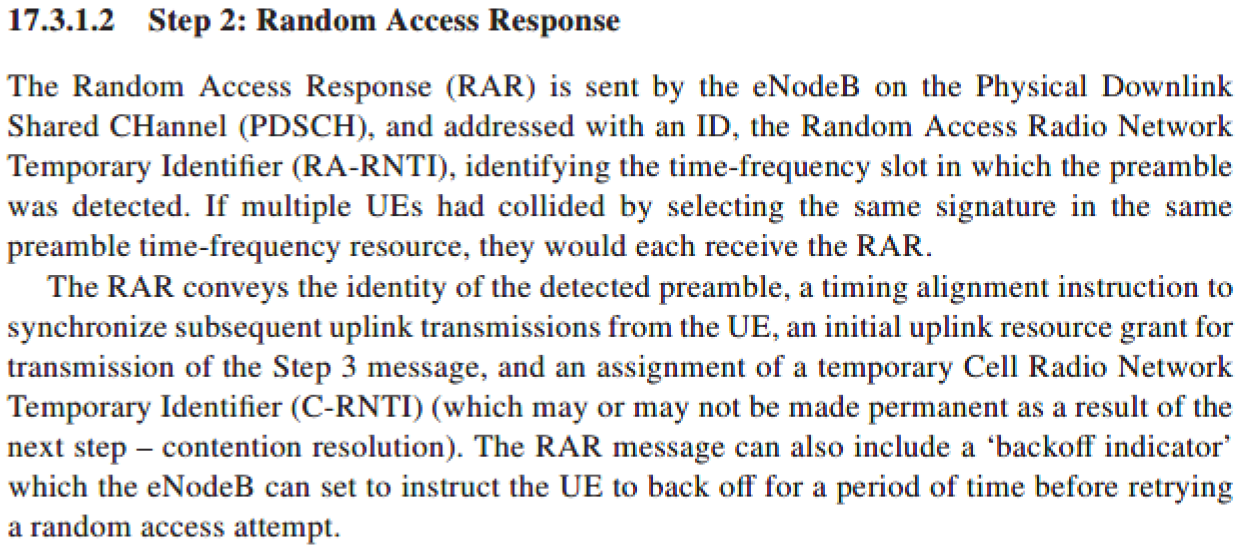
15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Volkswagen's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $RA\text{-}RNTI= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15
“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

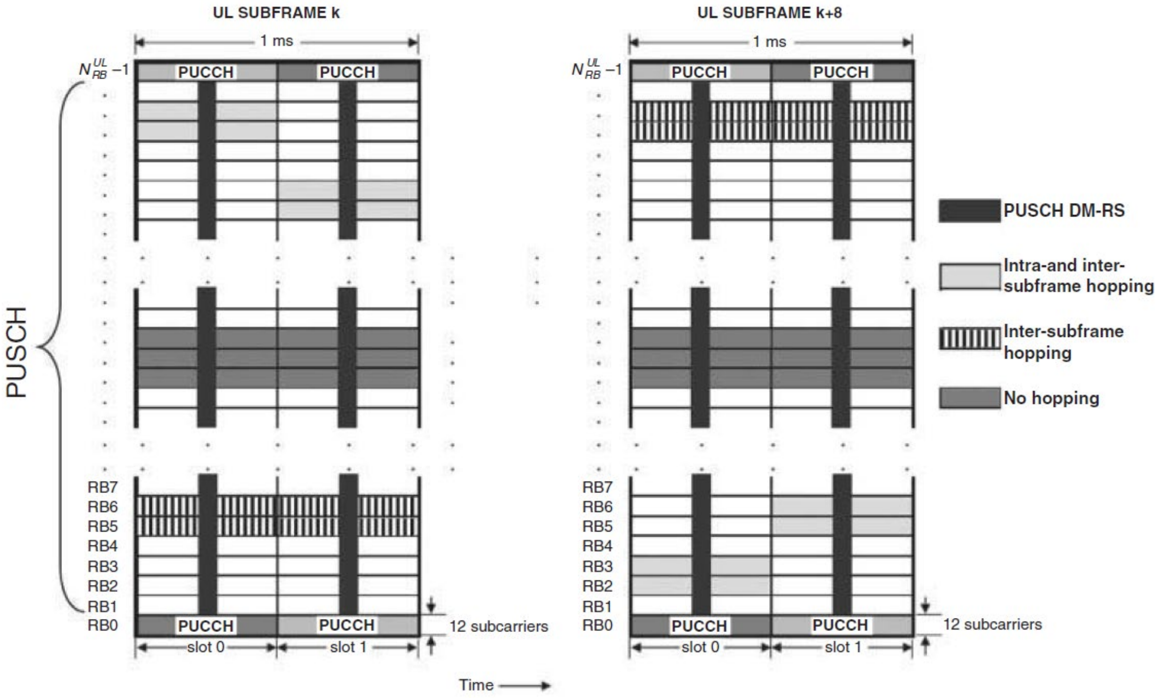
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 16
"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Volkswagen's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

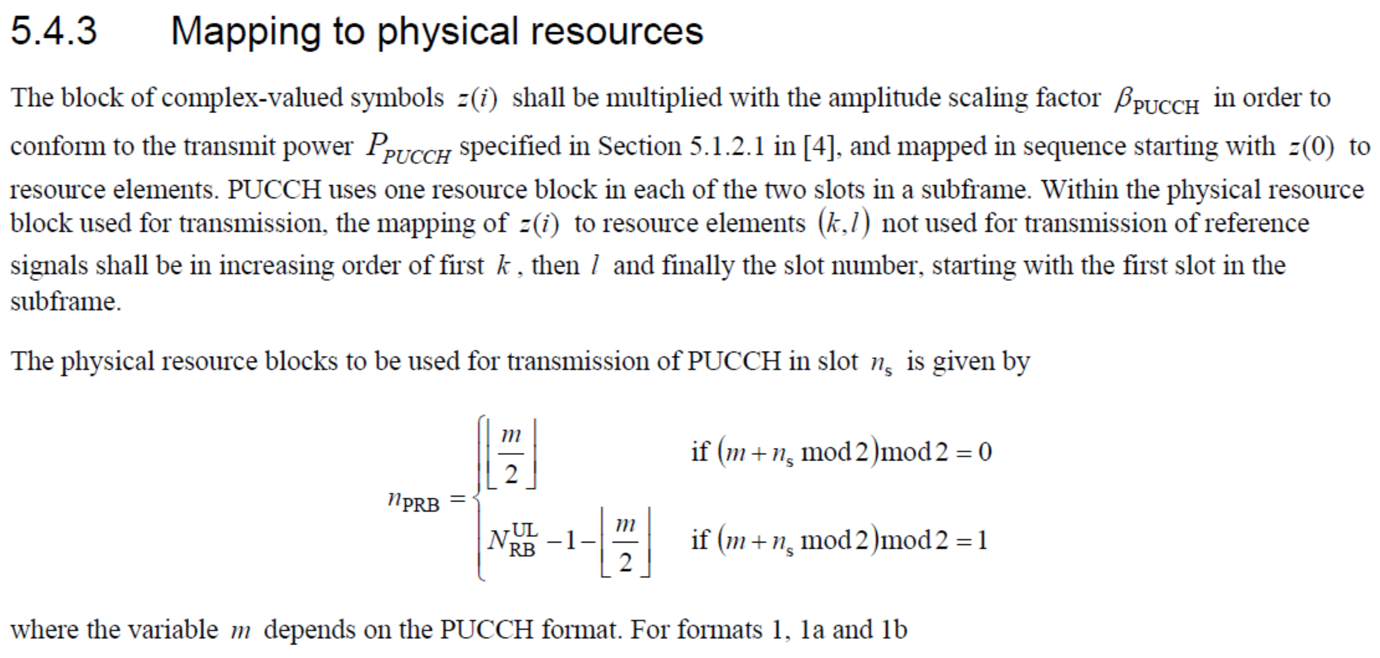
US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Volkswagen's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 17
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

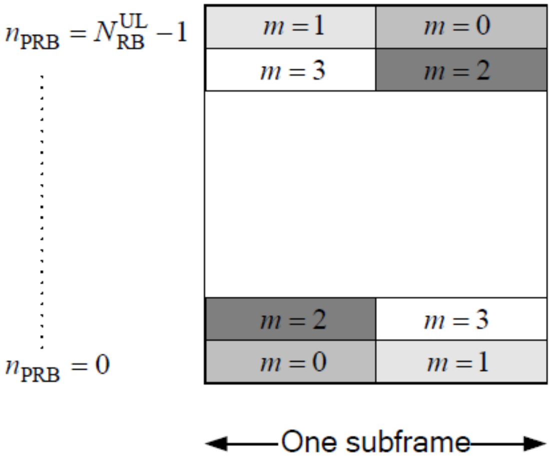
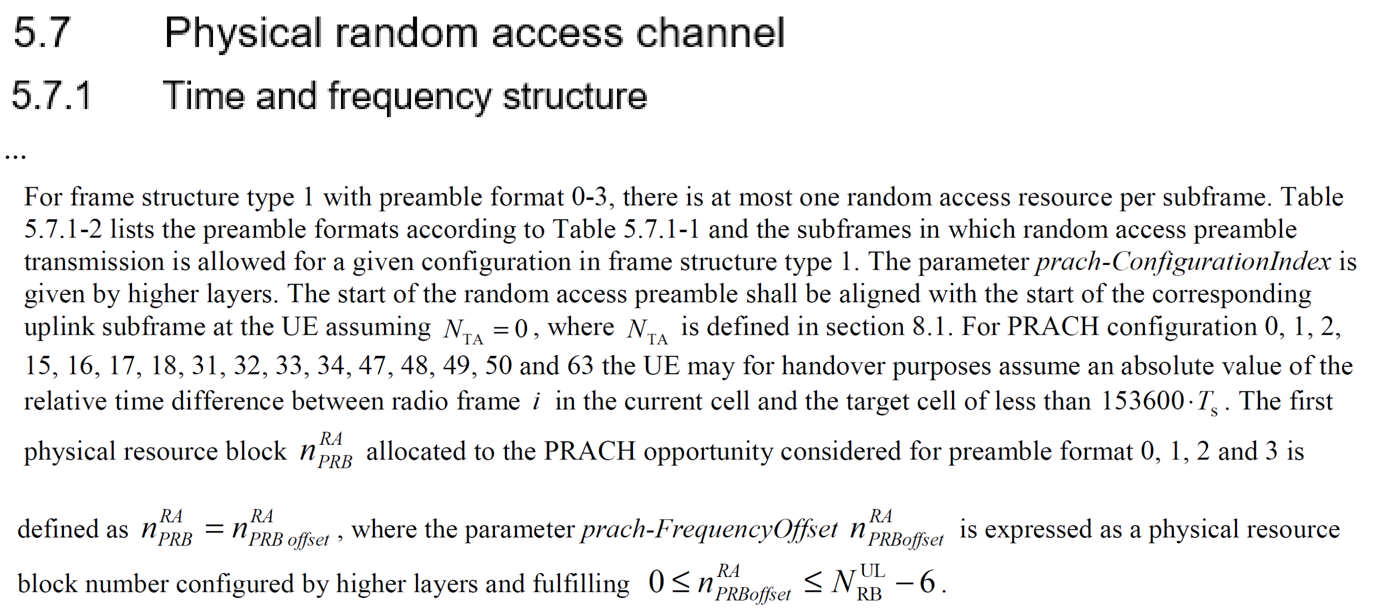


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

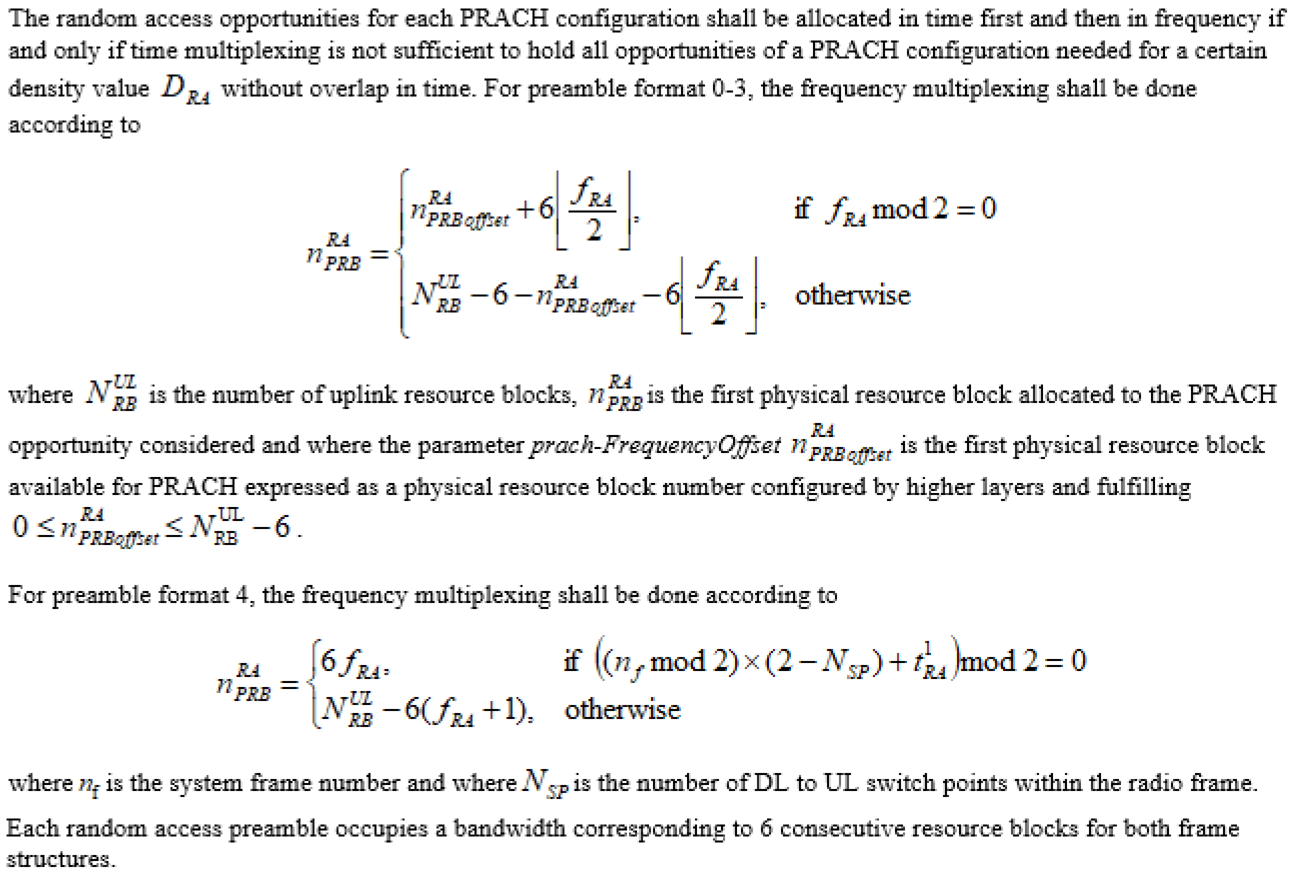
...

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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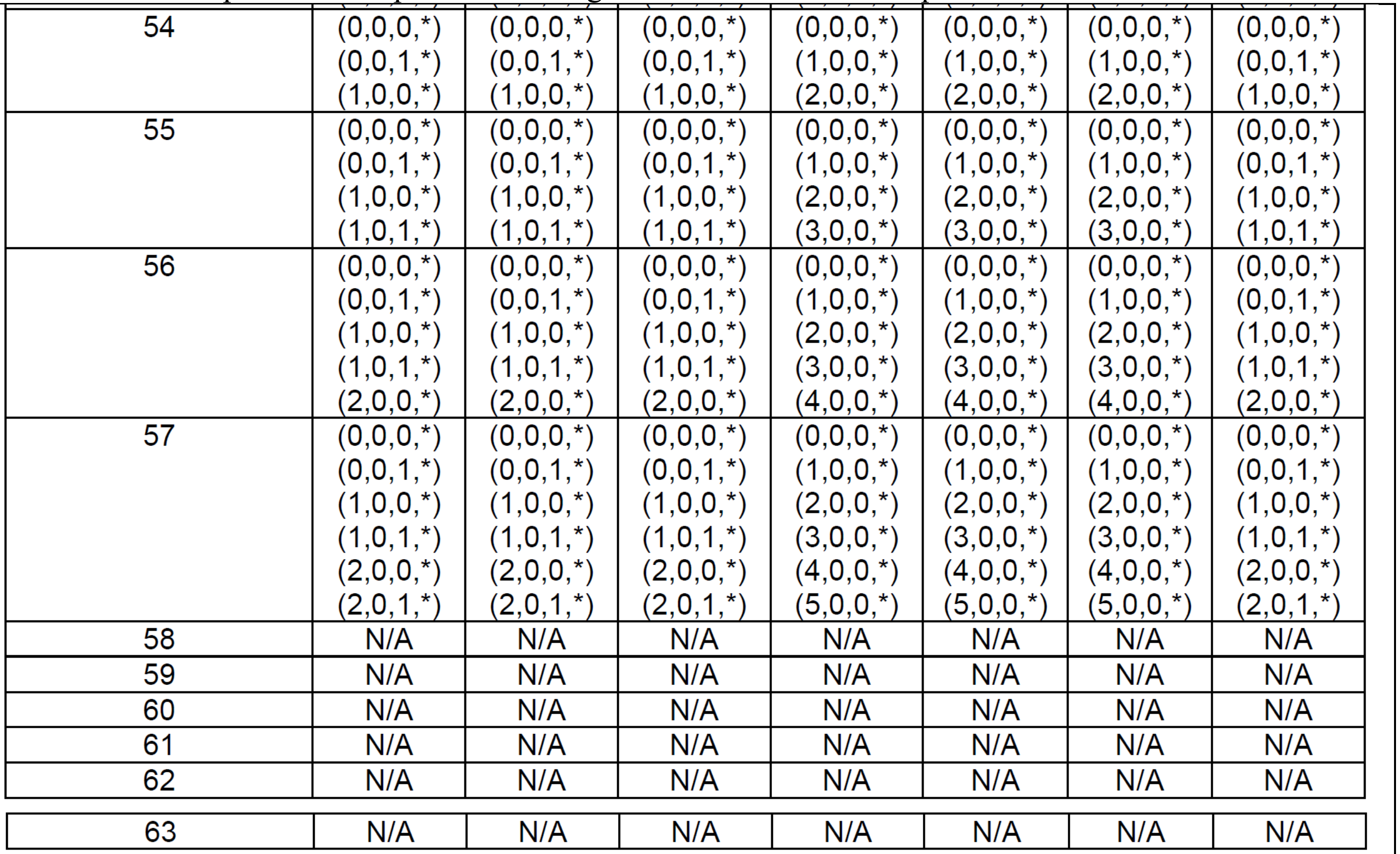
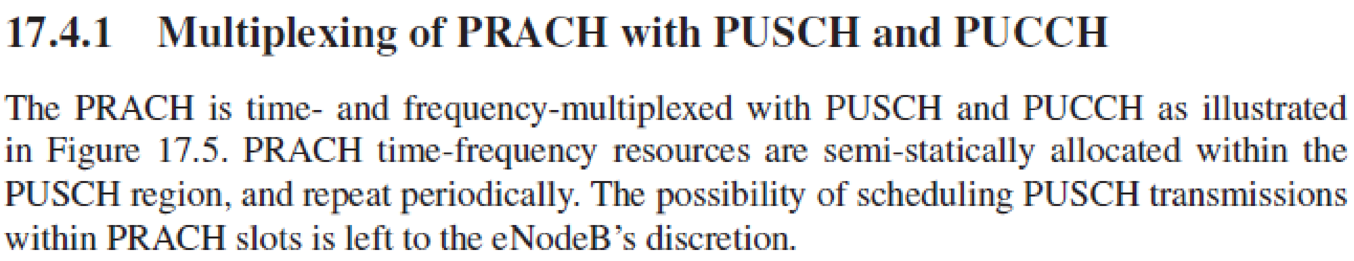


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

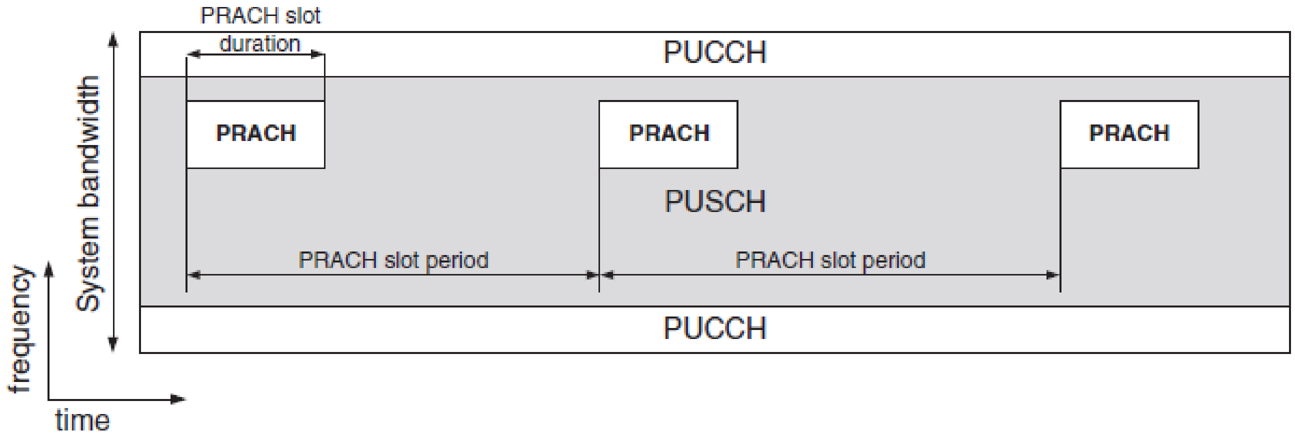
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



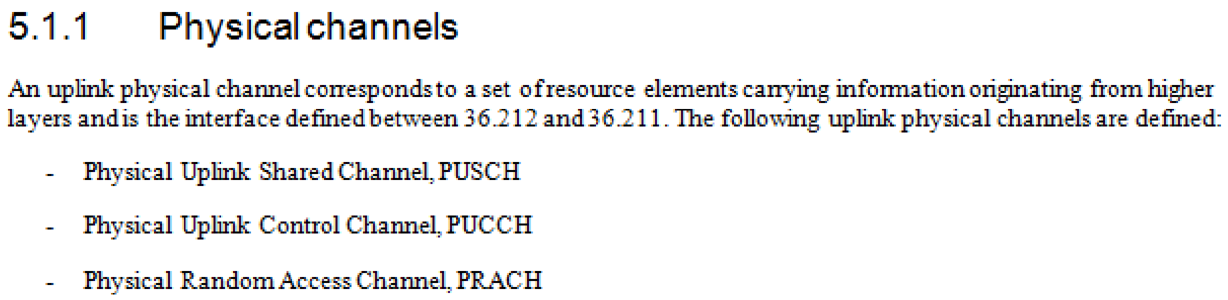
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

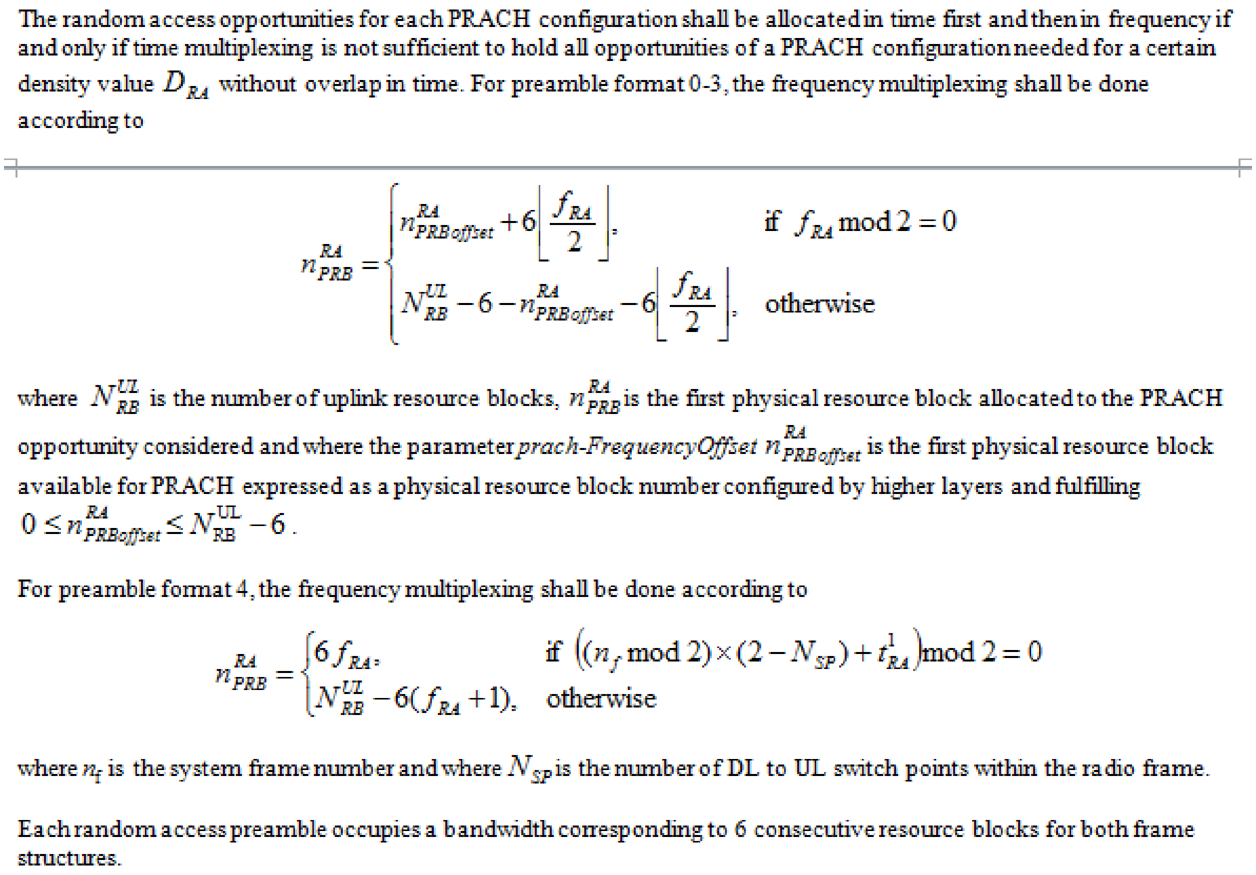
US Patent No. 10,833,908: Claim 17
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

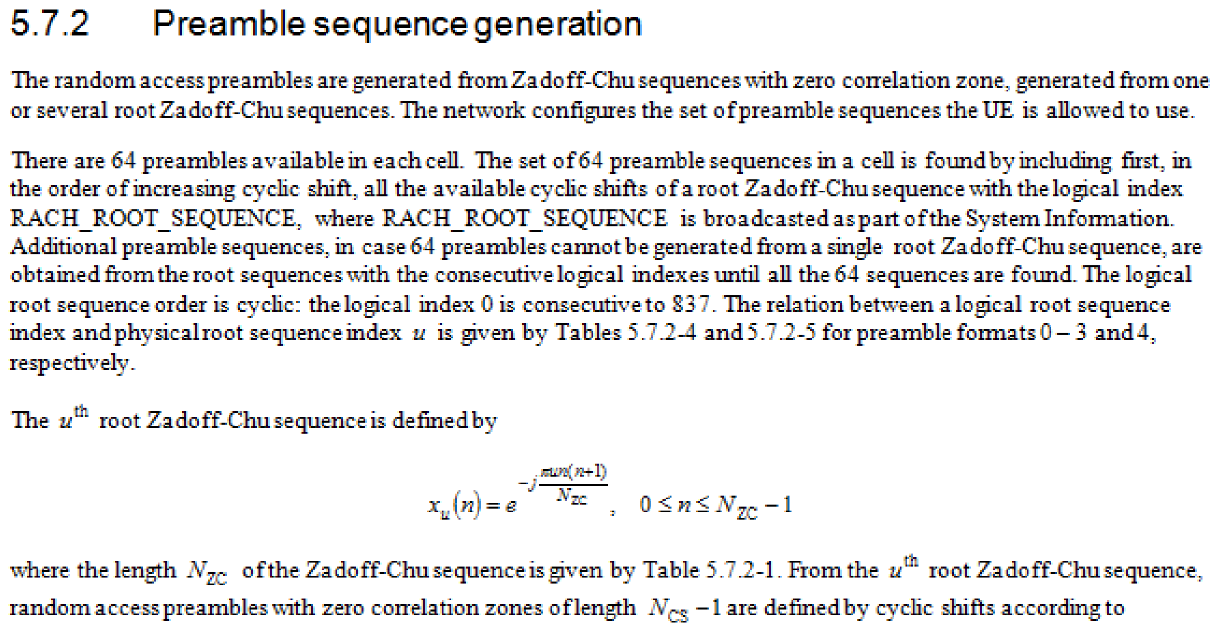
US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Volkswagen's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

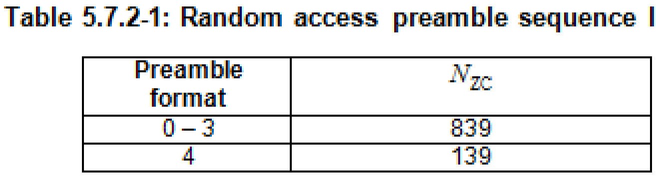
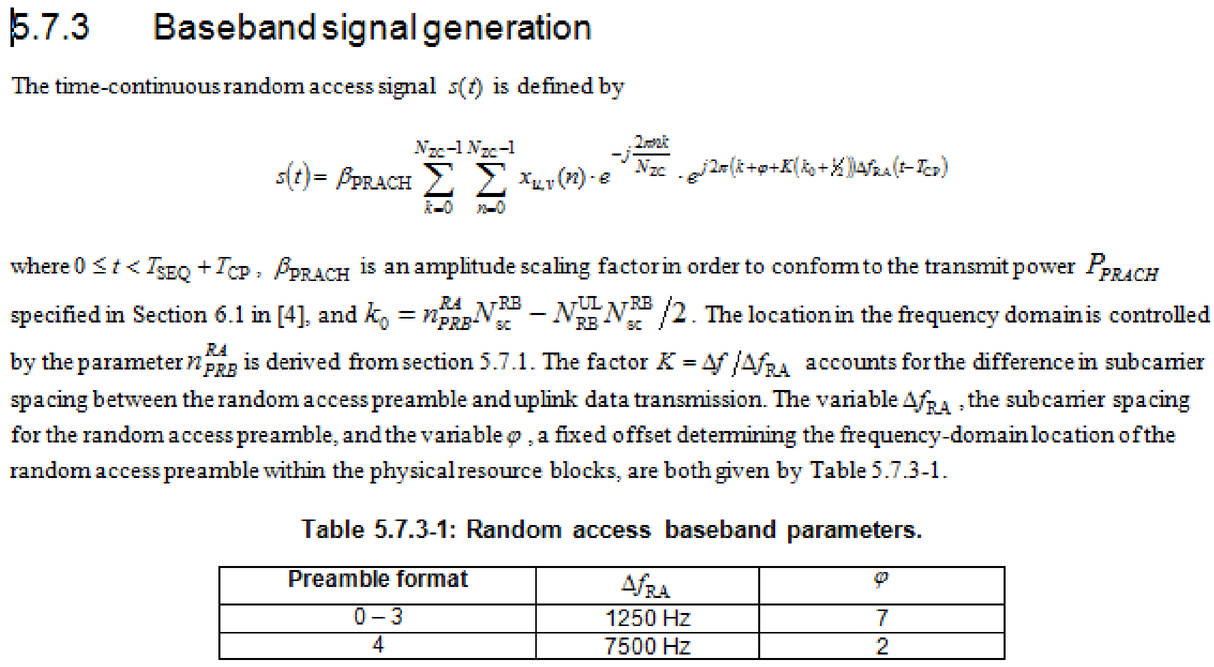


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

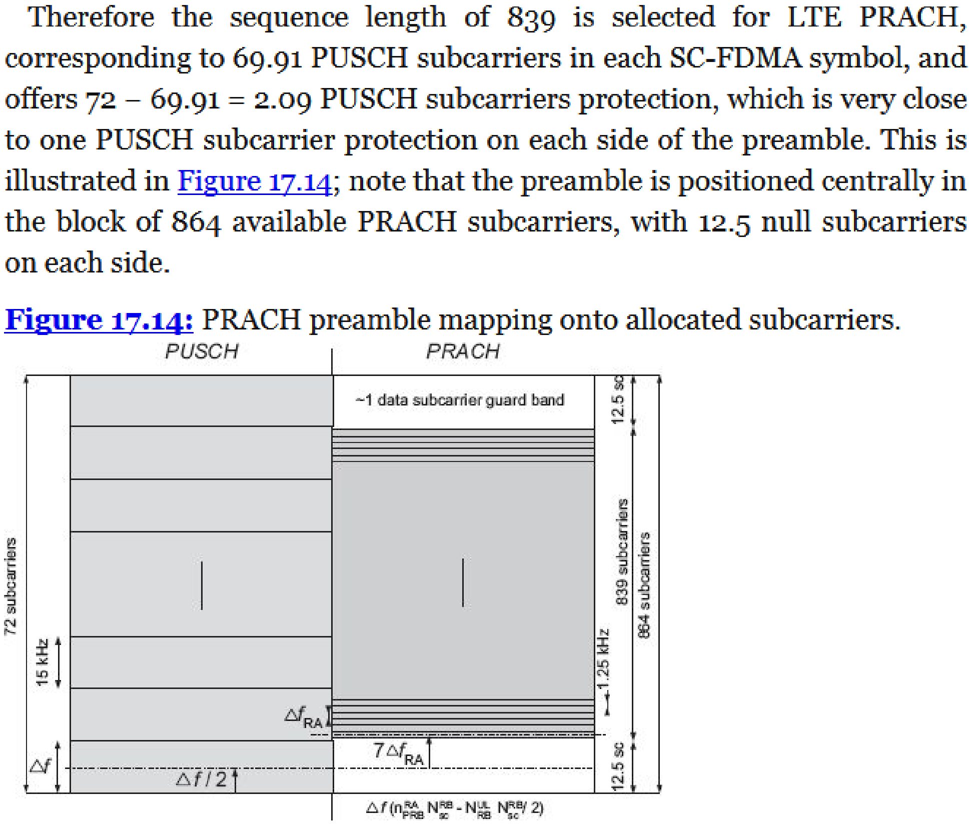
where $0\leq t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

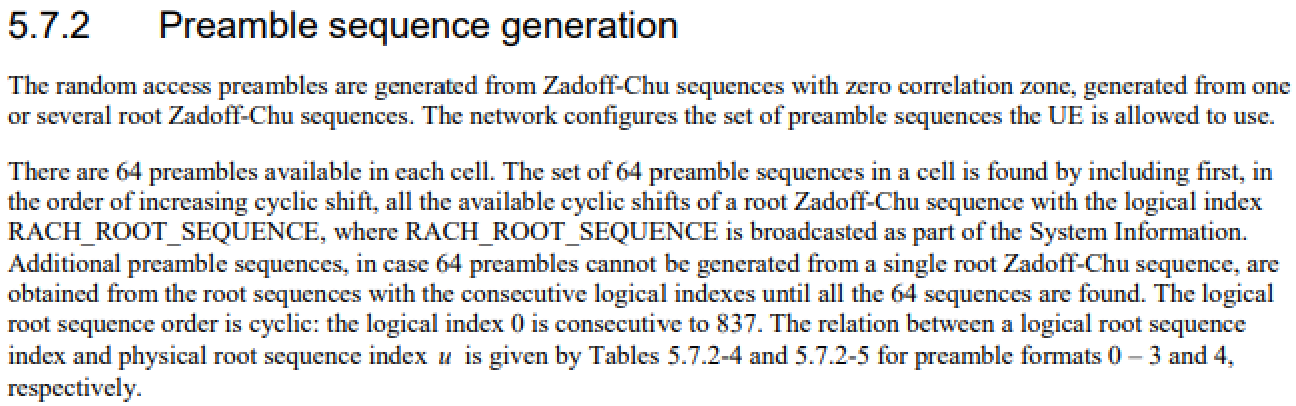
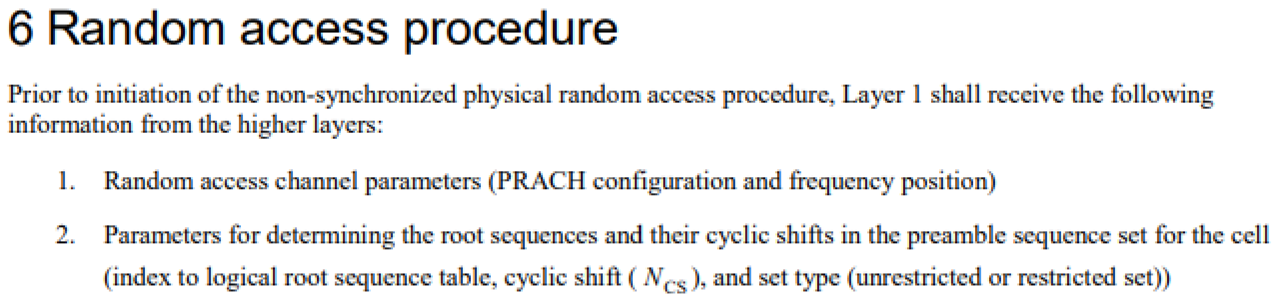
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”

	 Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 19
"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Volkswagen's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19
“The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

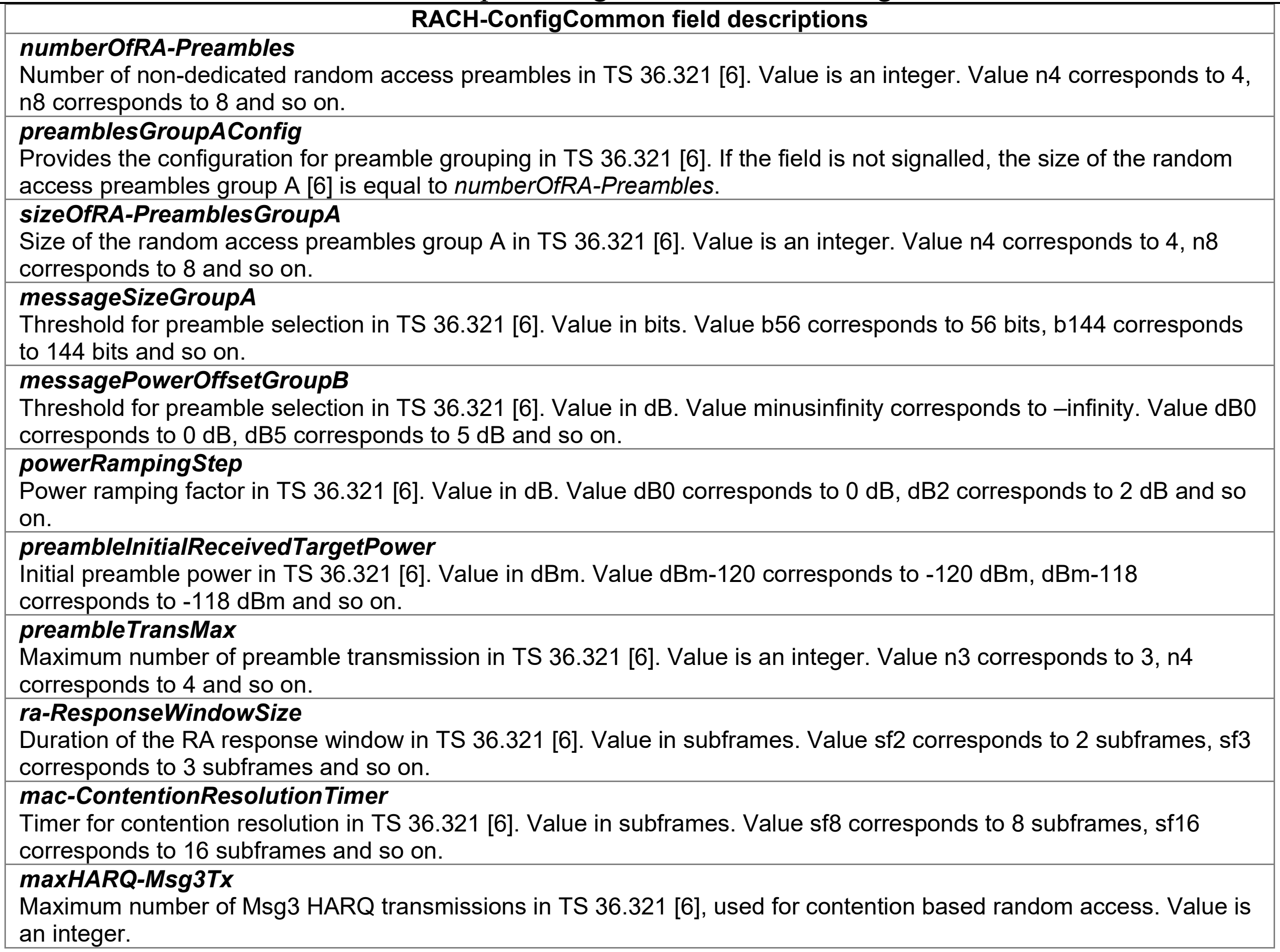
***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                            -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19
"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

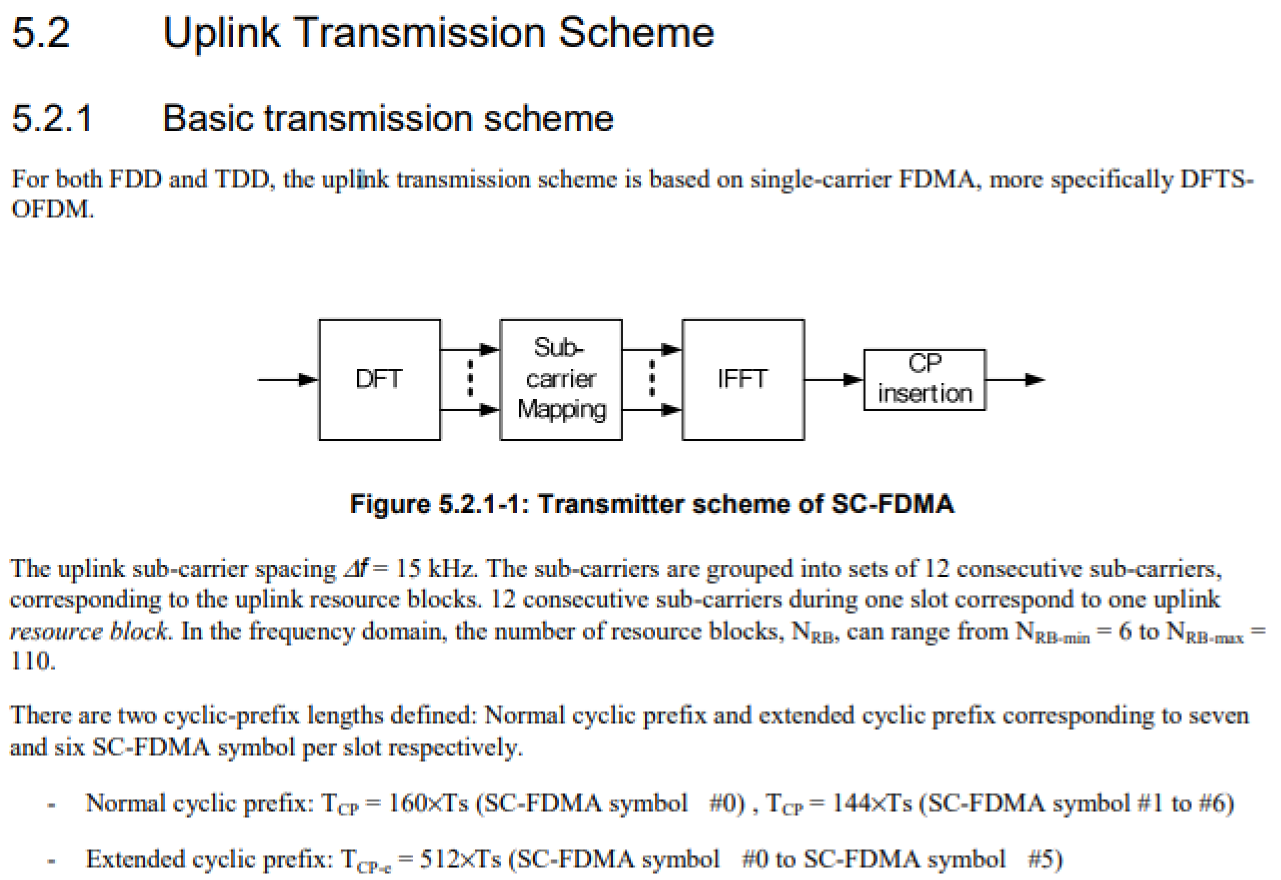


RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

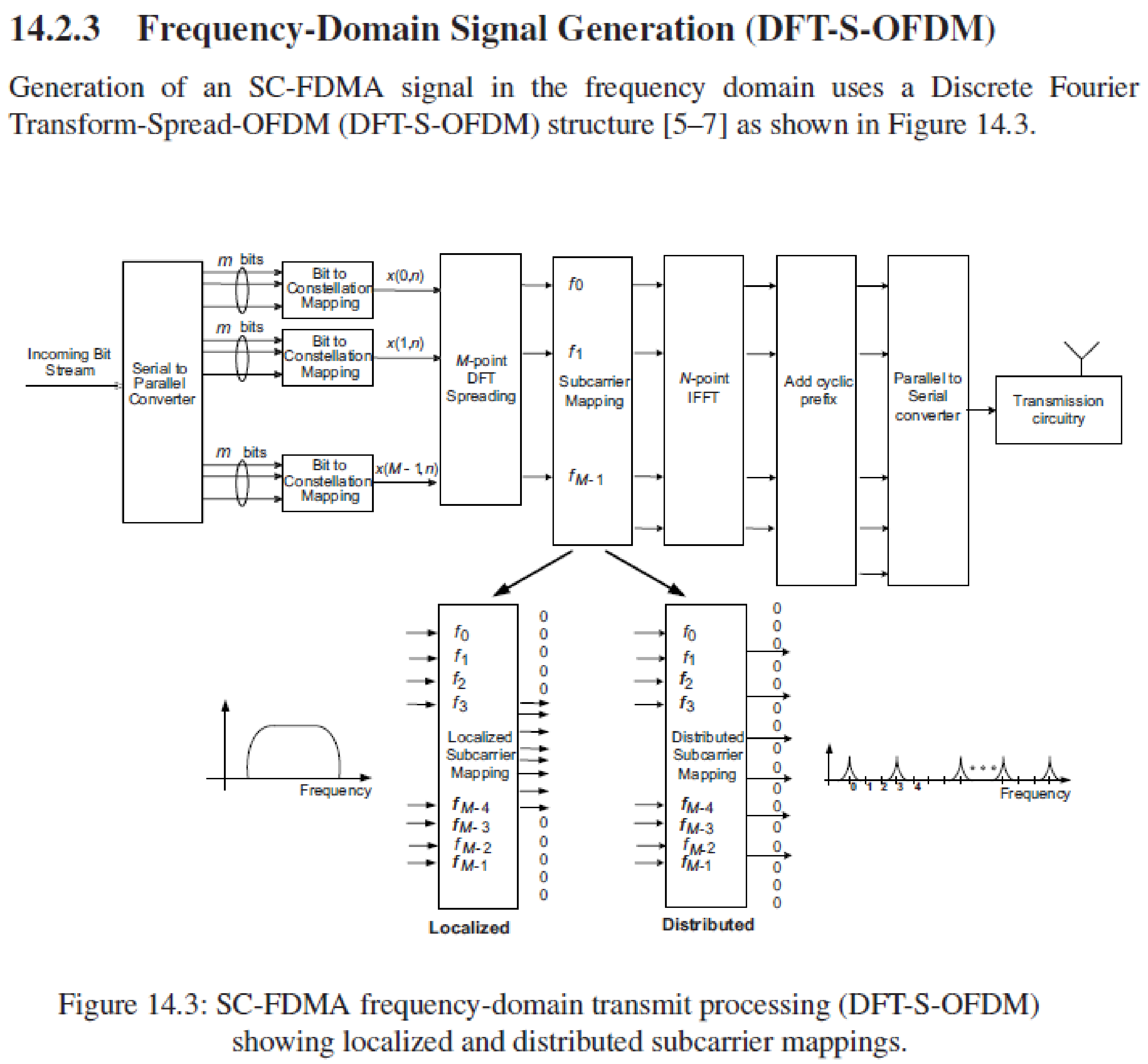
US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. Volkswagen's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,* Volkswagen's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5)

US Patent No. 10,833,908: Claim 20

"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

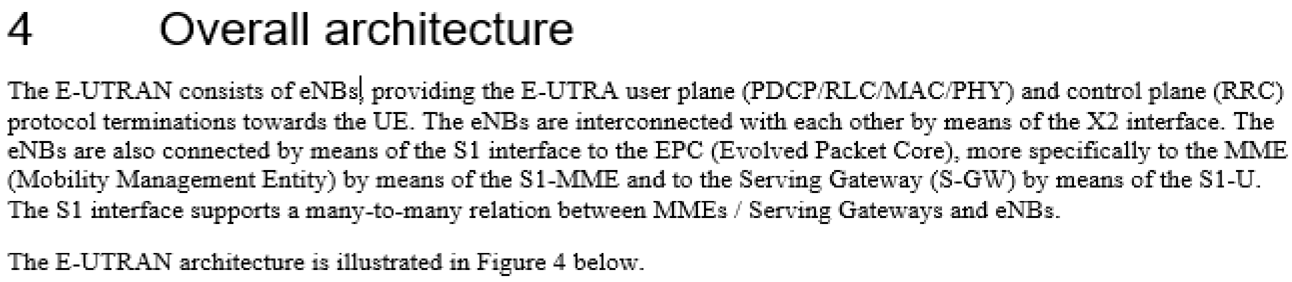
Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

21. A mobile station comprising:	To the extent the preamble is considered a limitation, Volkswagen's Accused Instrumentalities meet the preamble of claim 21 of the '908 patent. *E.g.,* Volkswagen's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Volkswagen offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  **4 Overall architecture** The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

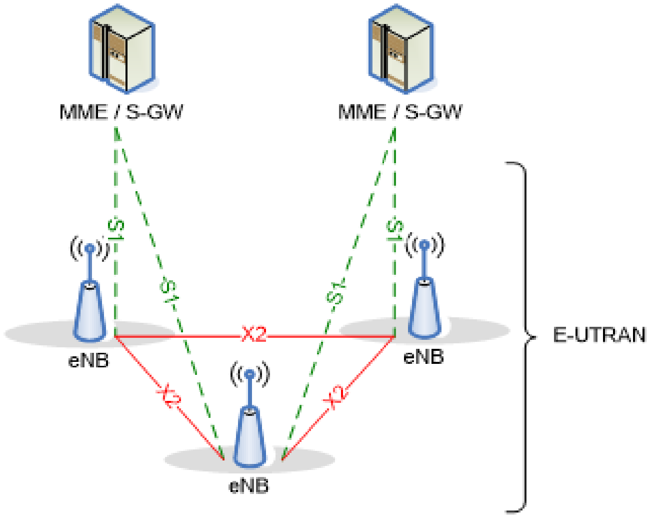
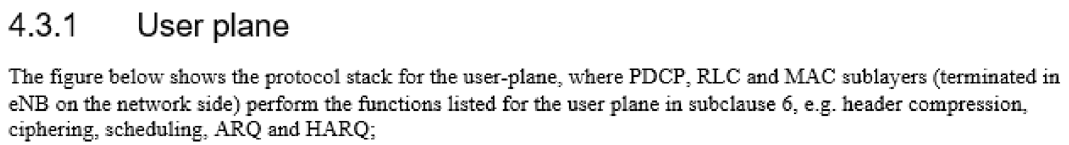


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

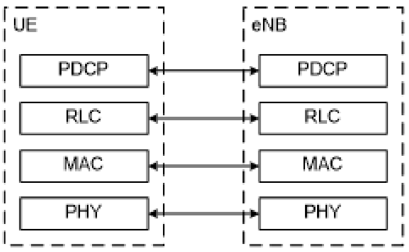


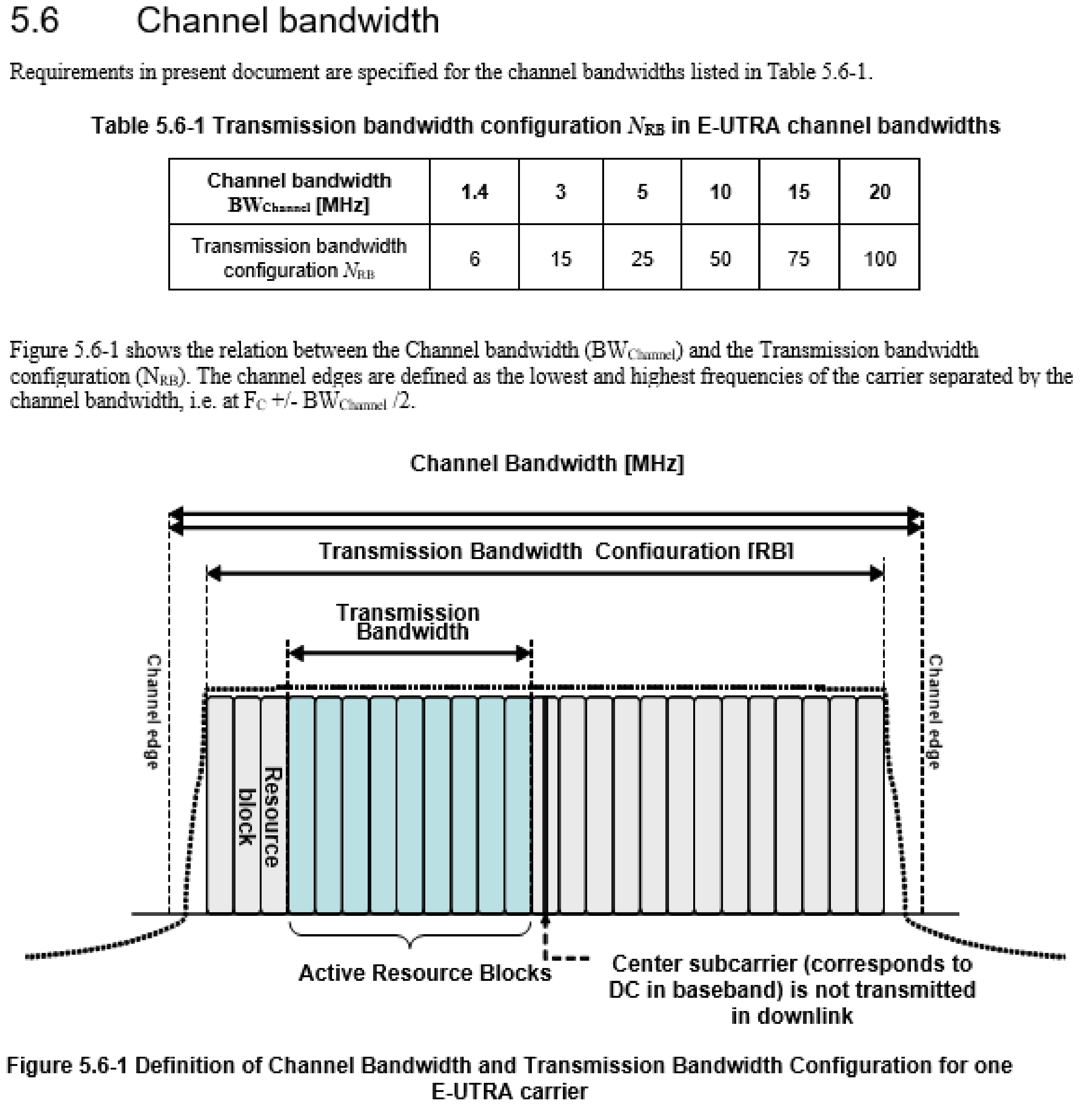
Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	Volkswagen's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The Volkswagen Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

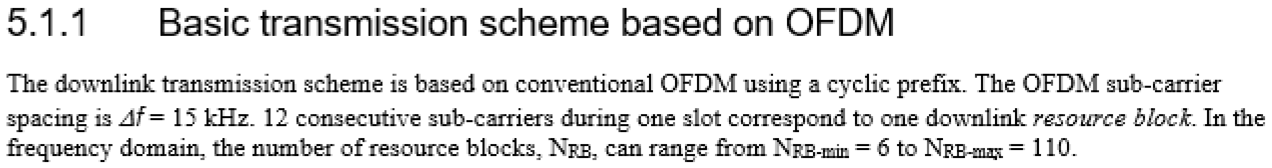
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

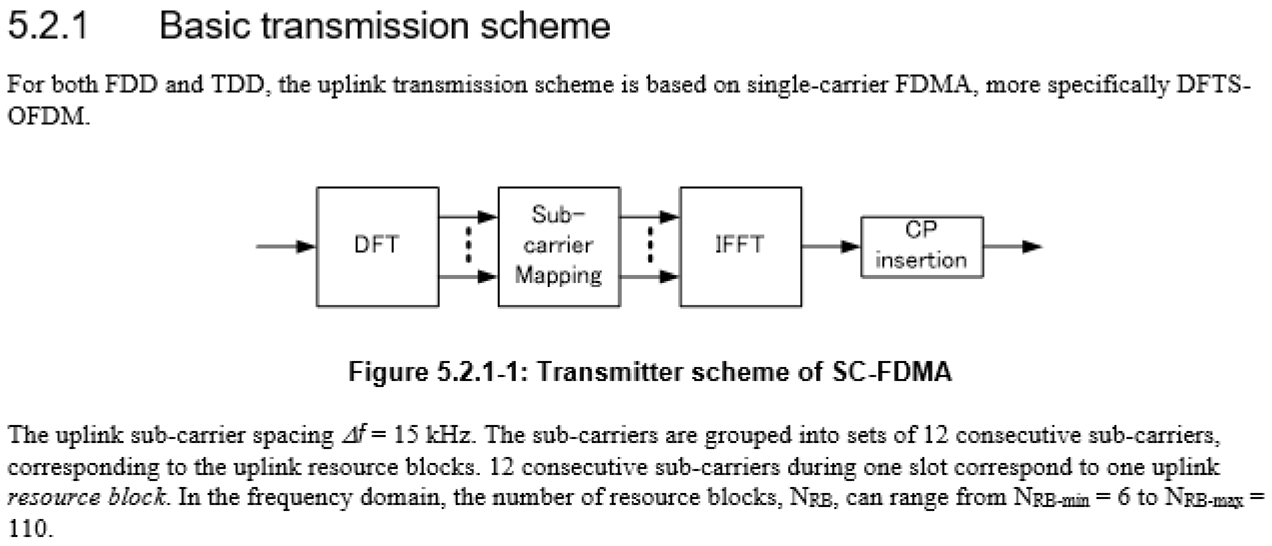
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

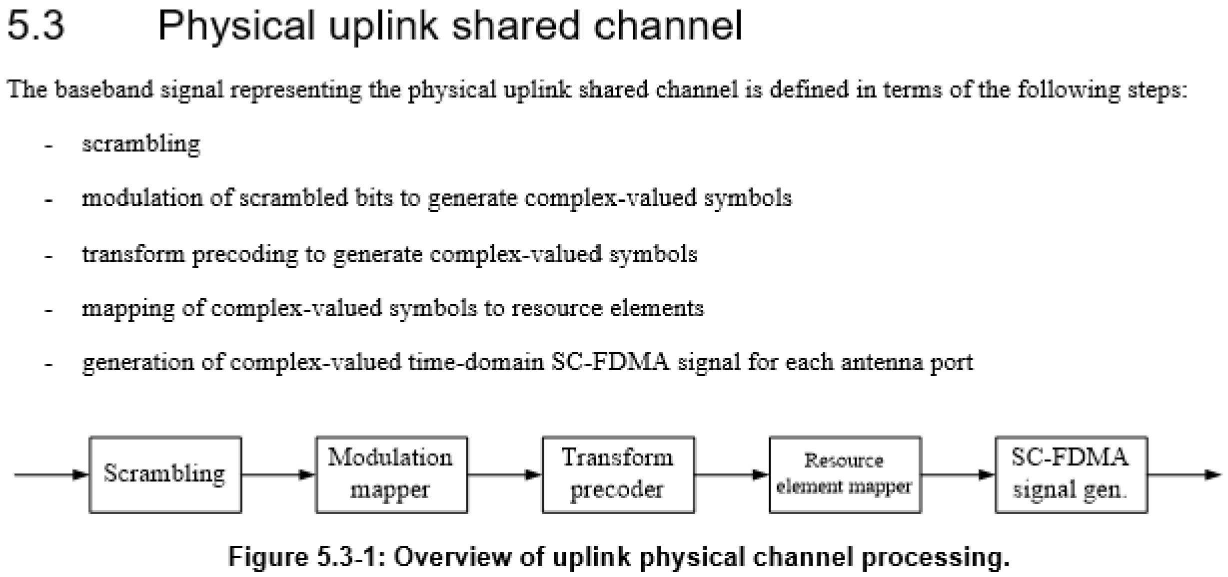
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

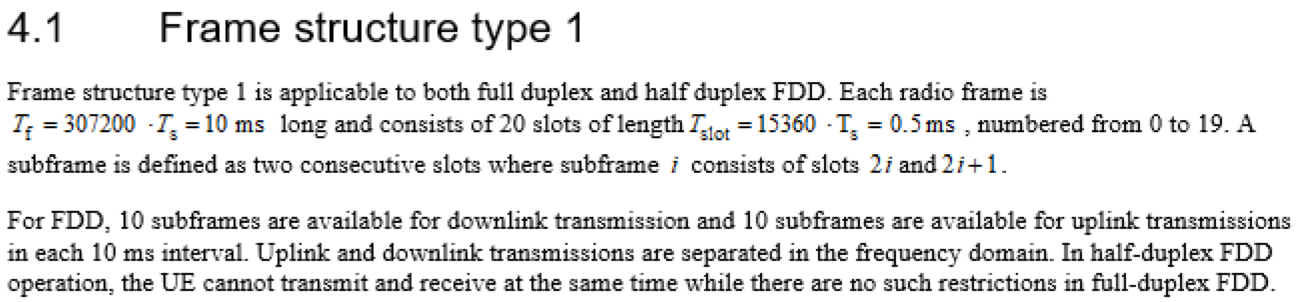
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\text{ ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\text{ ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

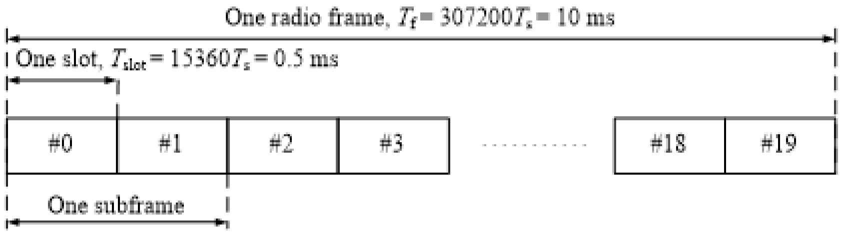
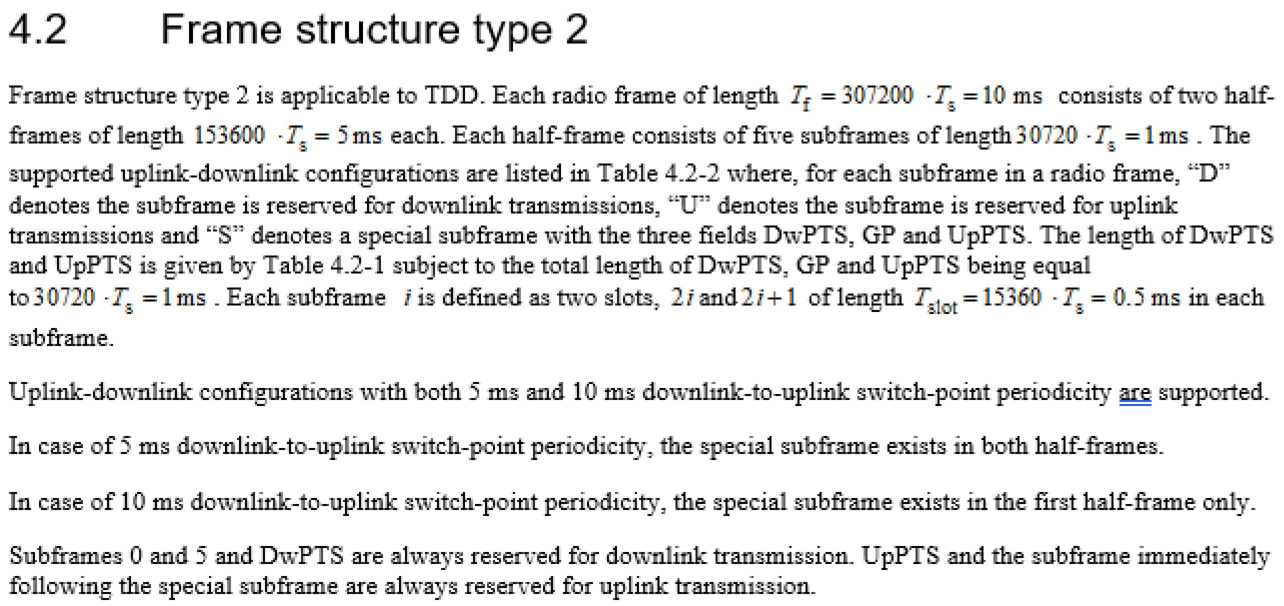


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

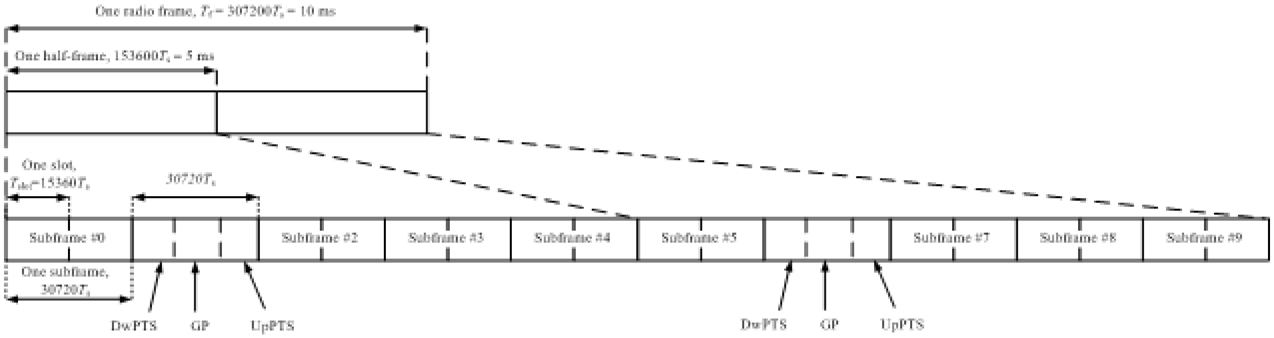
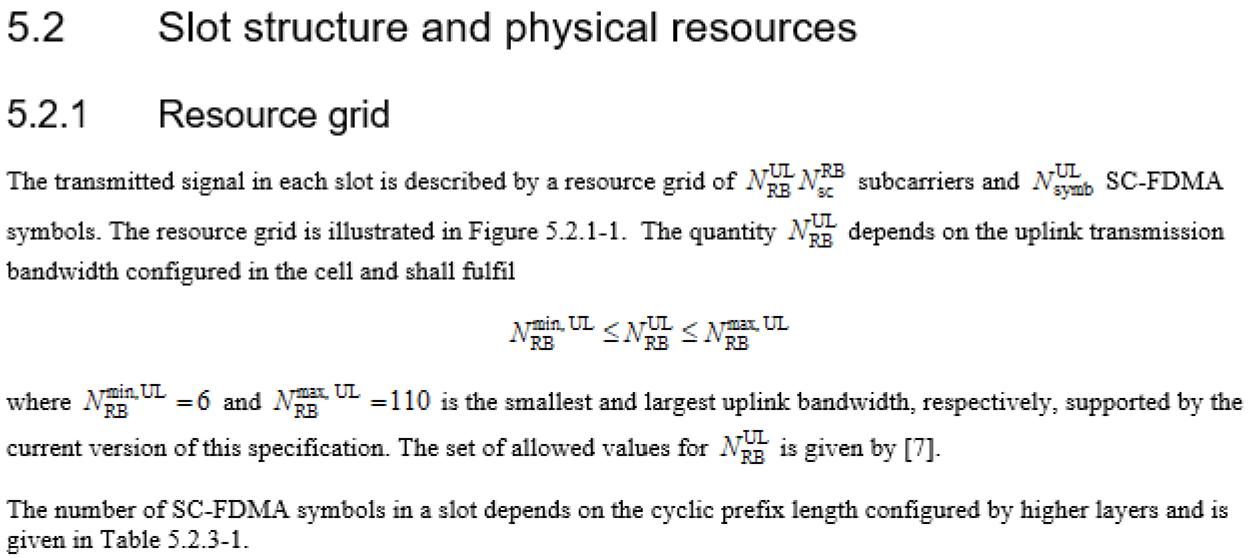


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

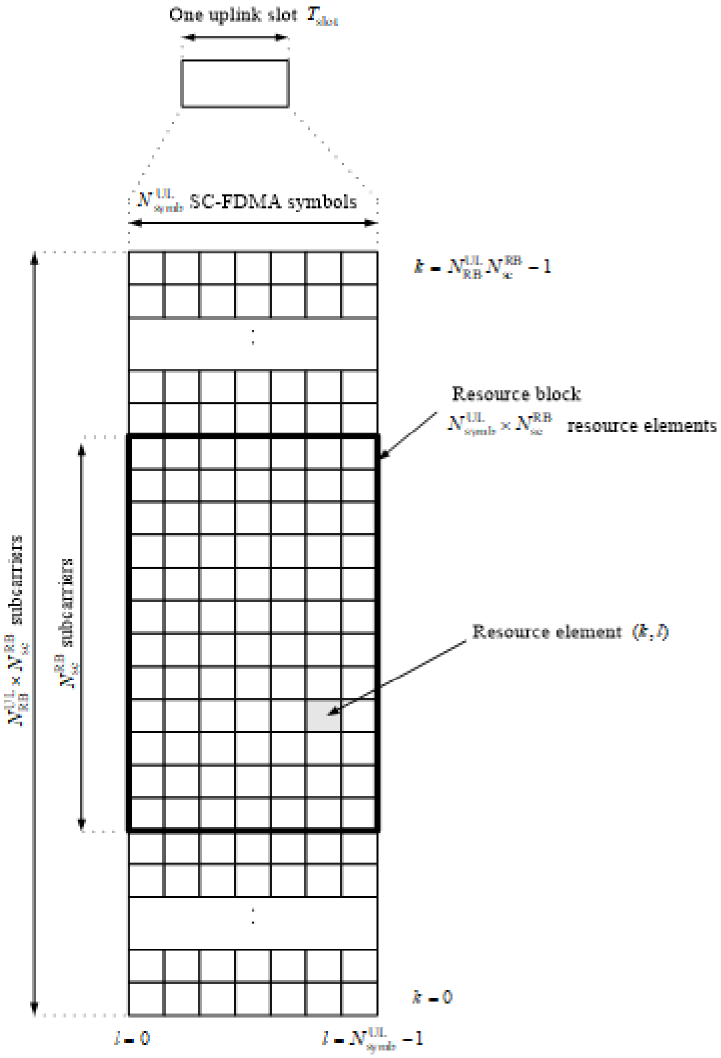
The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

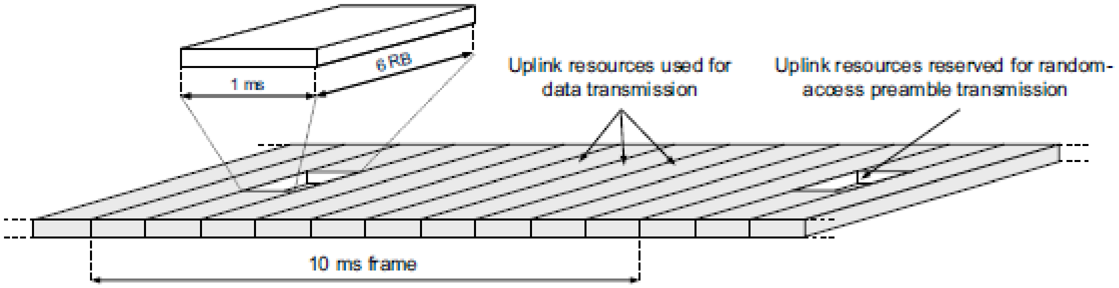
where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

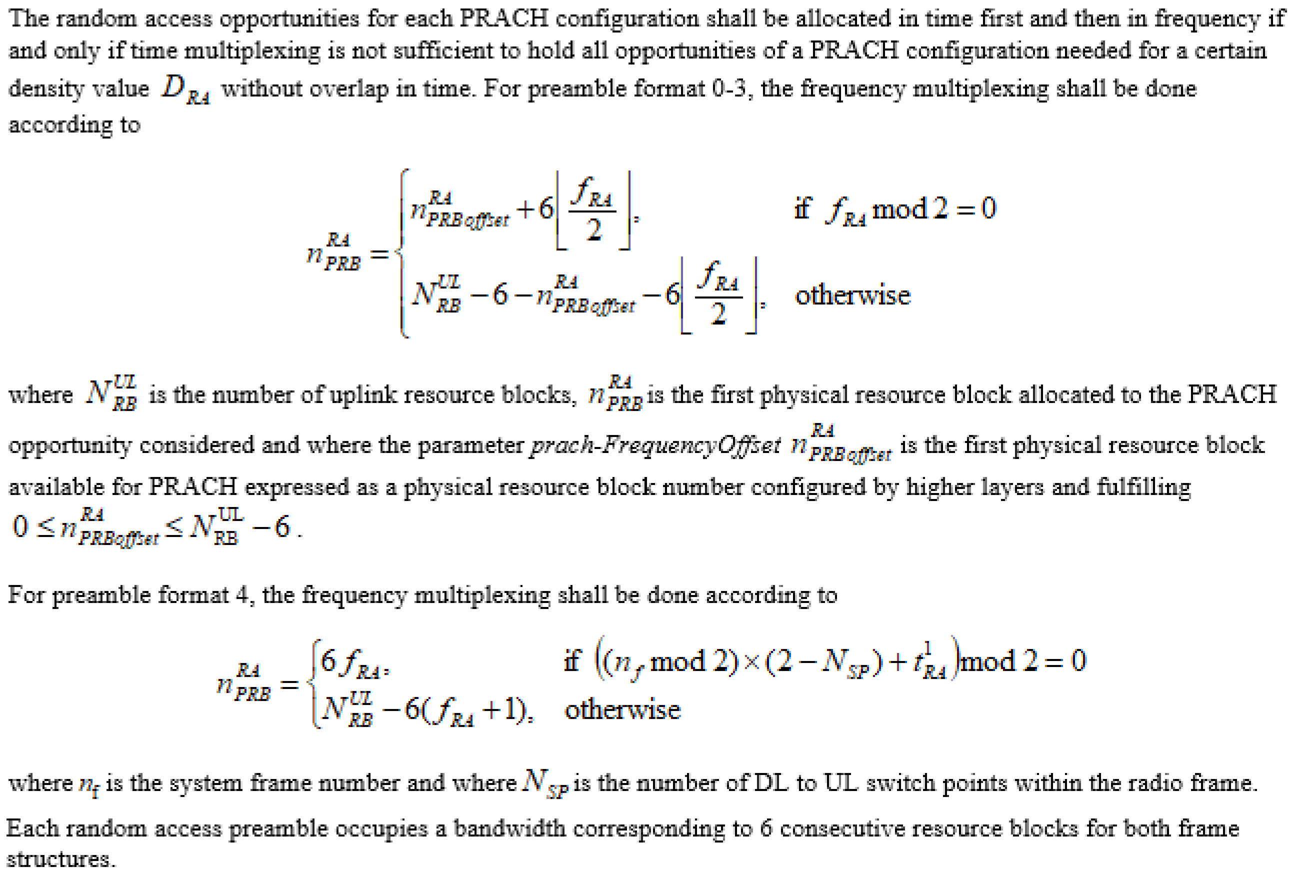
US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

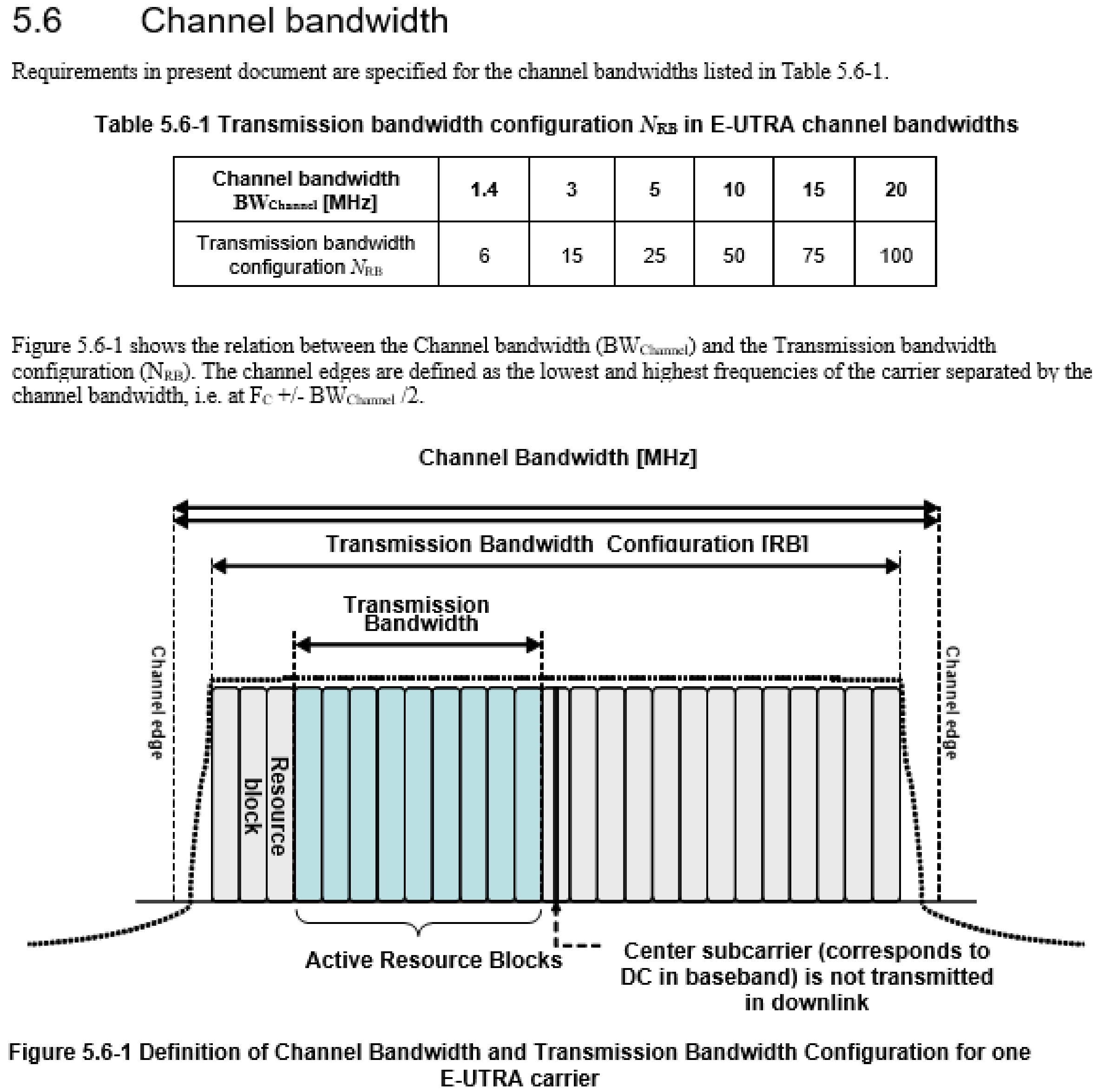
US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	Volkswagen’s Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

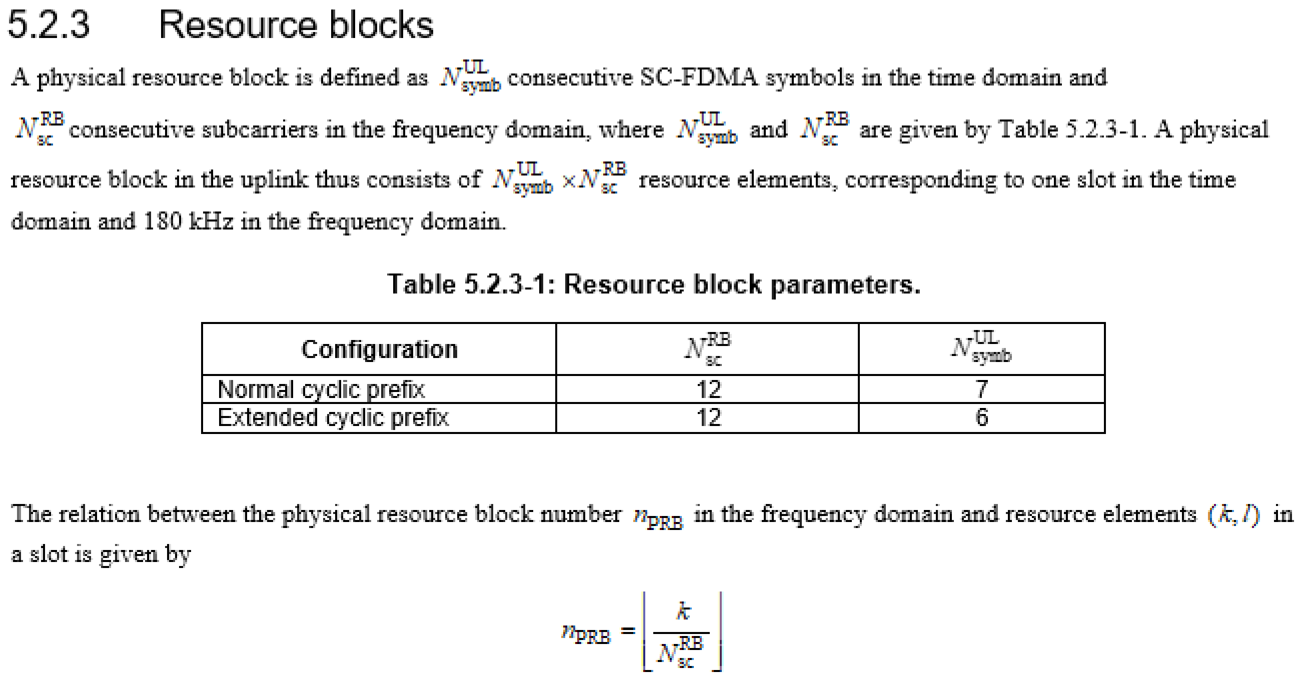
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

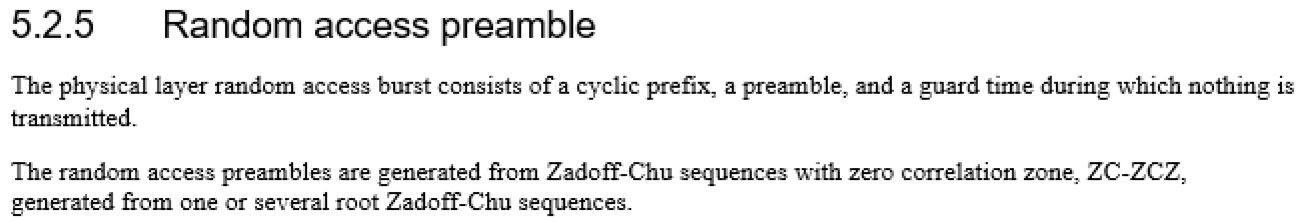
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

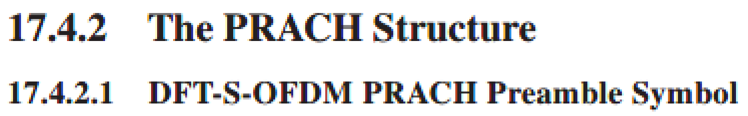


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

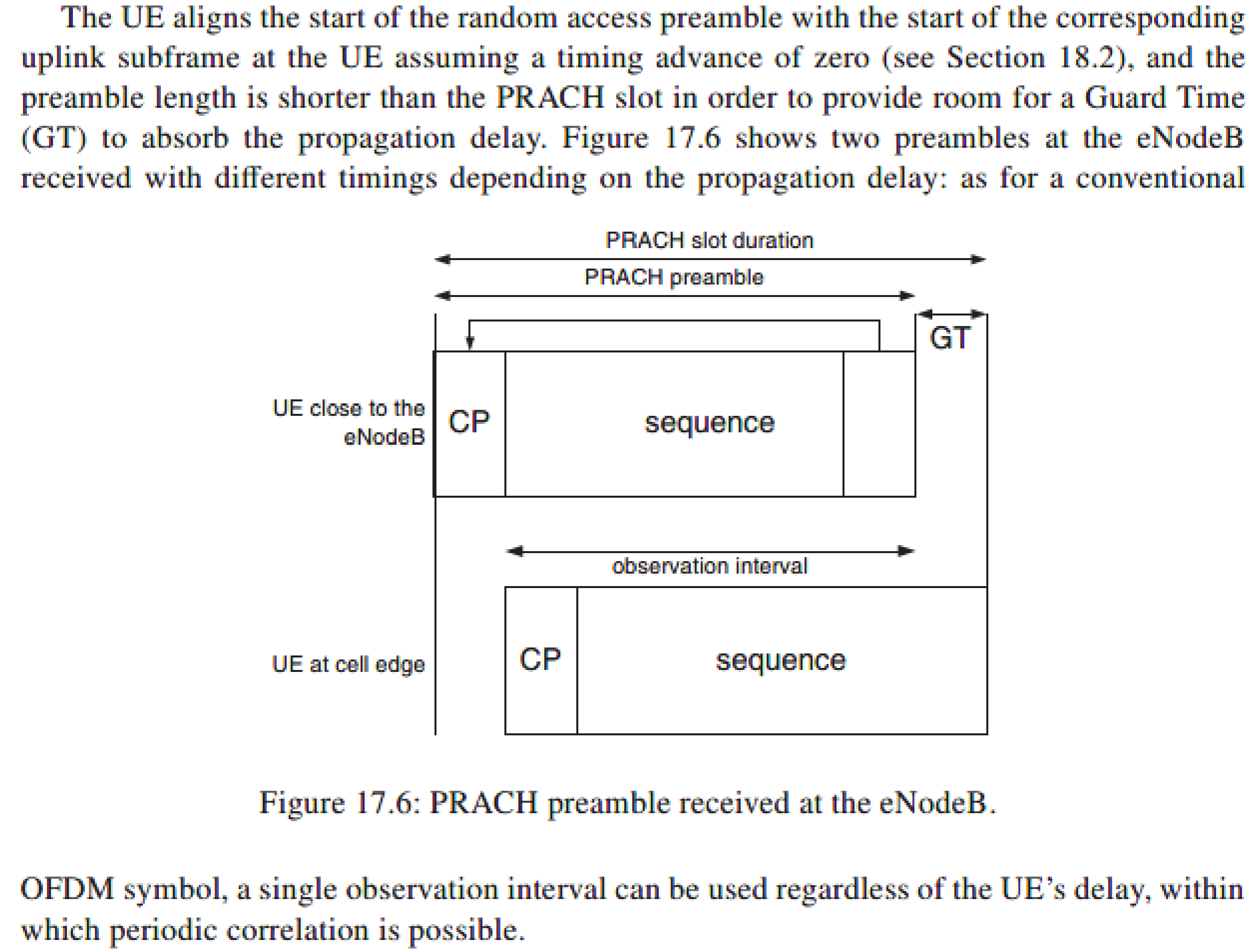


17.4.2 The PRACH Structure

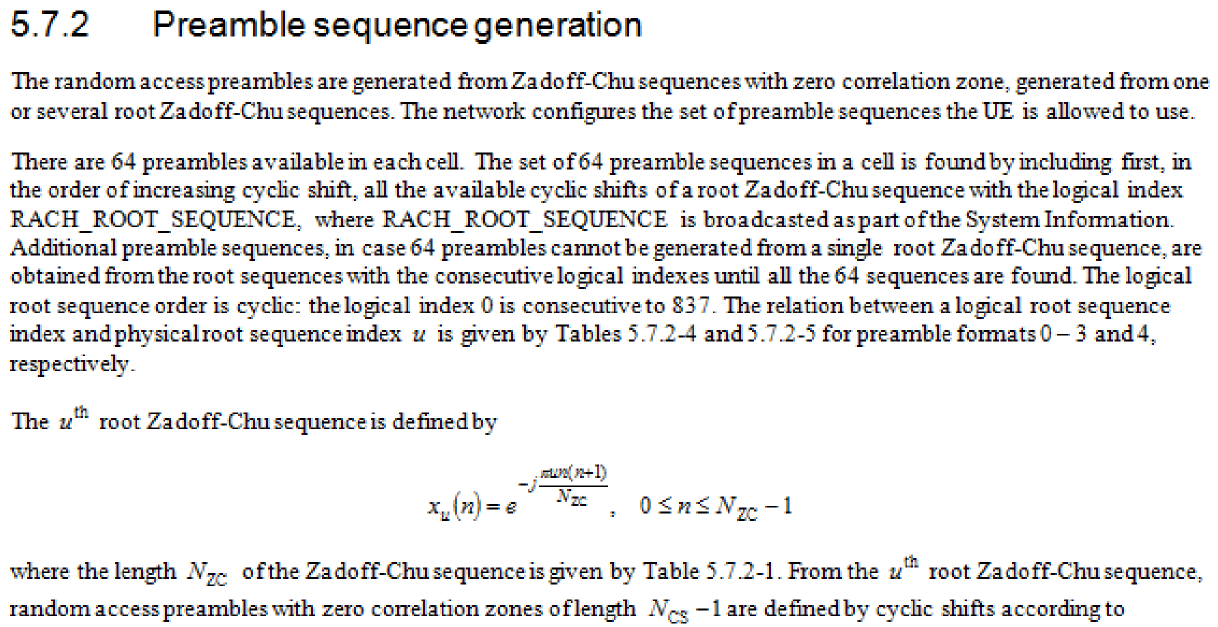
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

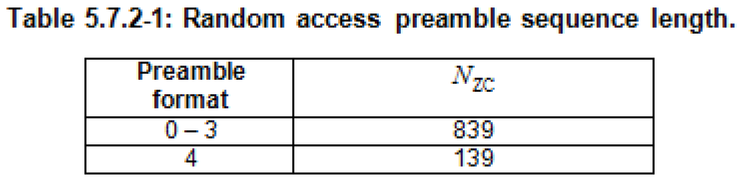
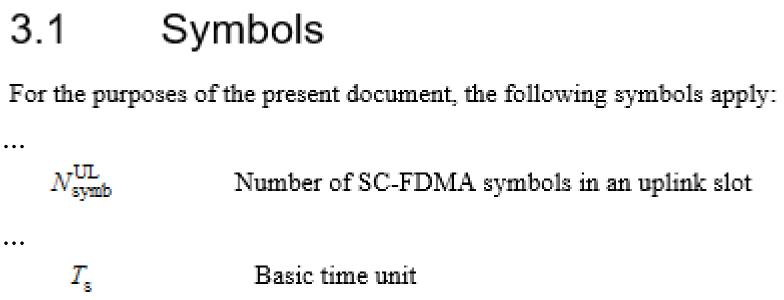
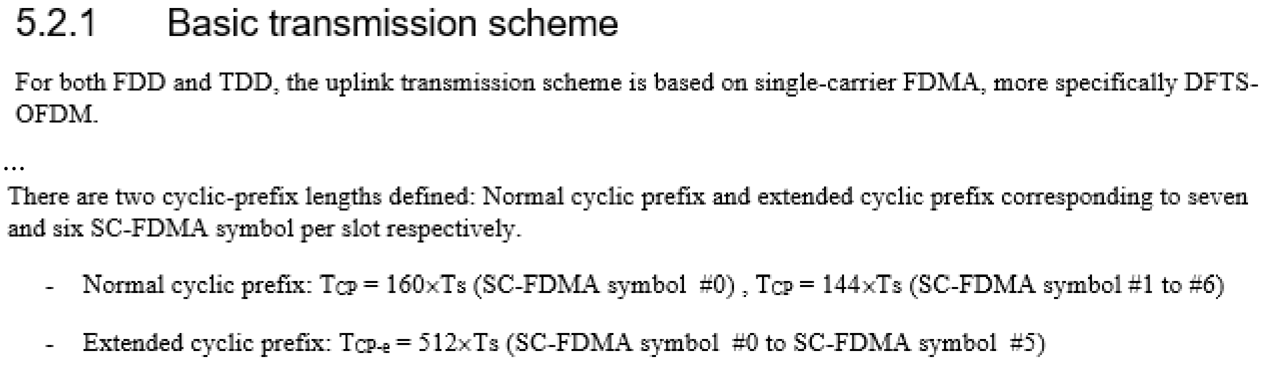


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Volkswagen’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)

“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

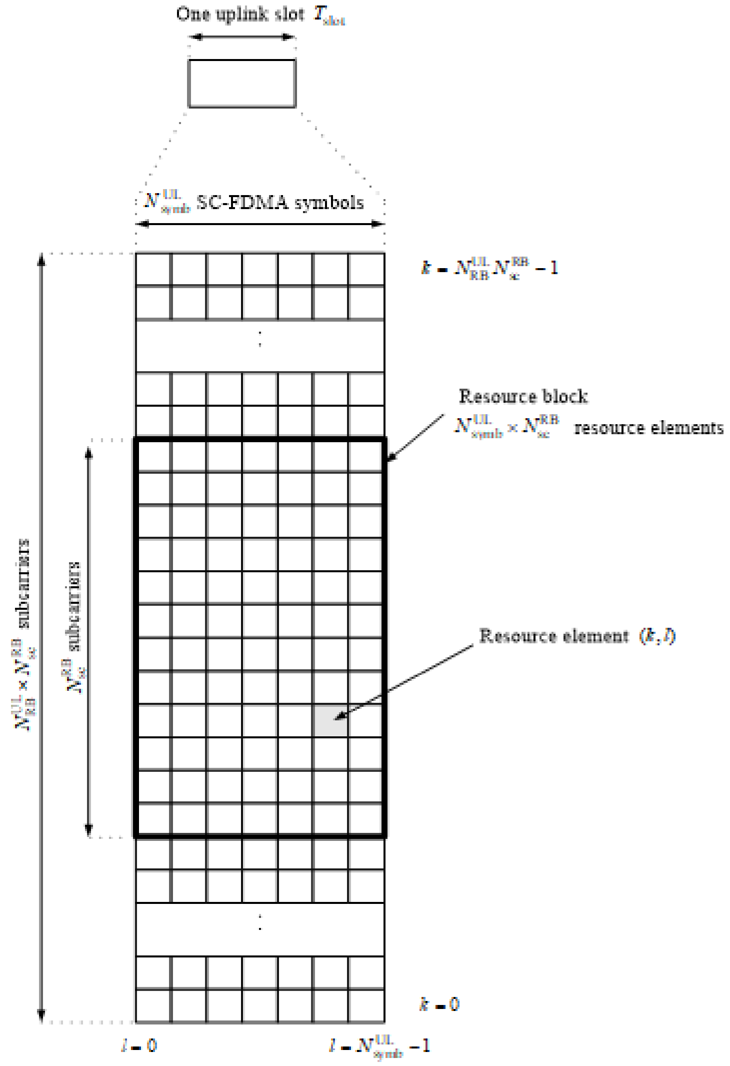
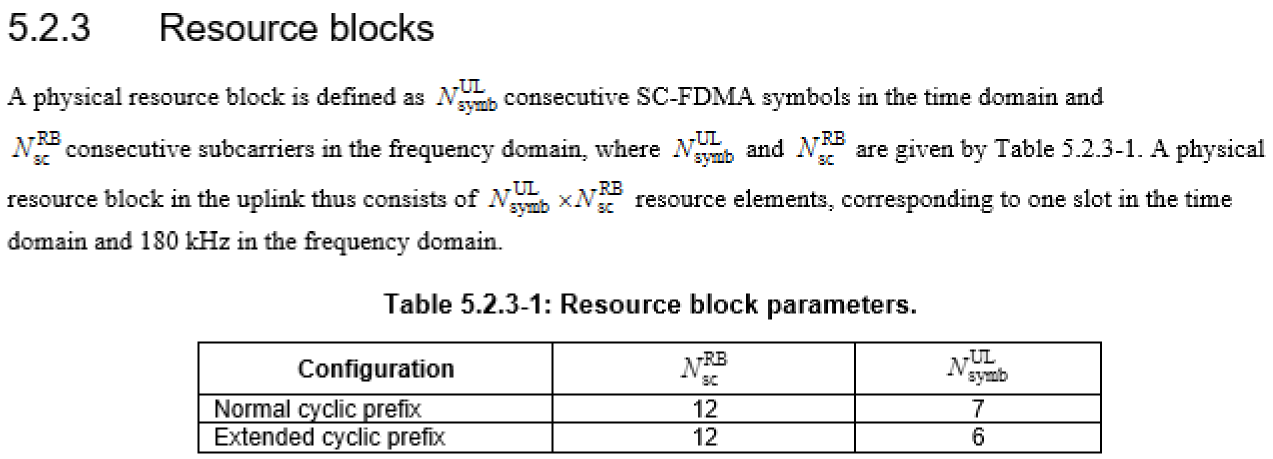


Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

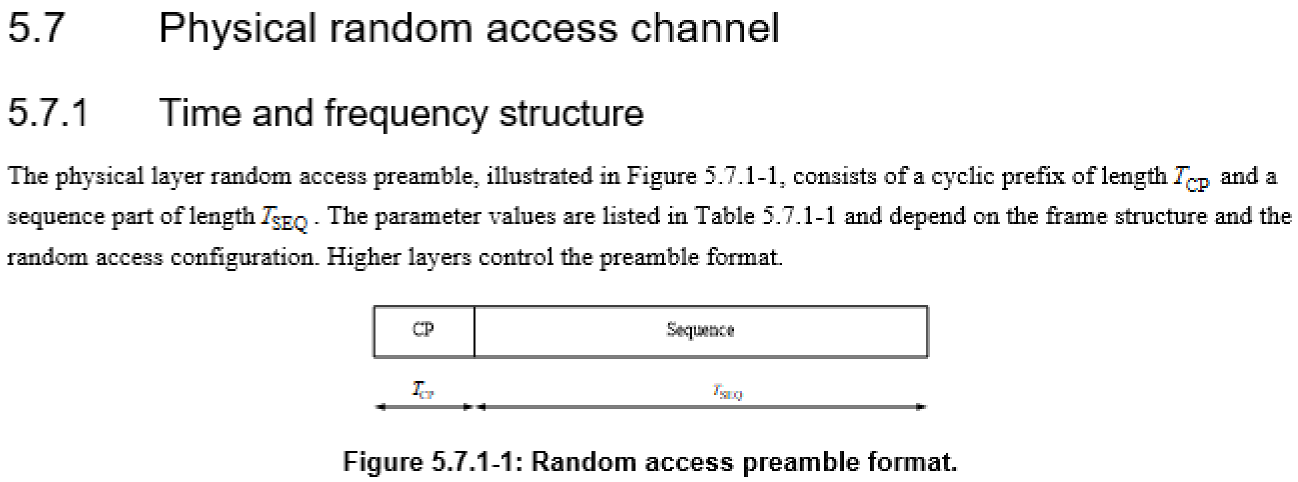
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

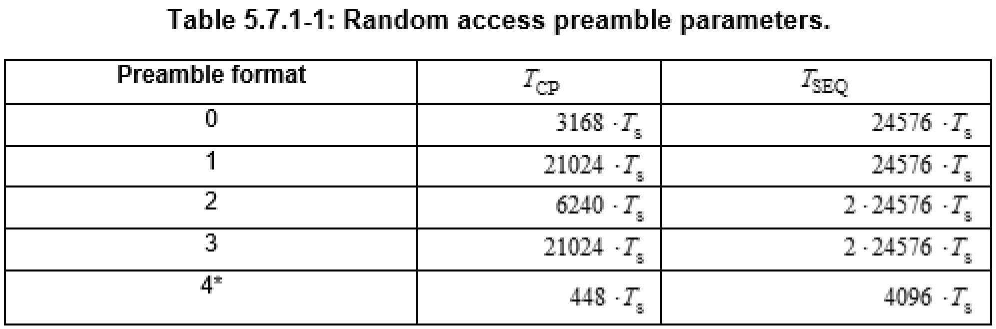
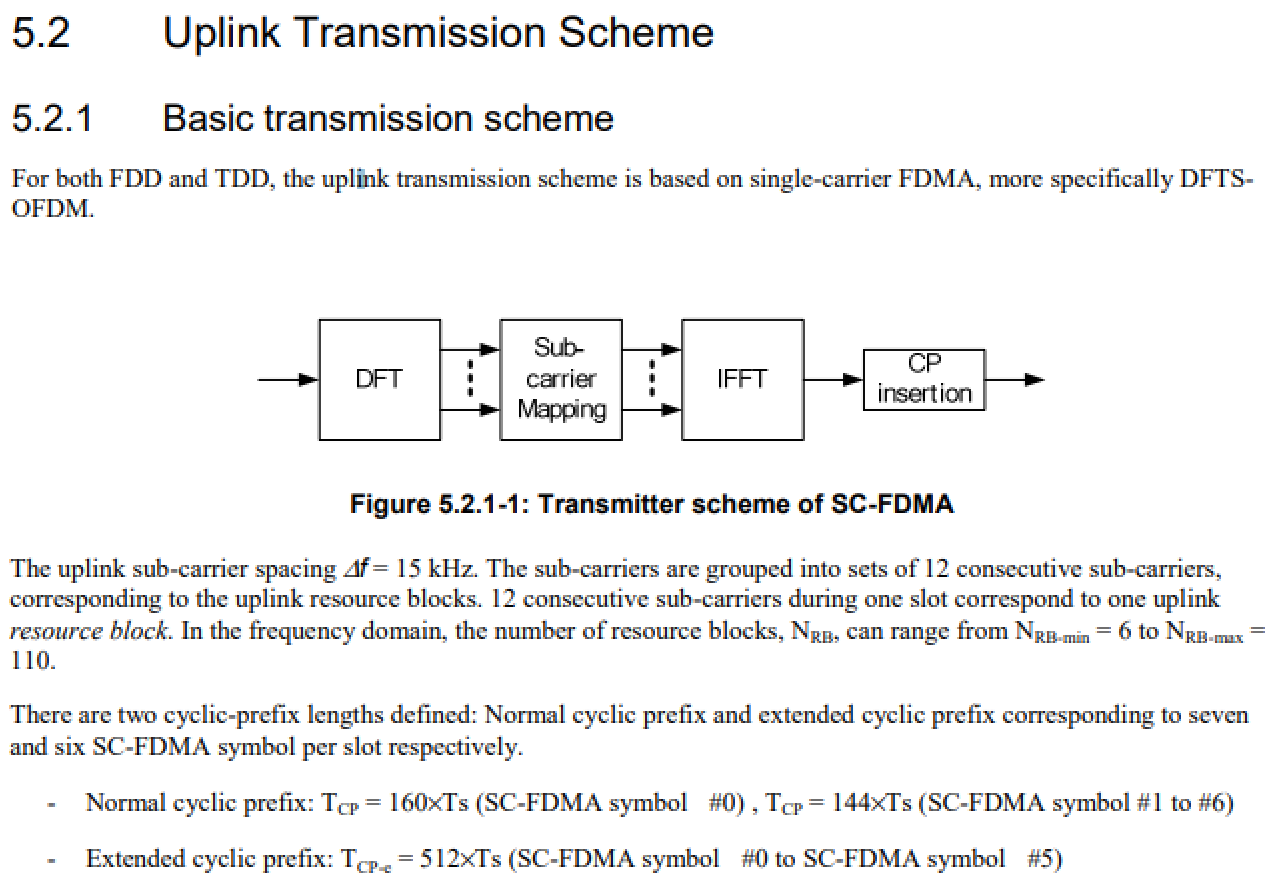


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	Volkswagen’s Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, Volkswagen’s Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)

"a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;"

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

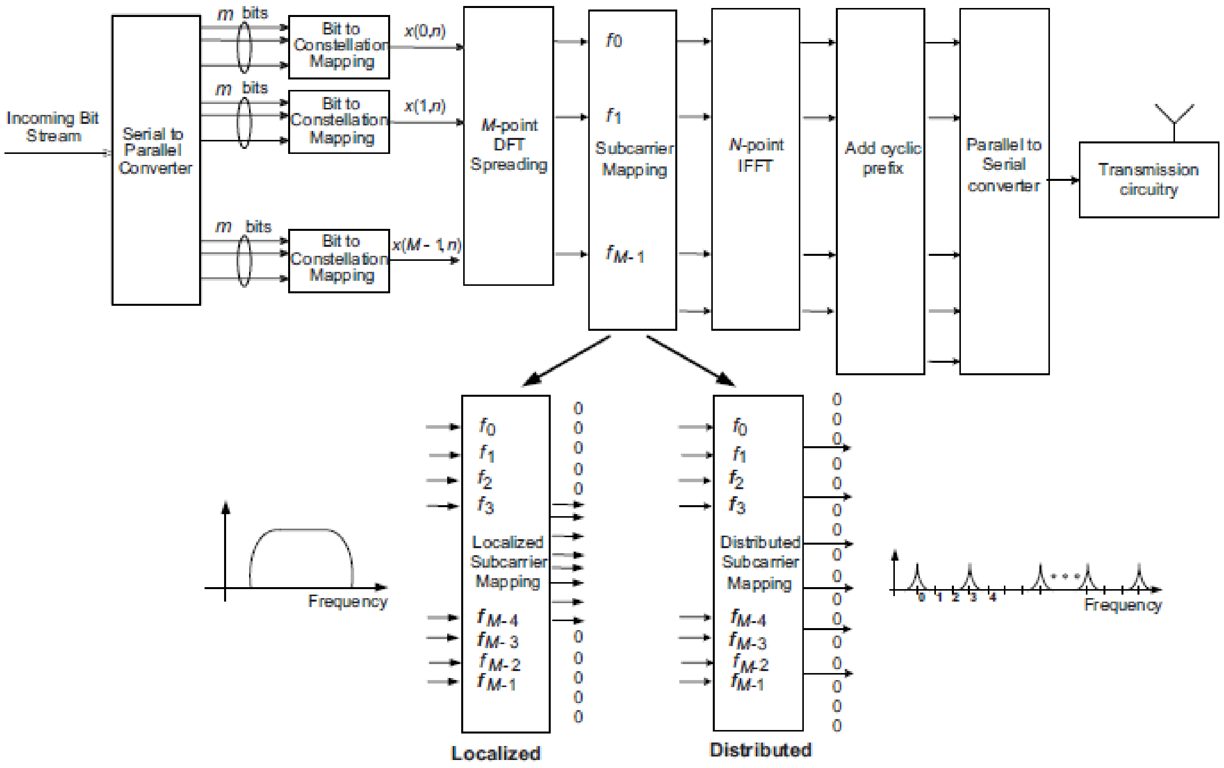
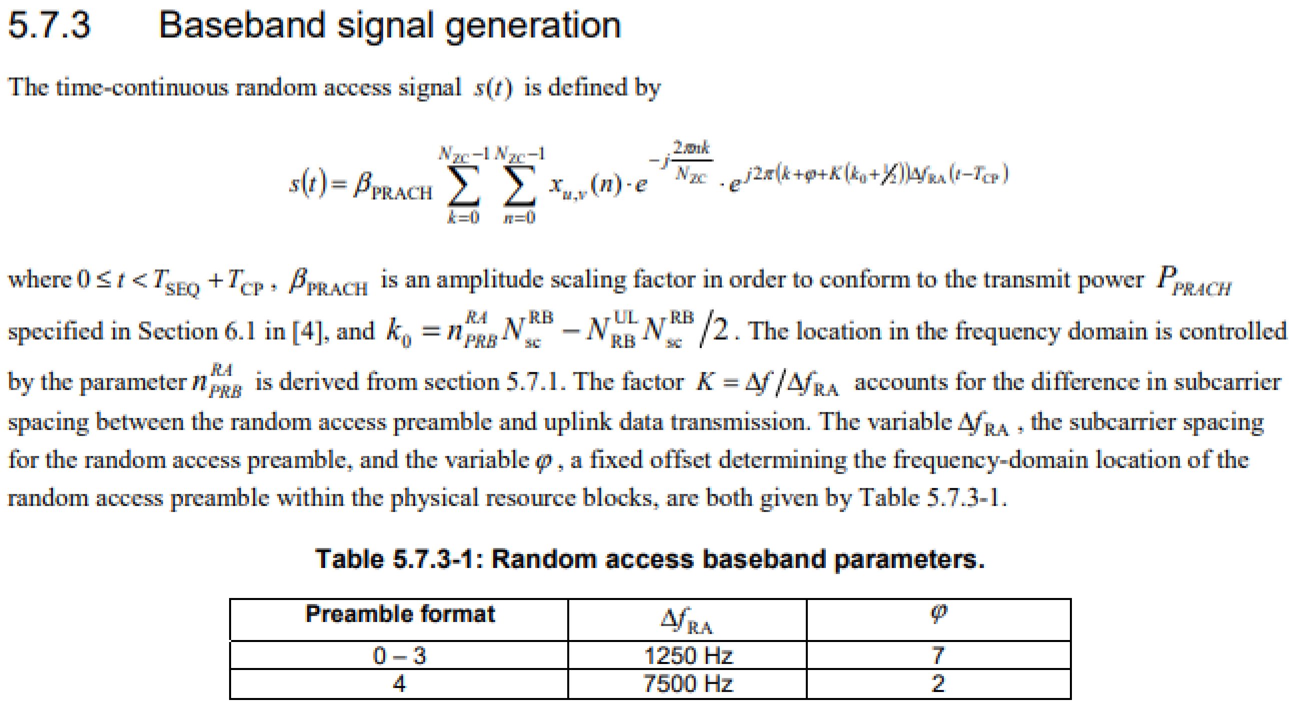


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

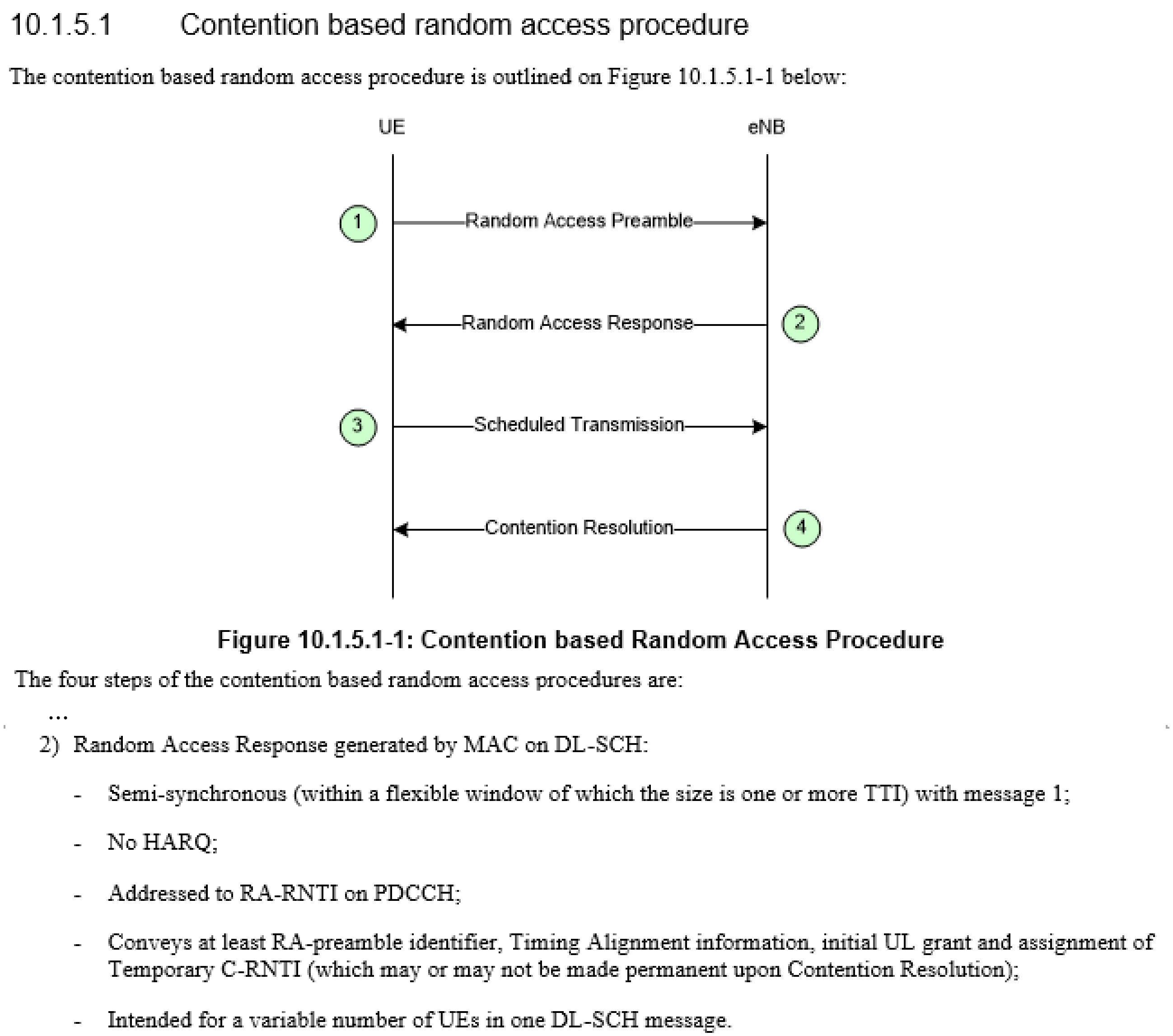
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 21(f)

“wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band”

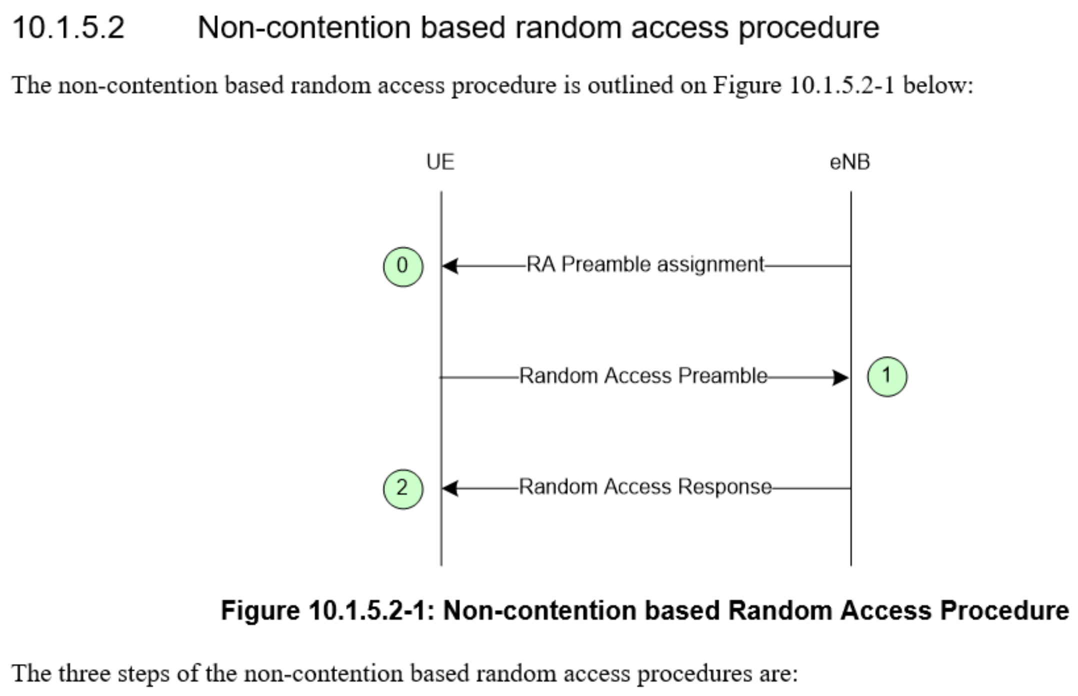
wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;	Volkswagen’s Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*, Random access signals are generated only for a portion of the frequency spectrum of an uplink.  **5.7.3 Baseband signal generation** The time-continuous random access signal $s(t)$ is defined by $s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$ where $0\le t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1. **Table 5.7.3-1: Random access baseband parameters.** Preamble format | Δf_{RA} | φ 0 – 3 | 1250 Hz | 7 4 | 7500 Hz | 2 See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

wherein the mobile station is further configured to receive, from the base station, a second analog signal	Volkswagen's Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



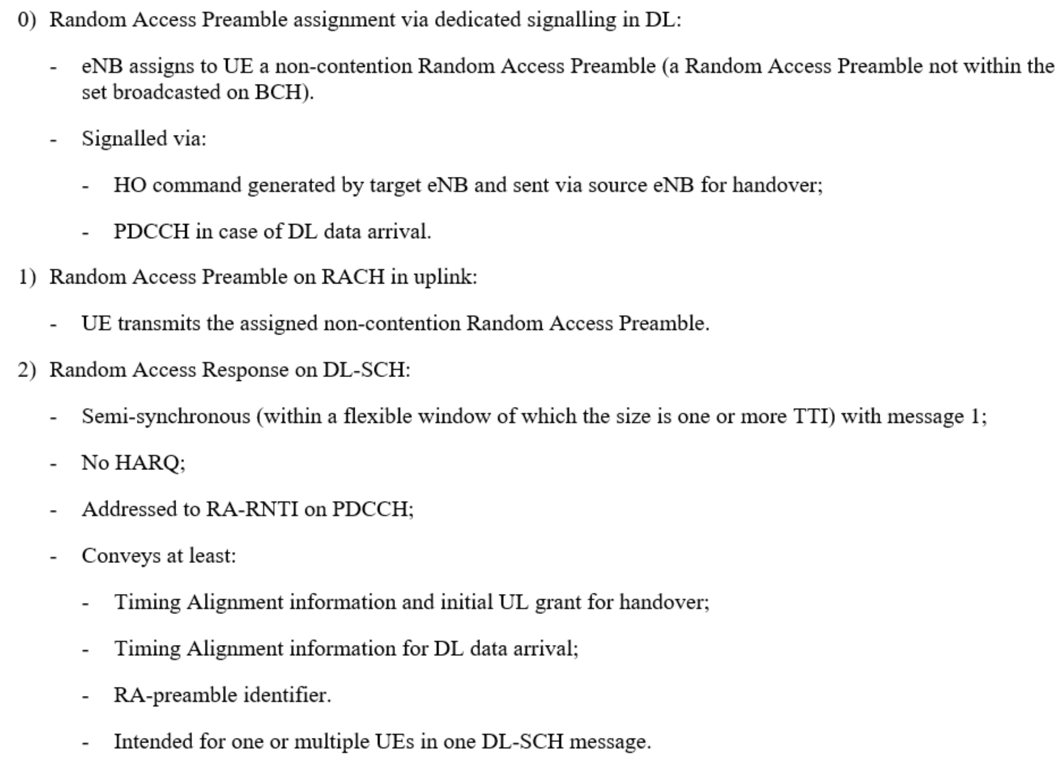
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

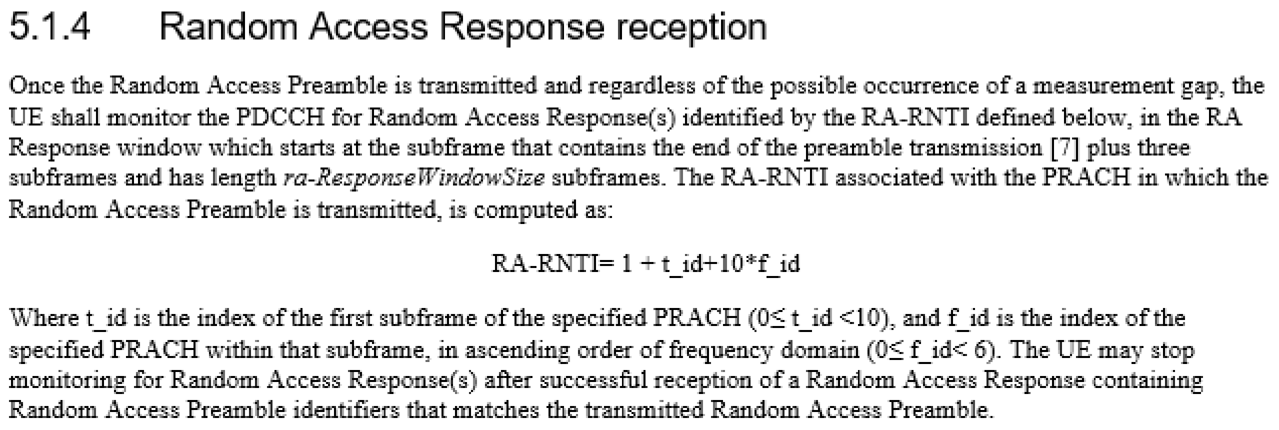


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



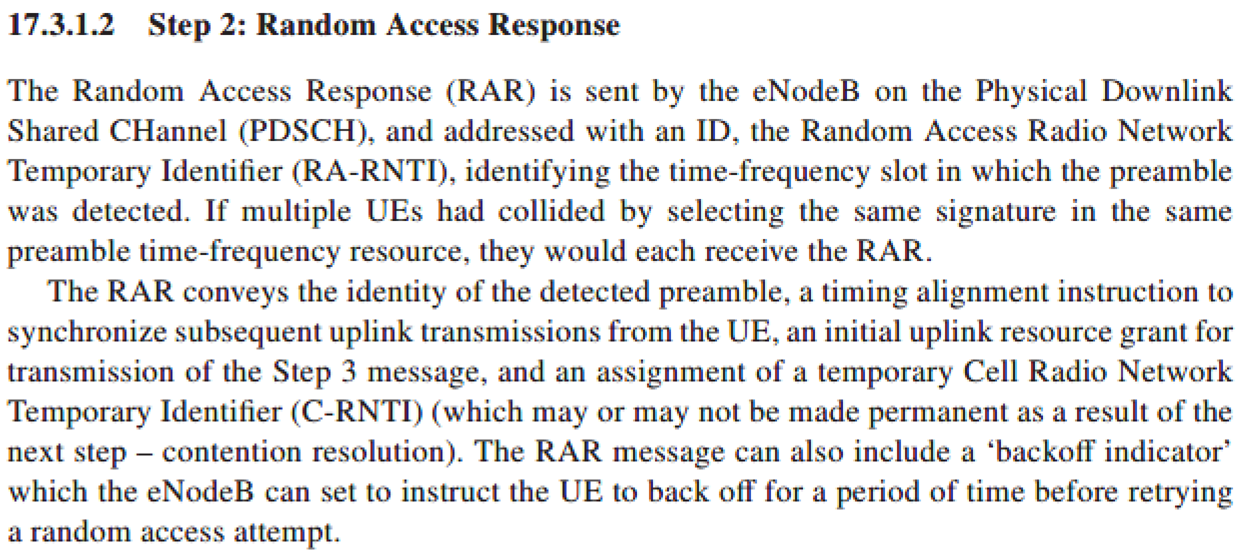
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.



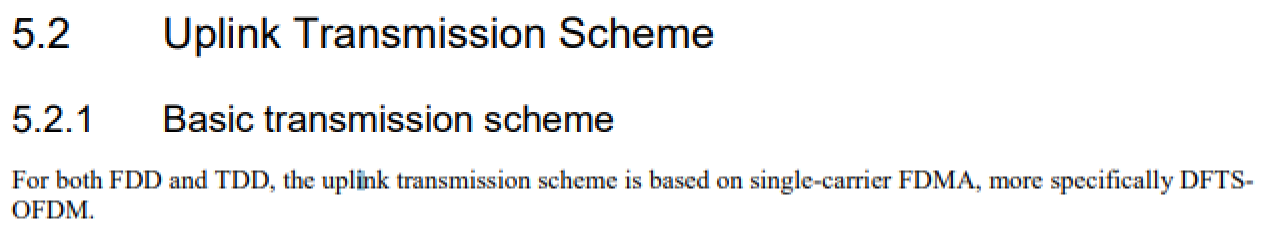
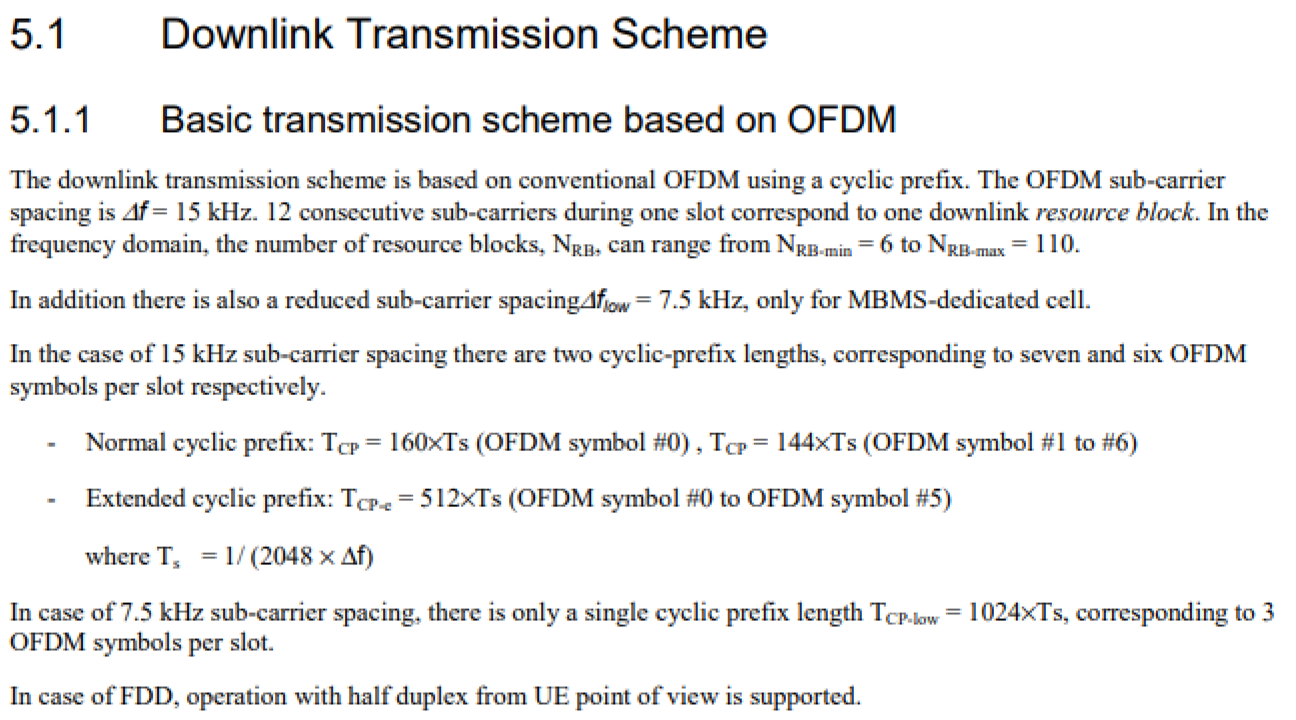
17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	Volkswagen's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, Volkswagen's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.  **5.1 Downlink Transmission Scheme** **5.1.1 Basic transmission scheme based on OFDM** The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. In addition there is also a reduced sub-carrier spacing $\Delta f_{low} = 7.5$ kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

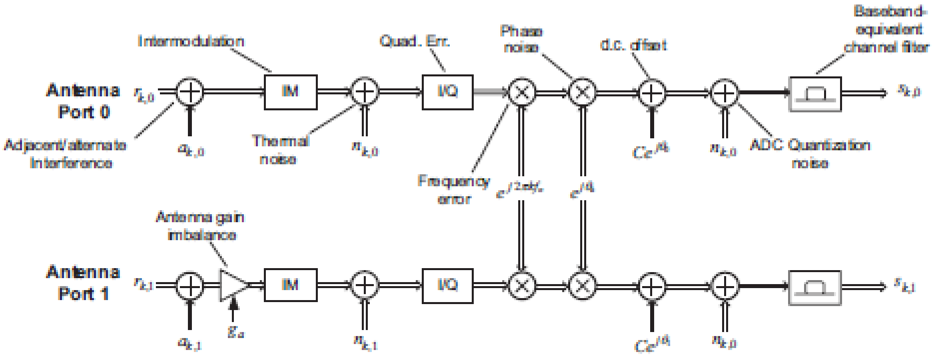
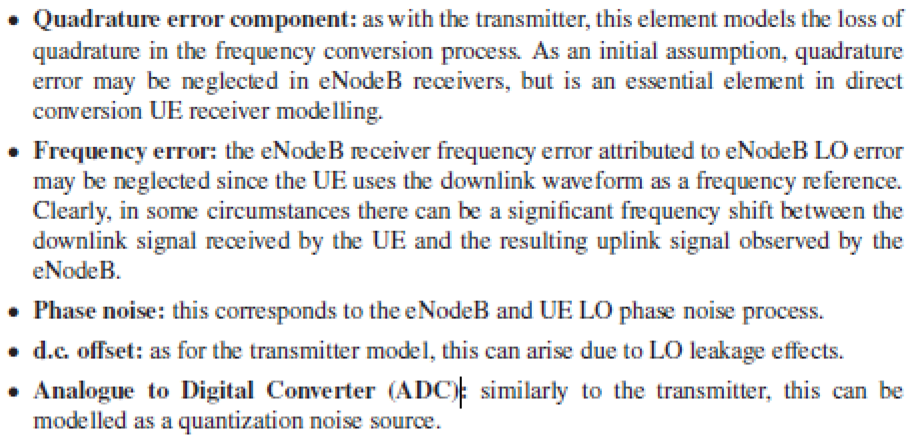


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.


- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

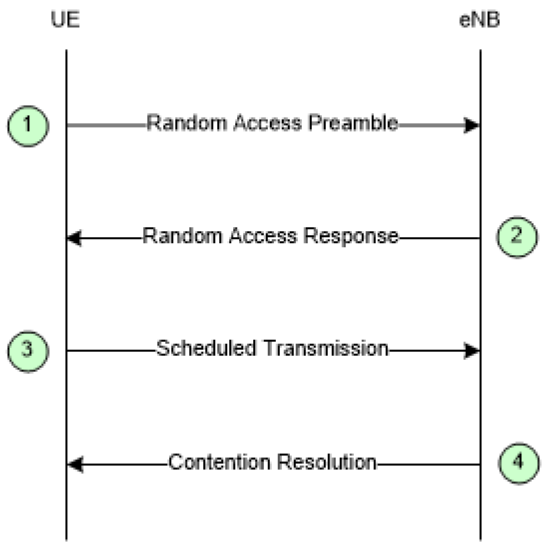


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

…

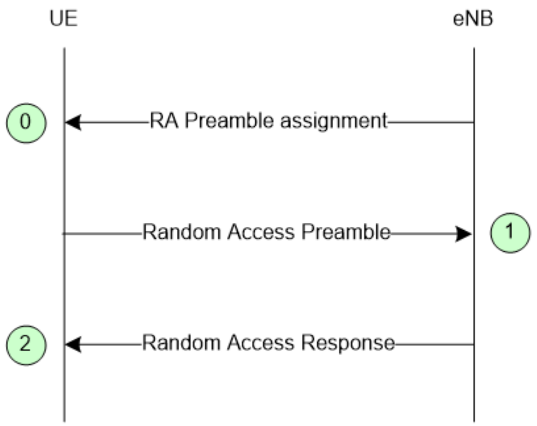
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

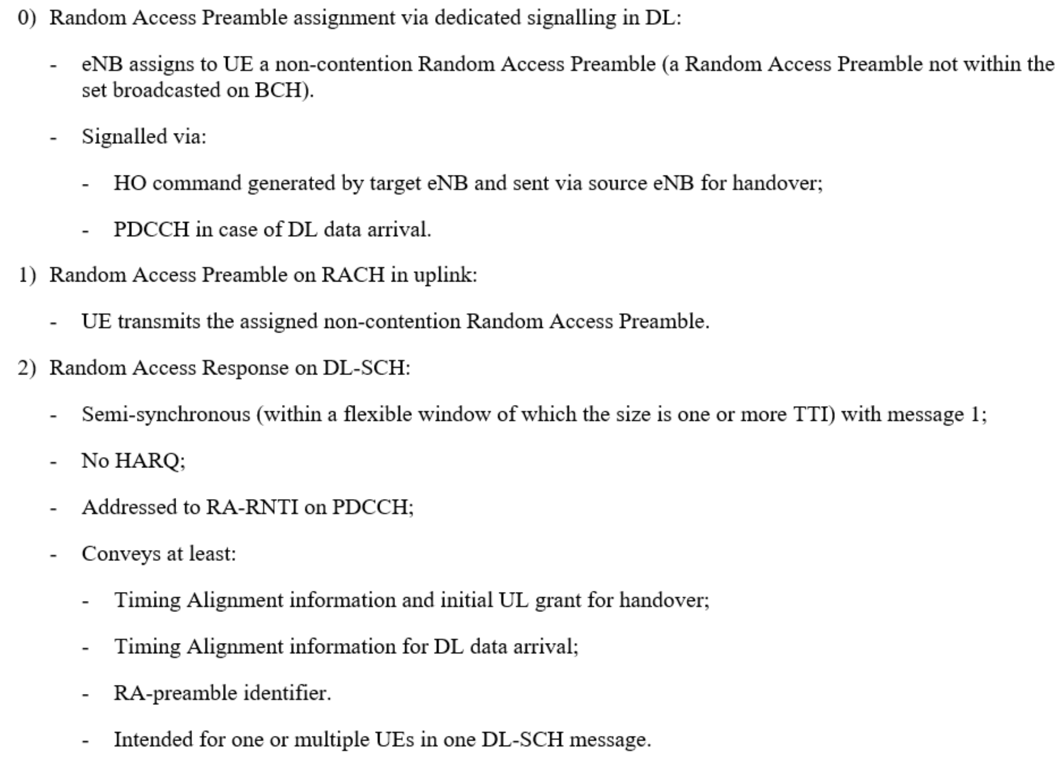
US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

	10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

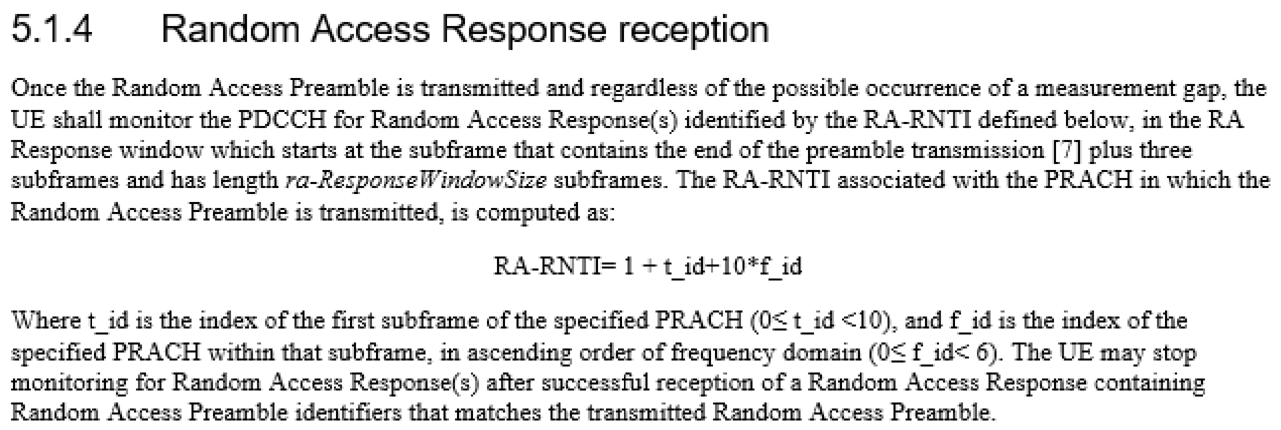


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



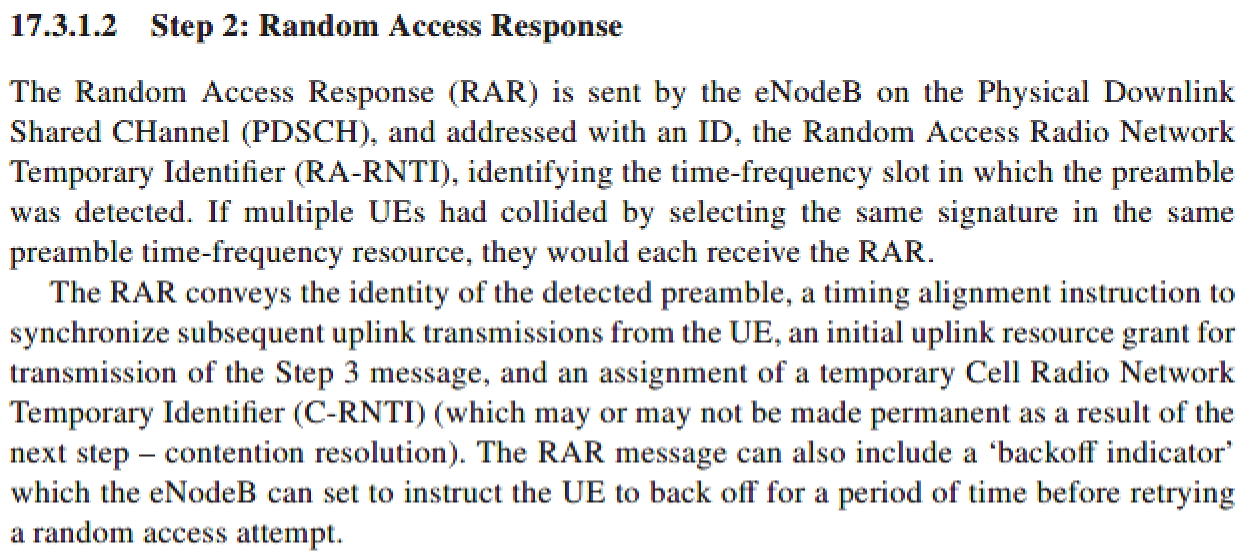
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

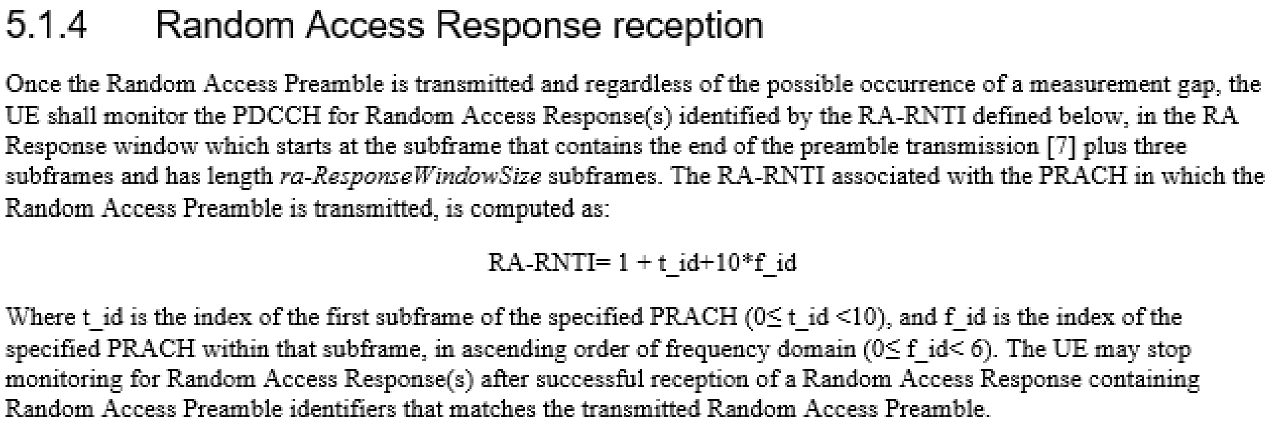
US Patent No. 10,833,908: Claim 21(h)
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

	See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

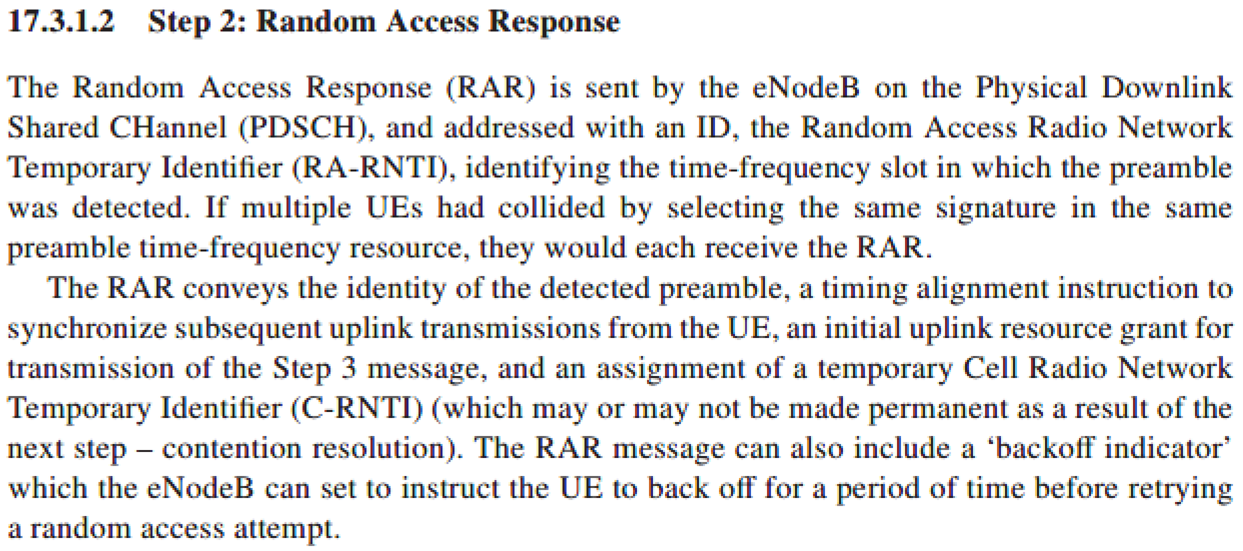
US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

22. The mobile station of claim 21, wherein:	*See* Claim 21.

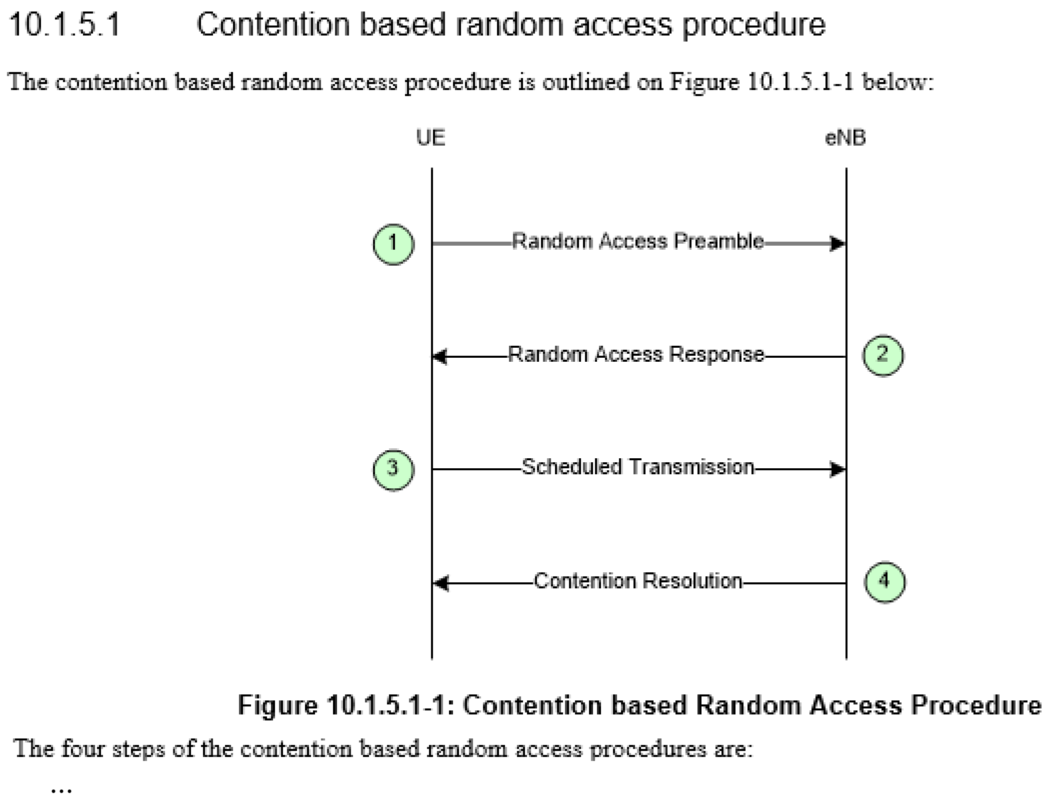
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	Volkswagen’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

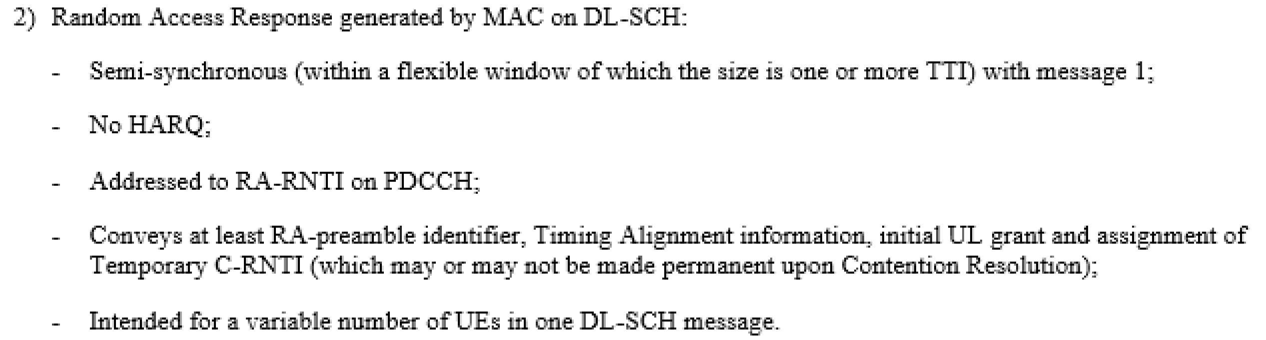
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Volkswagen’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

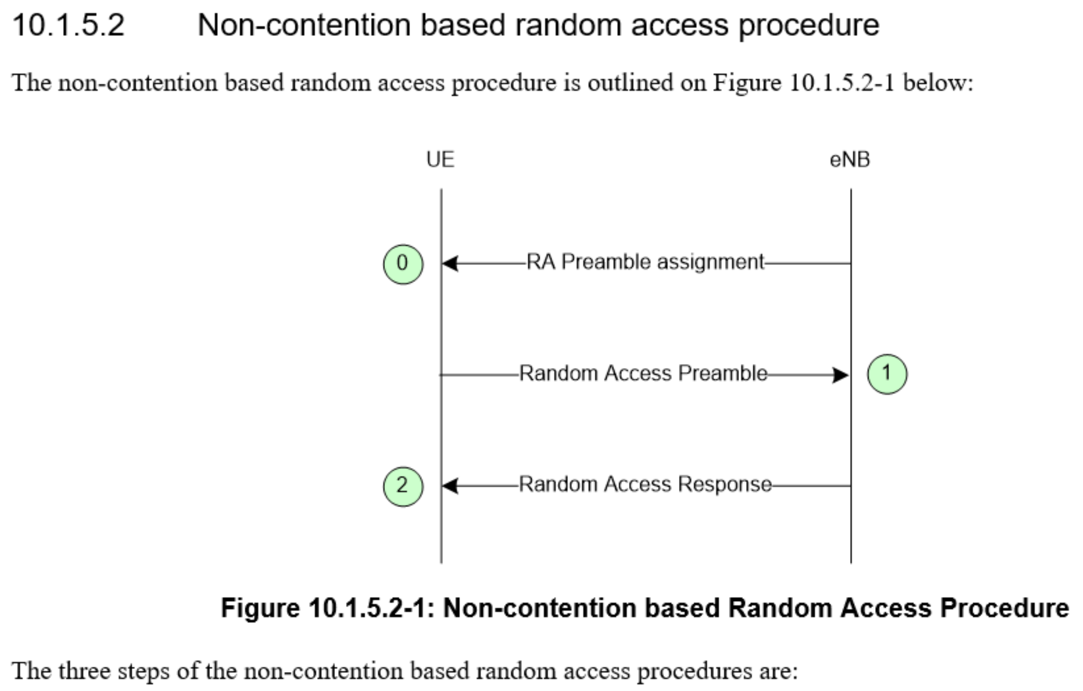
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



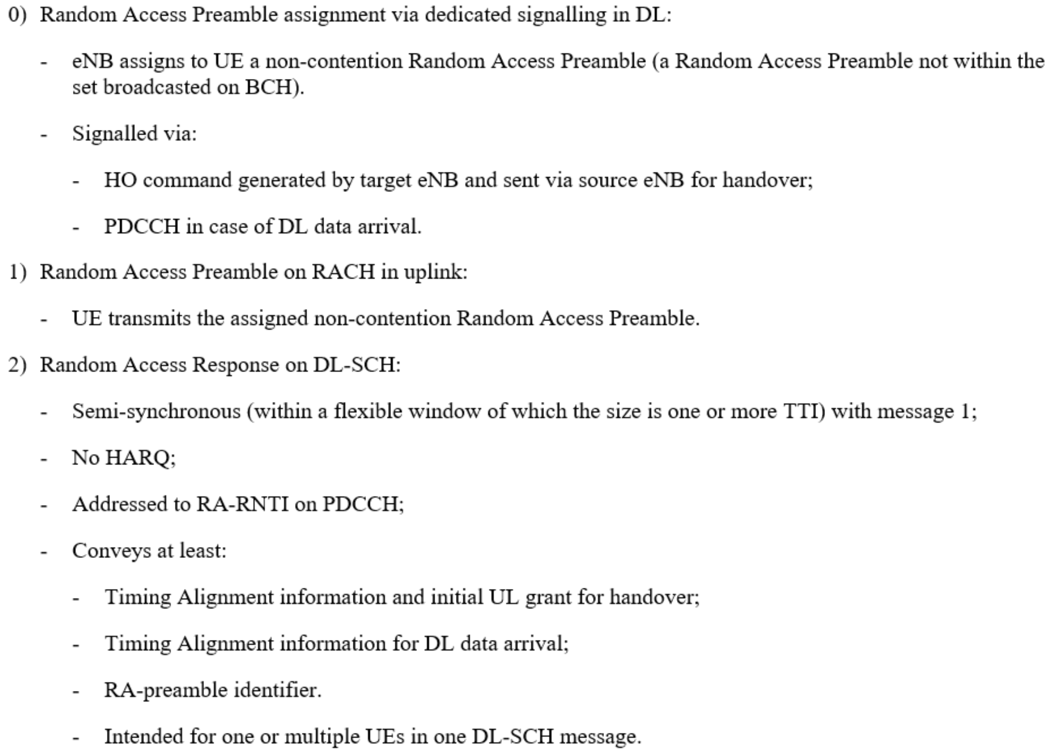
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

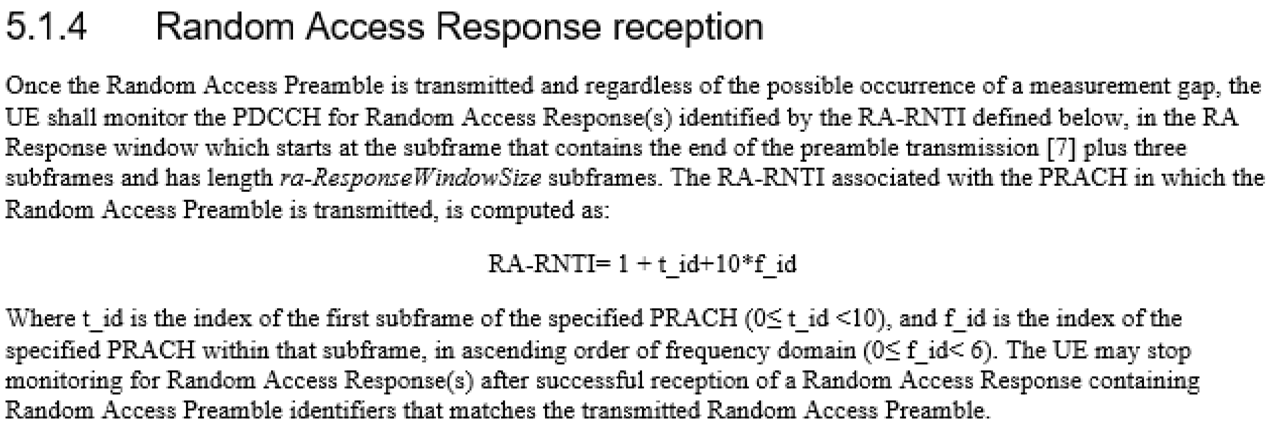


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

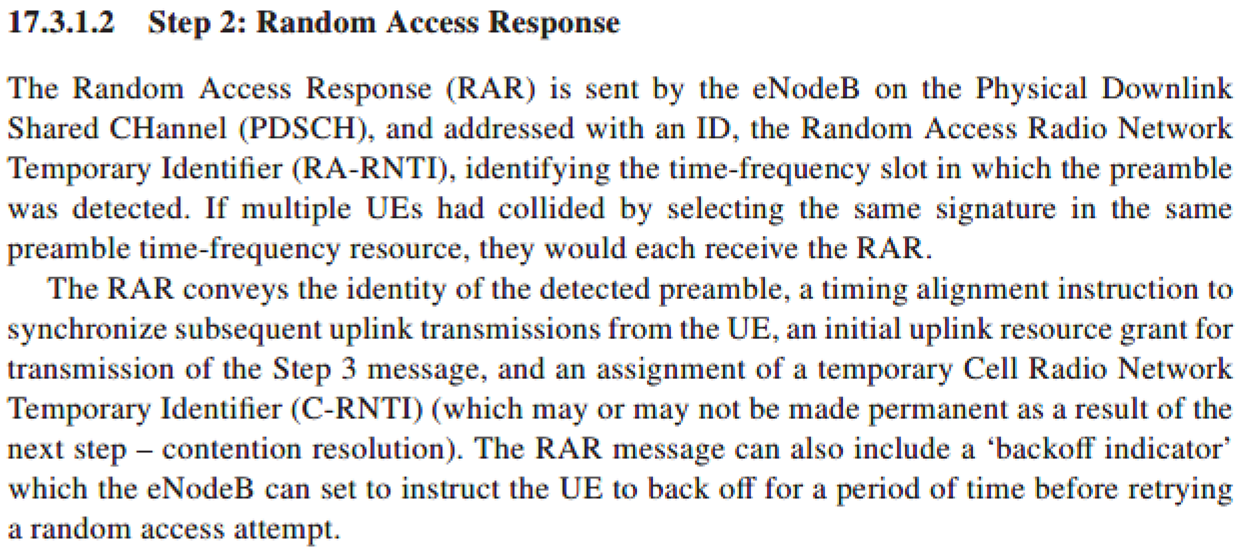
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

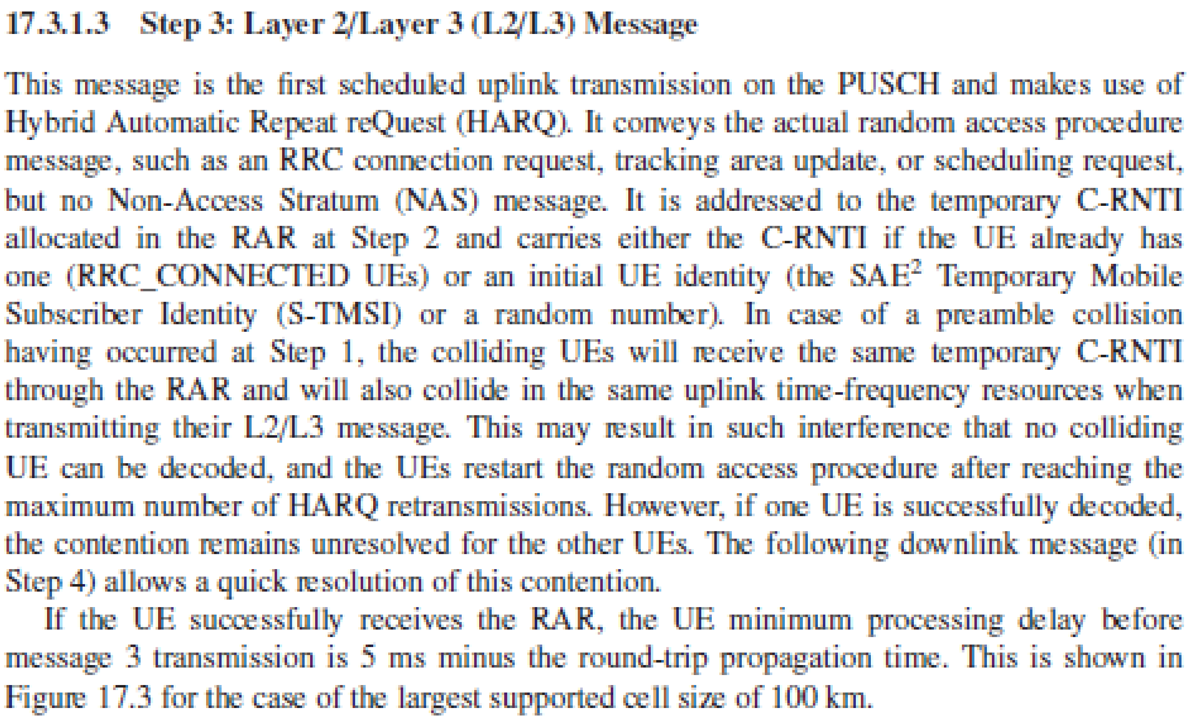
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

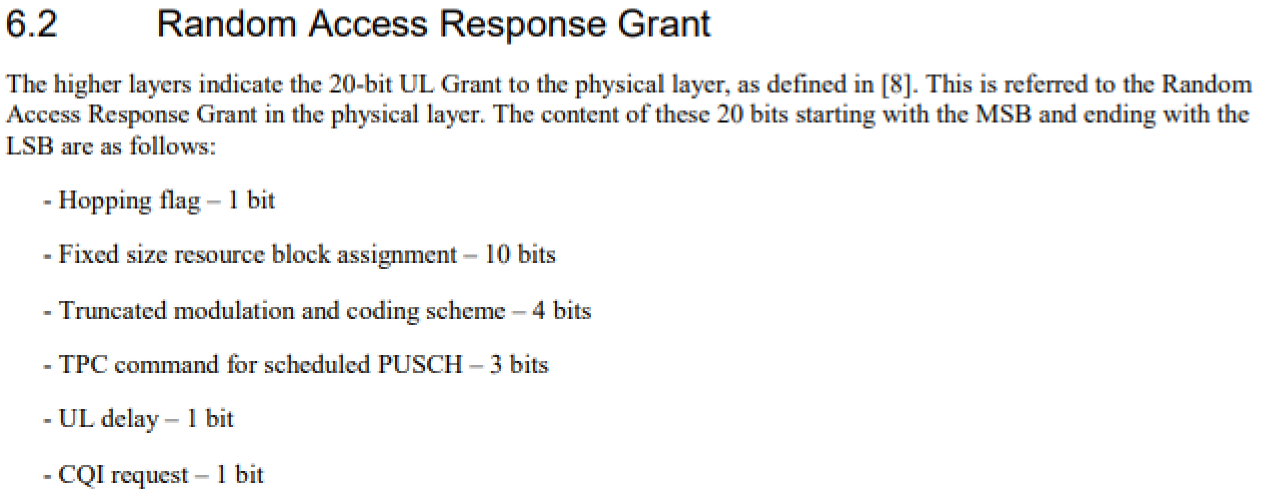
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

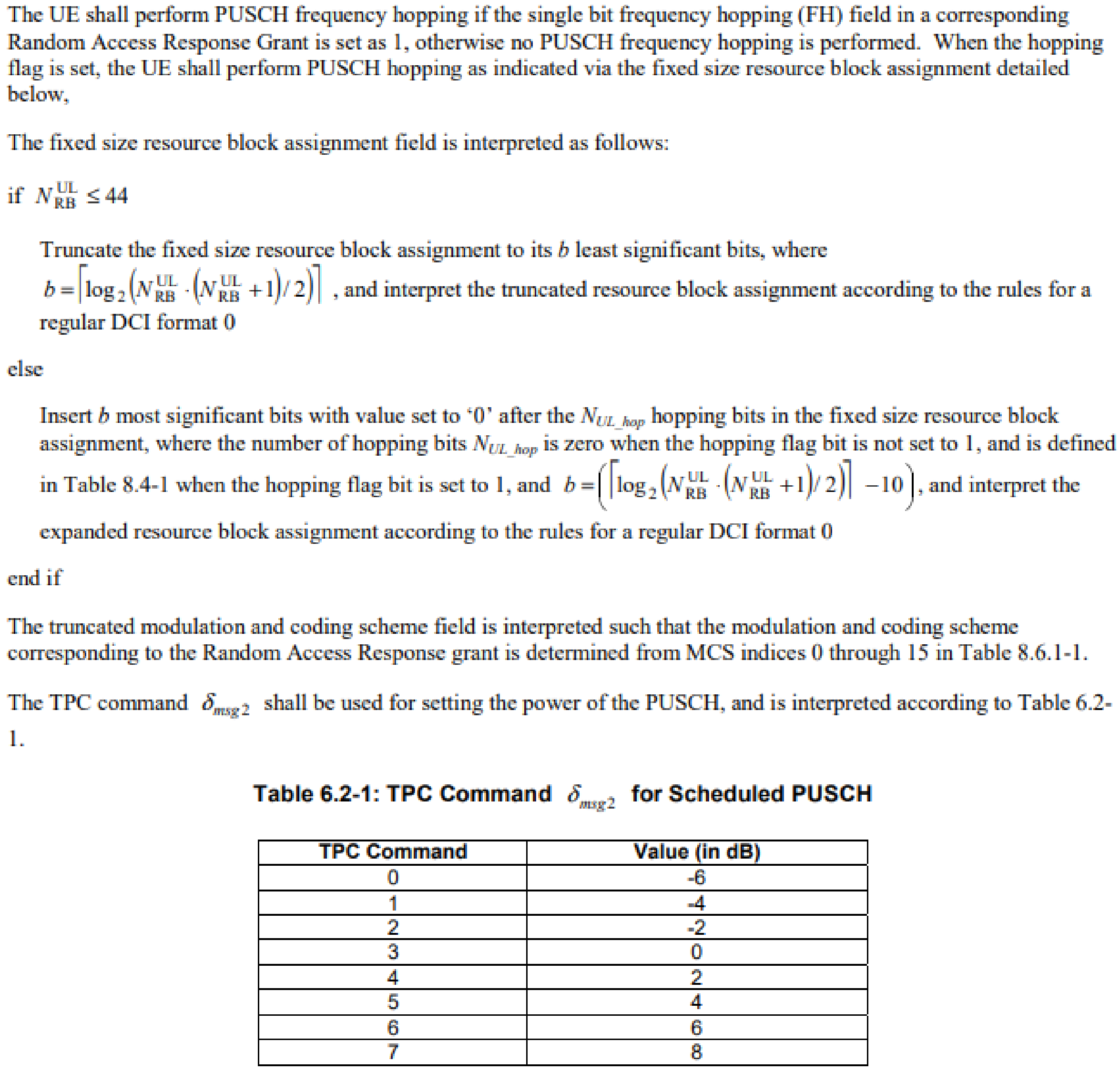
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by Volkswagen's Accused Instrumentalities includes power adjustment information. *E.g.,* *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
“The mobile station of claim 22, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

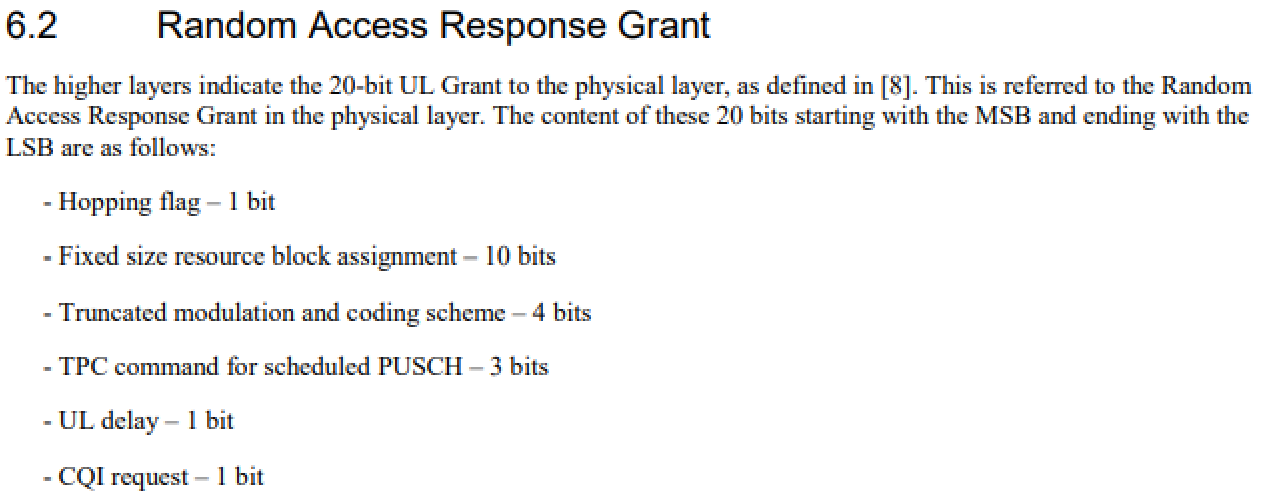
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

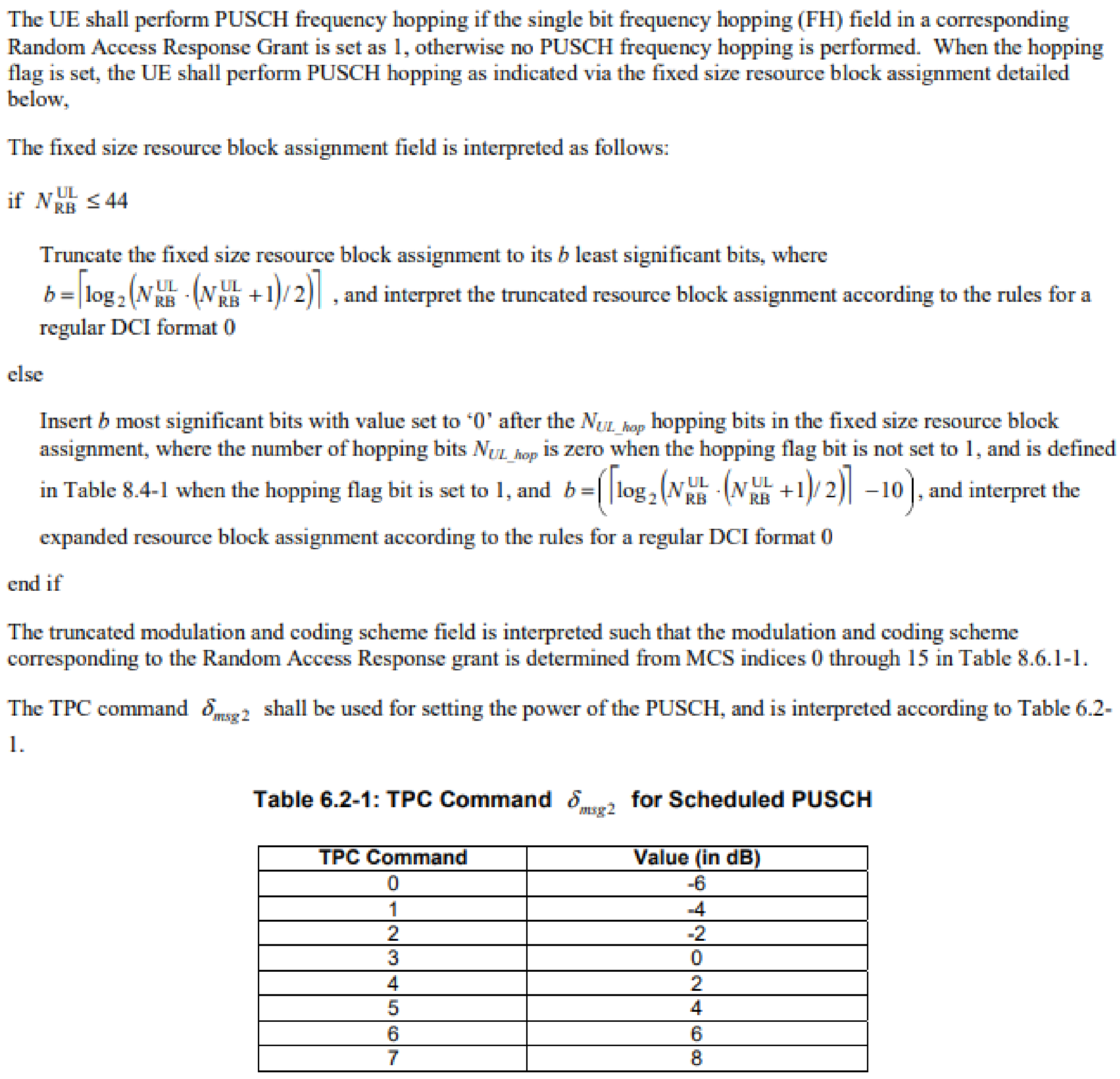
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	Volkswagen’s Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

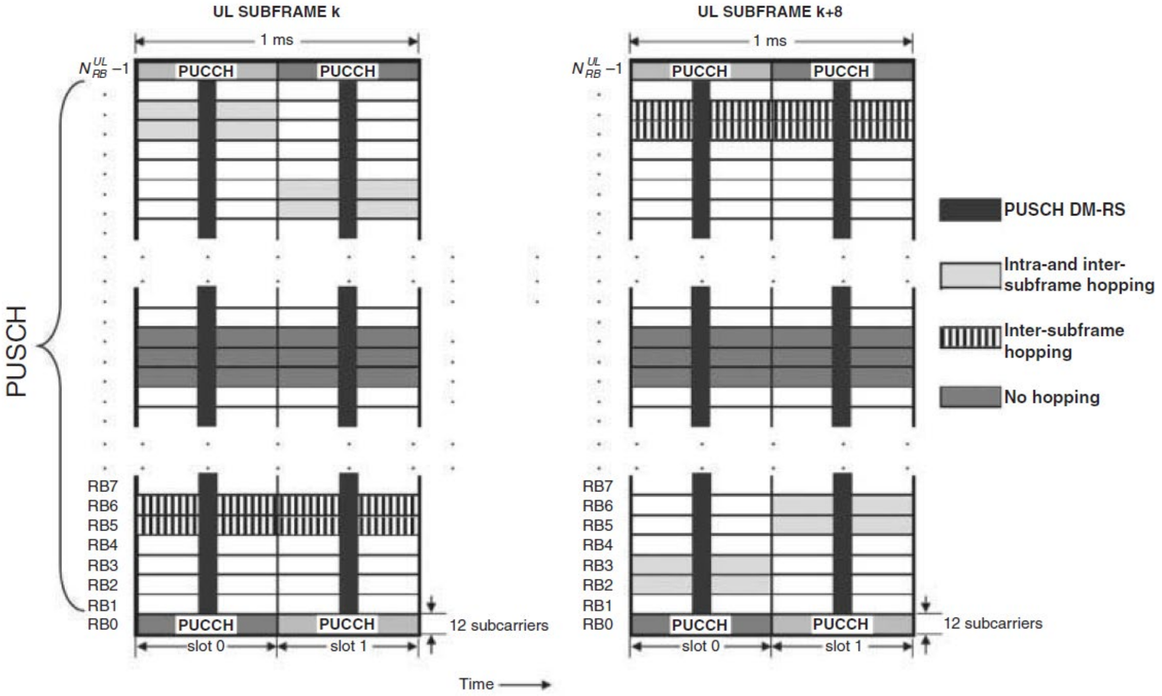
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

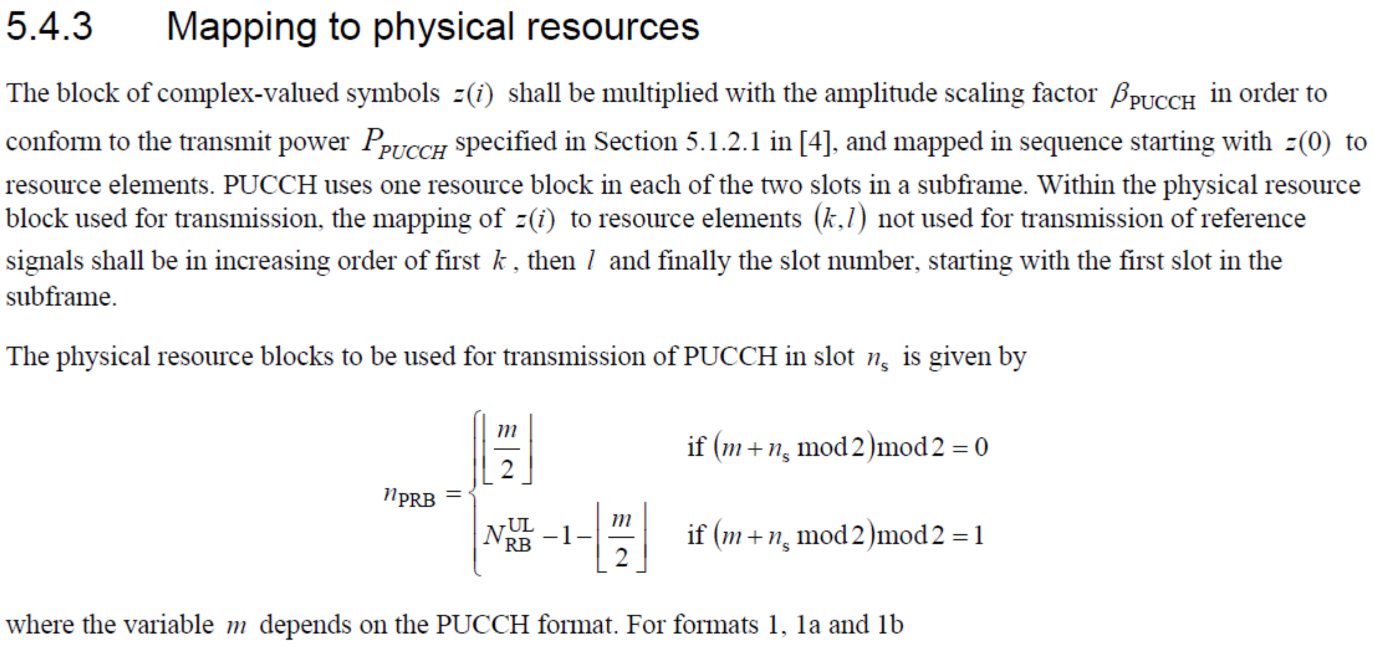
See also Claim 3.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Volkswagen’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

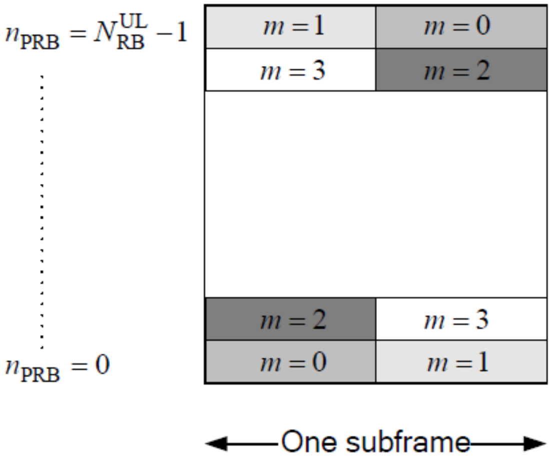


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

...

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

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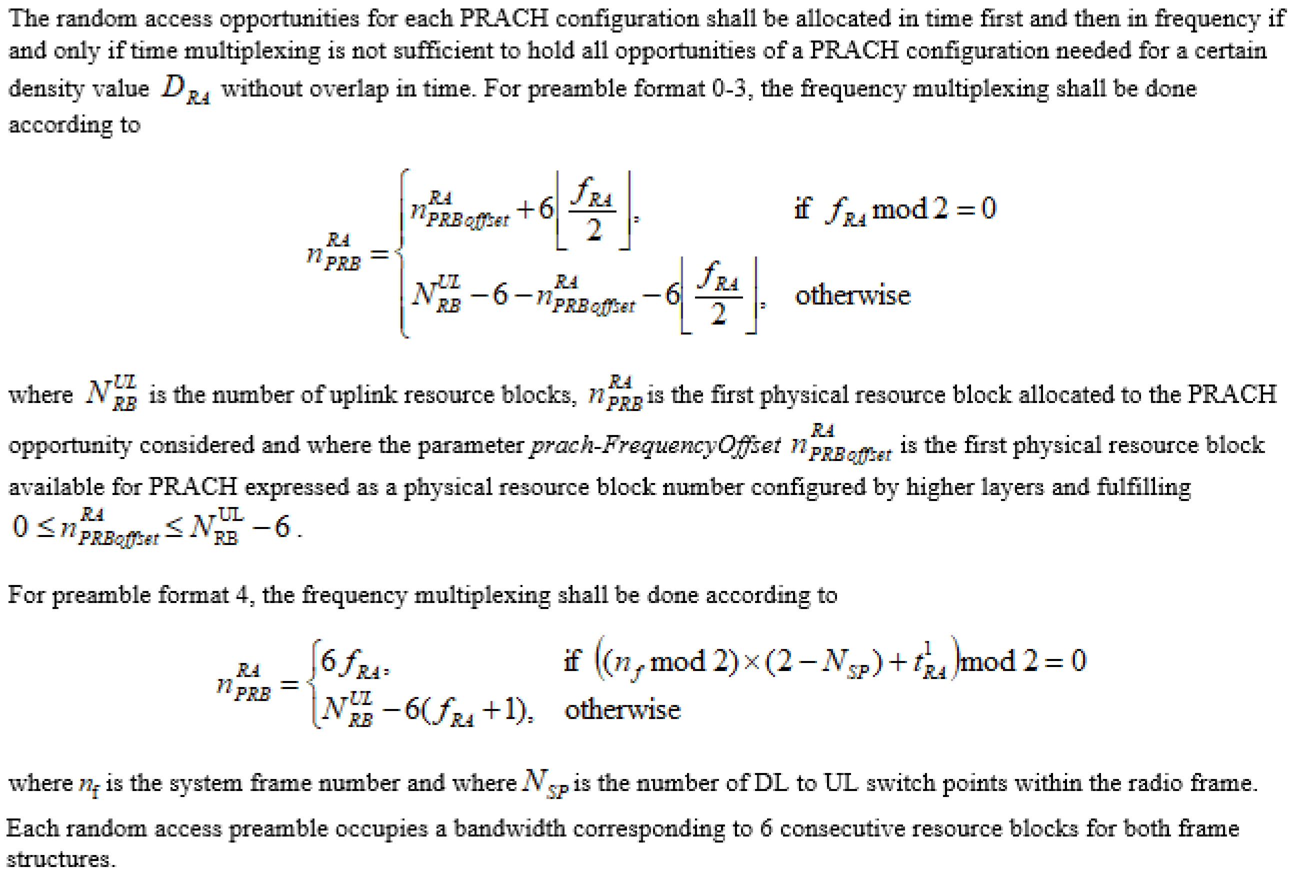

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.
</td>
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</table>

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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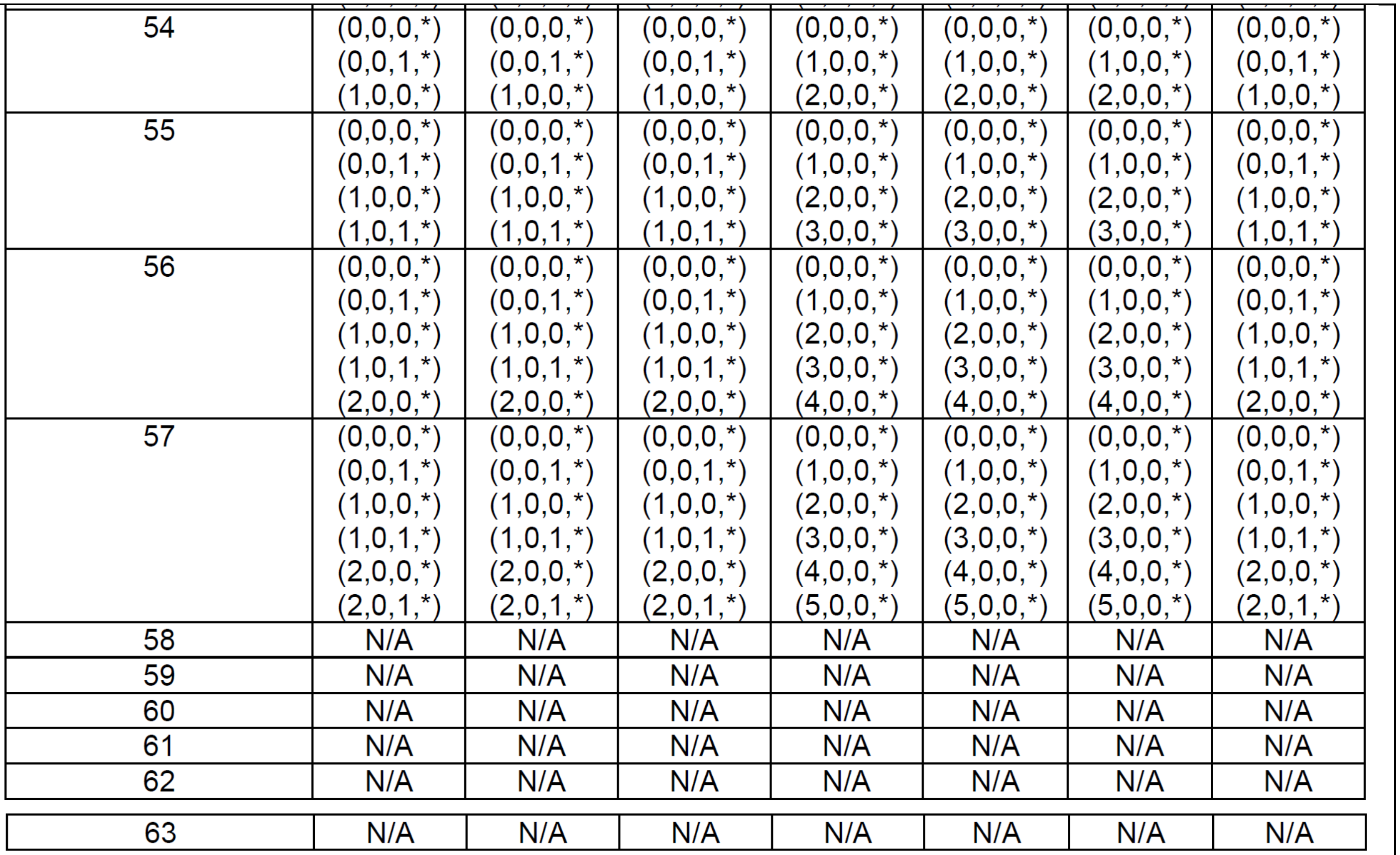
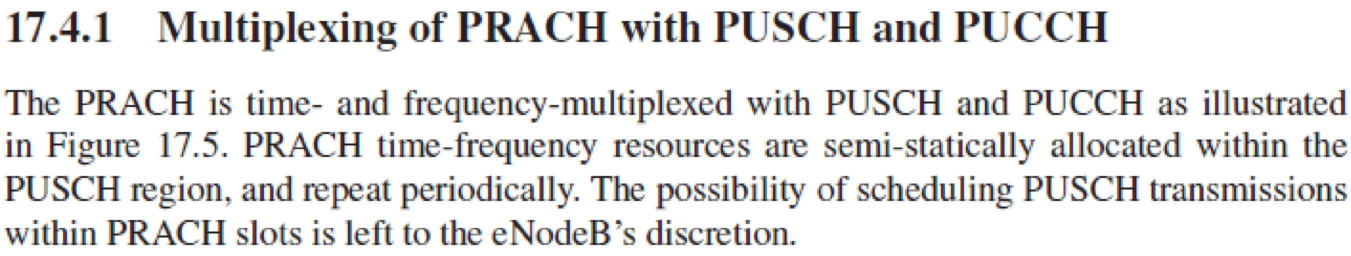


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

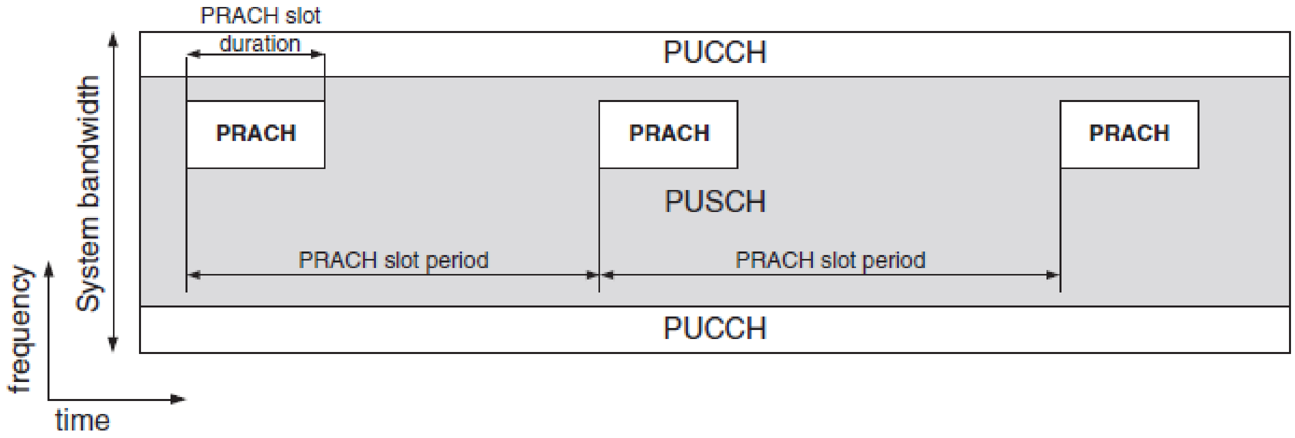
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



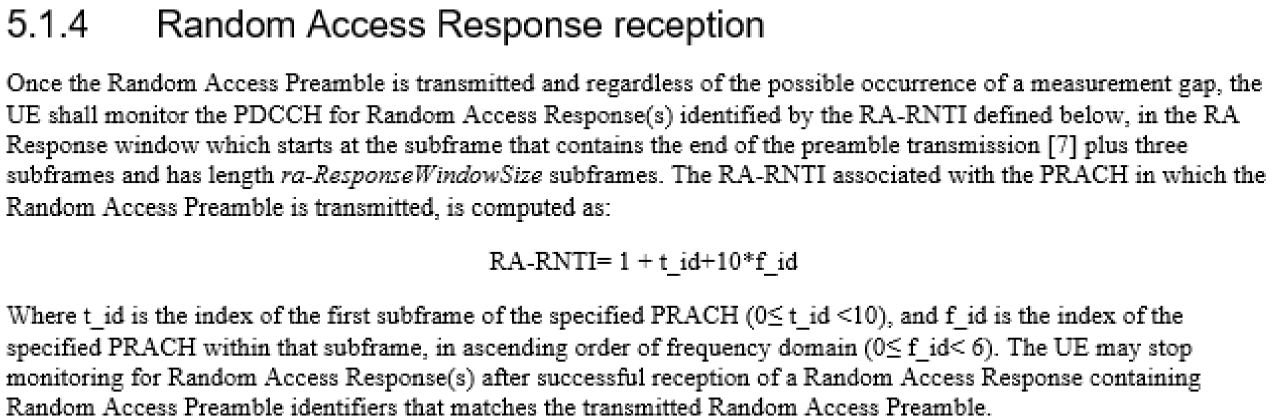
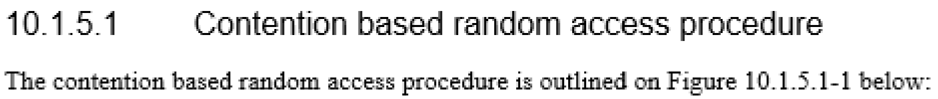
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

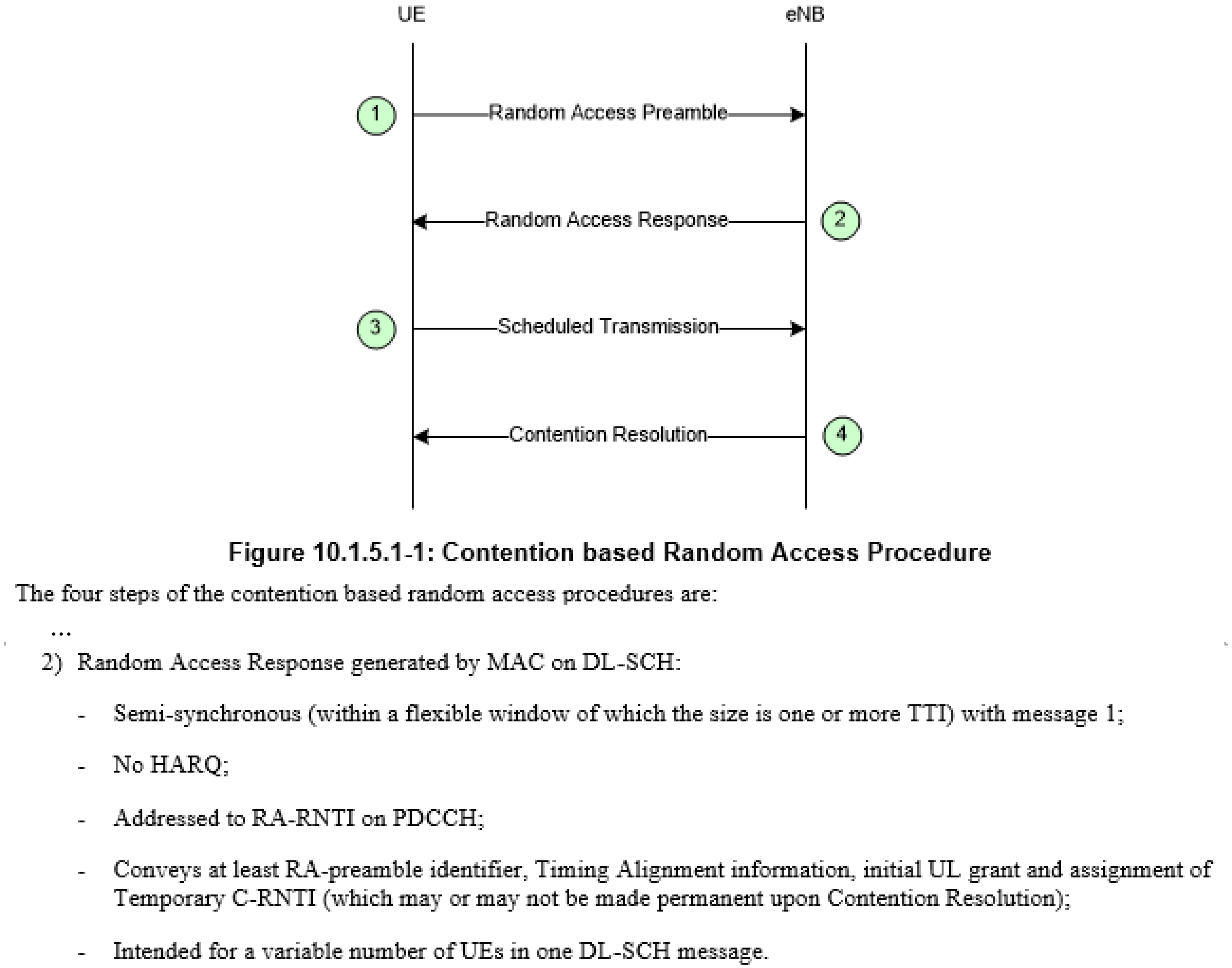
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

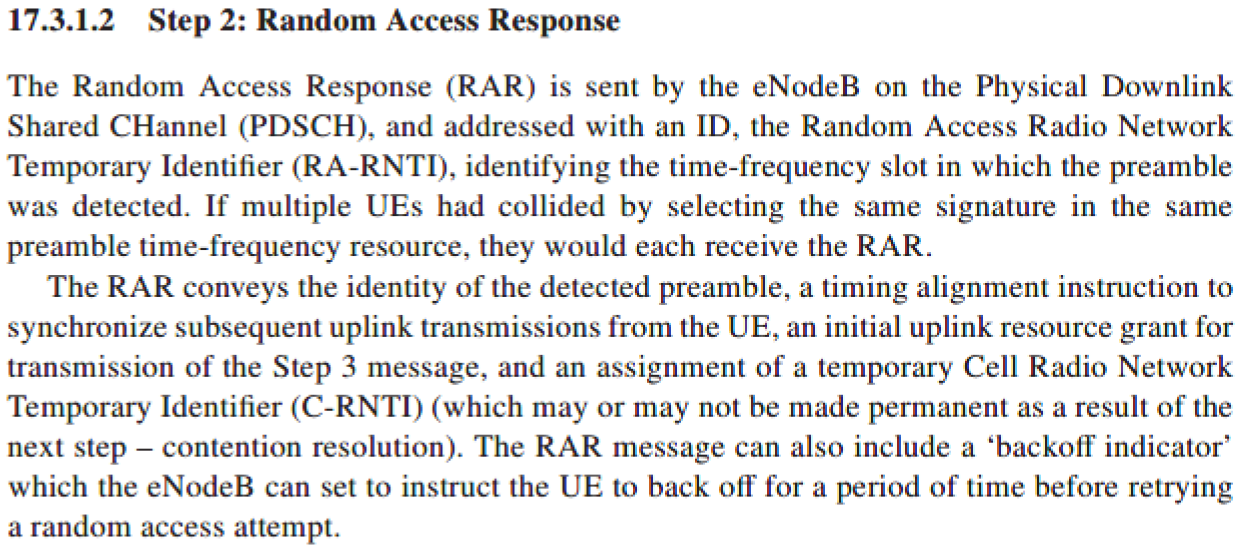
25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Volkswagen's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  **5.1.4 Random Access Response reception** Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\le t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\le f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **10.1.5.1 Contention based random access procedure** The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: ... 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25
“25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

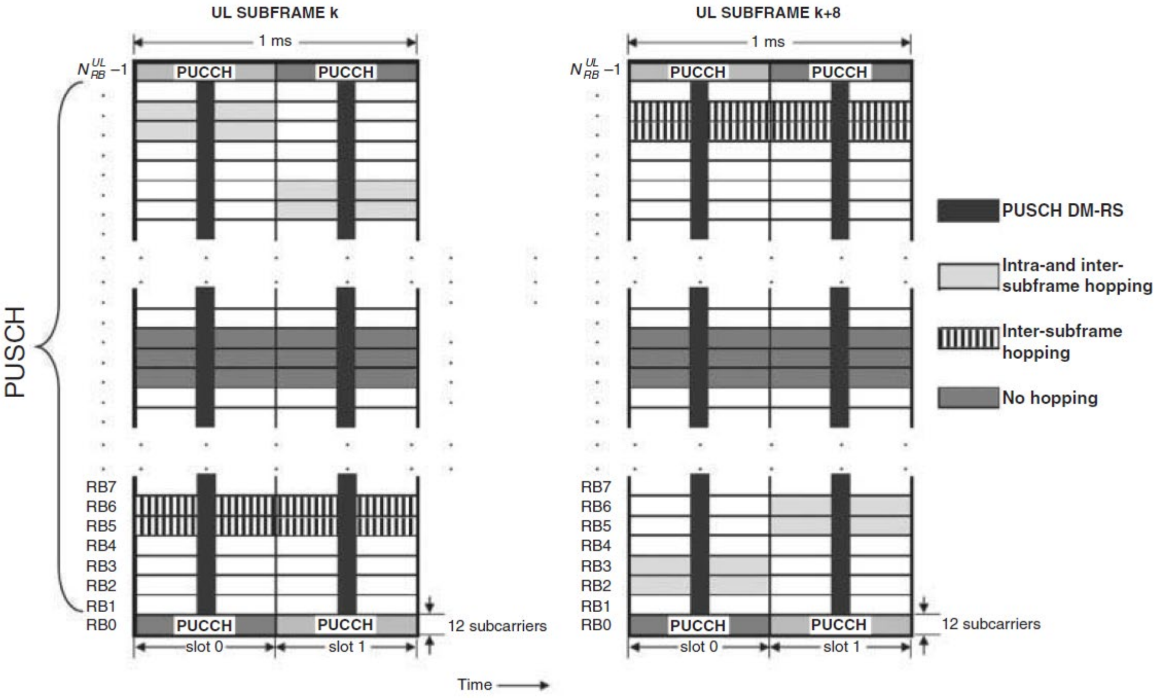
US Patent No. 10,833,908: Claim 26

"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Volkswagen's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

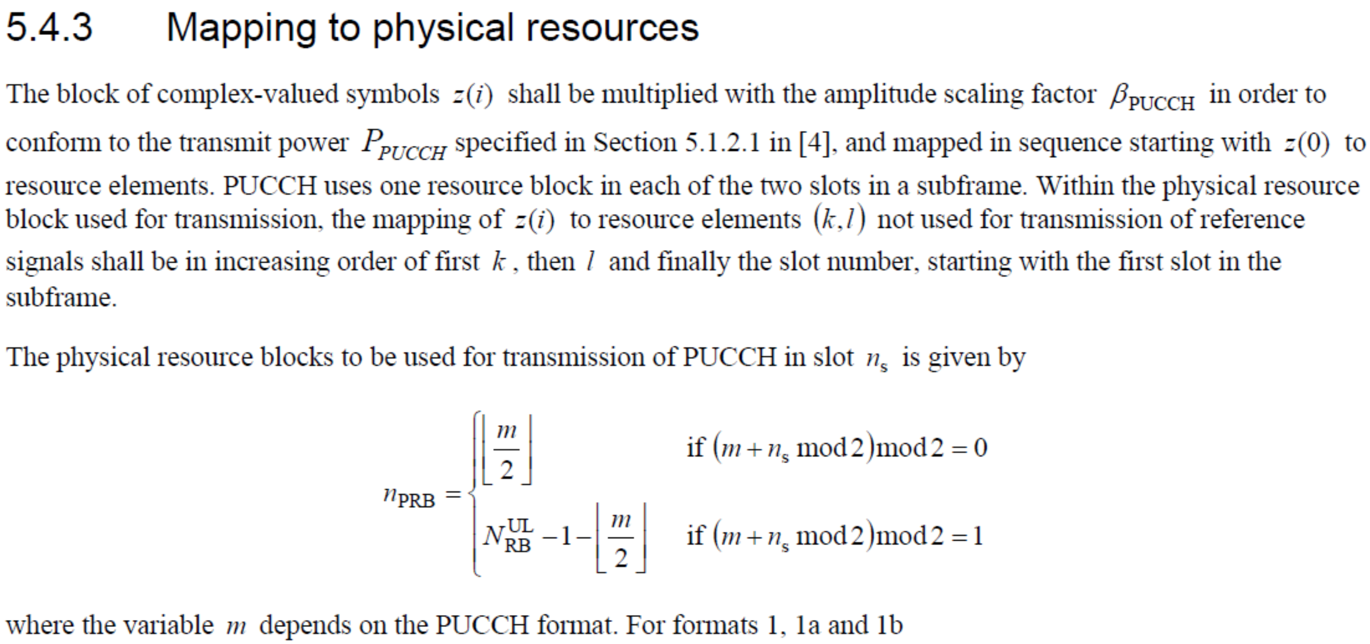
27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Volkswagen's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

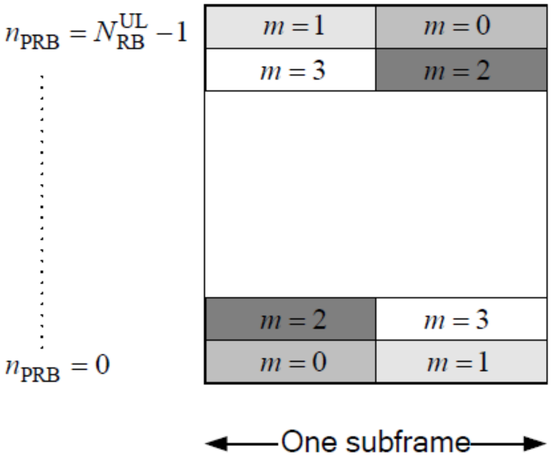
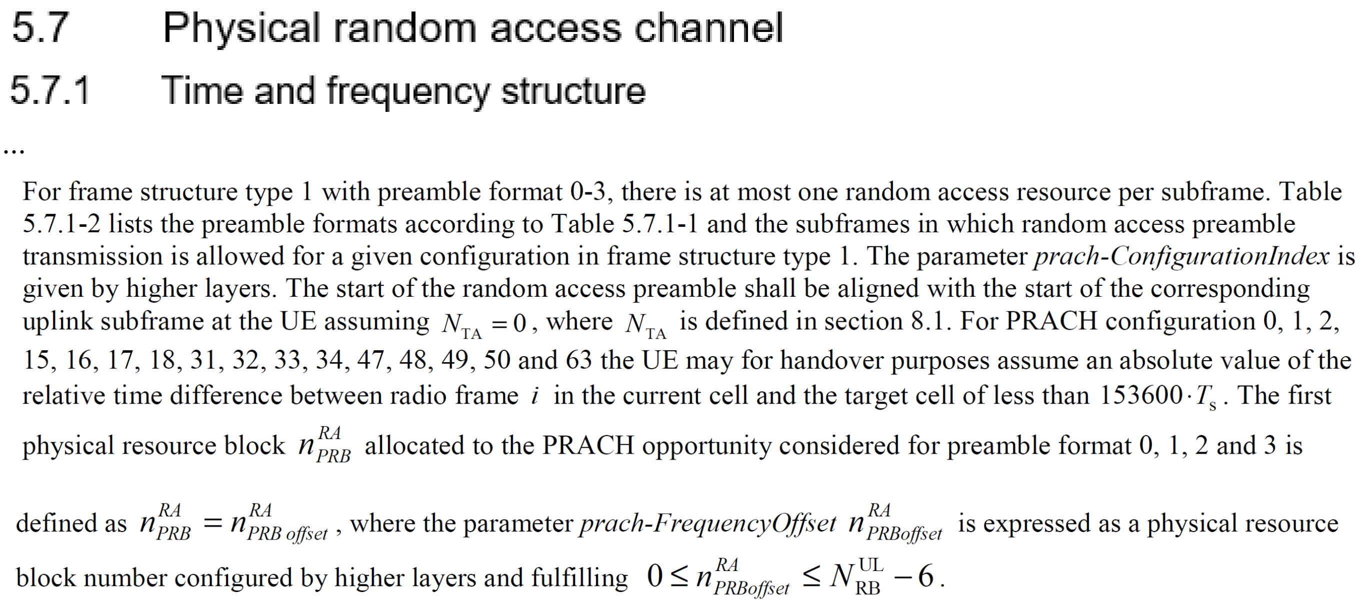


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

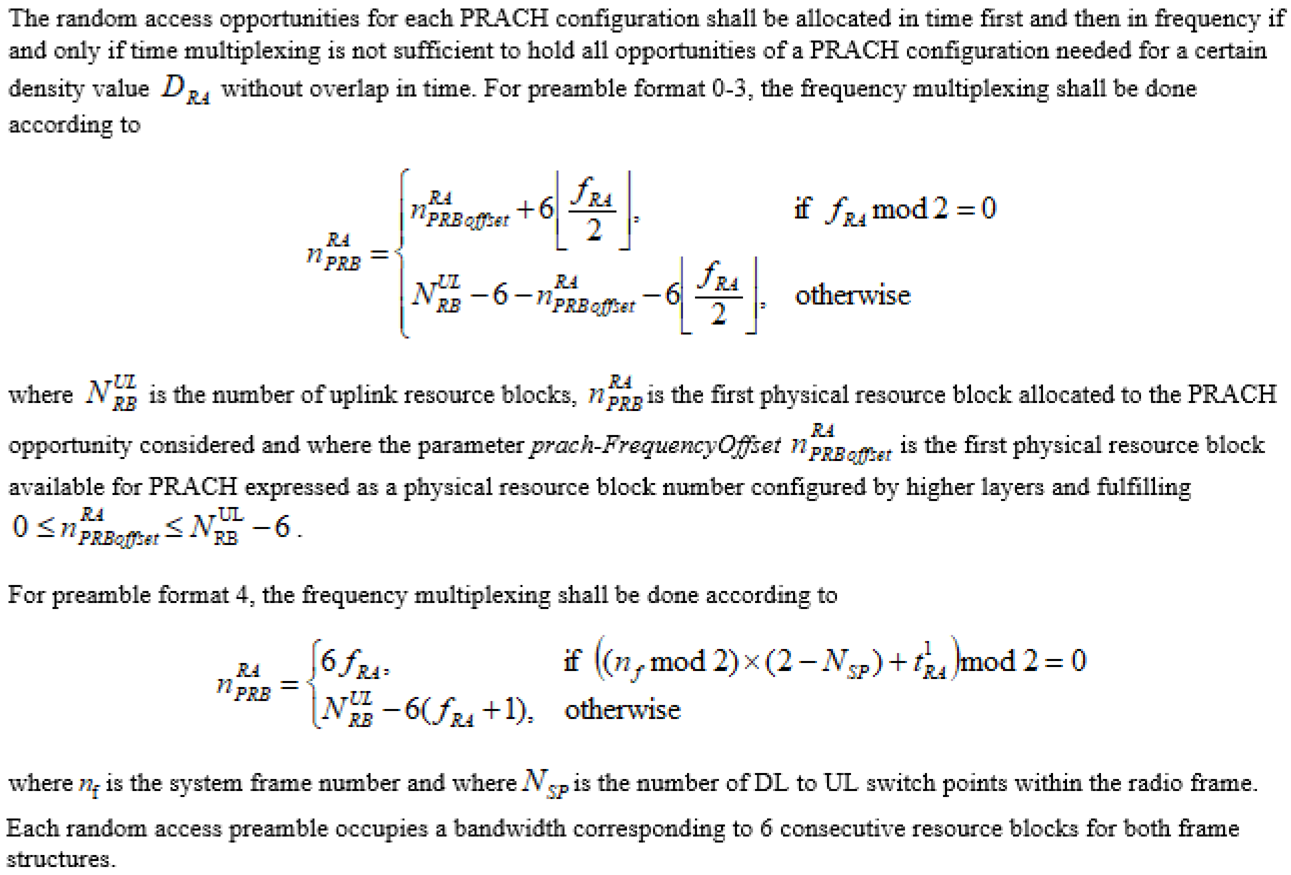
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$. …

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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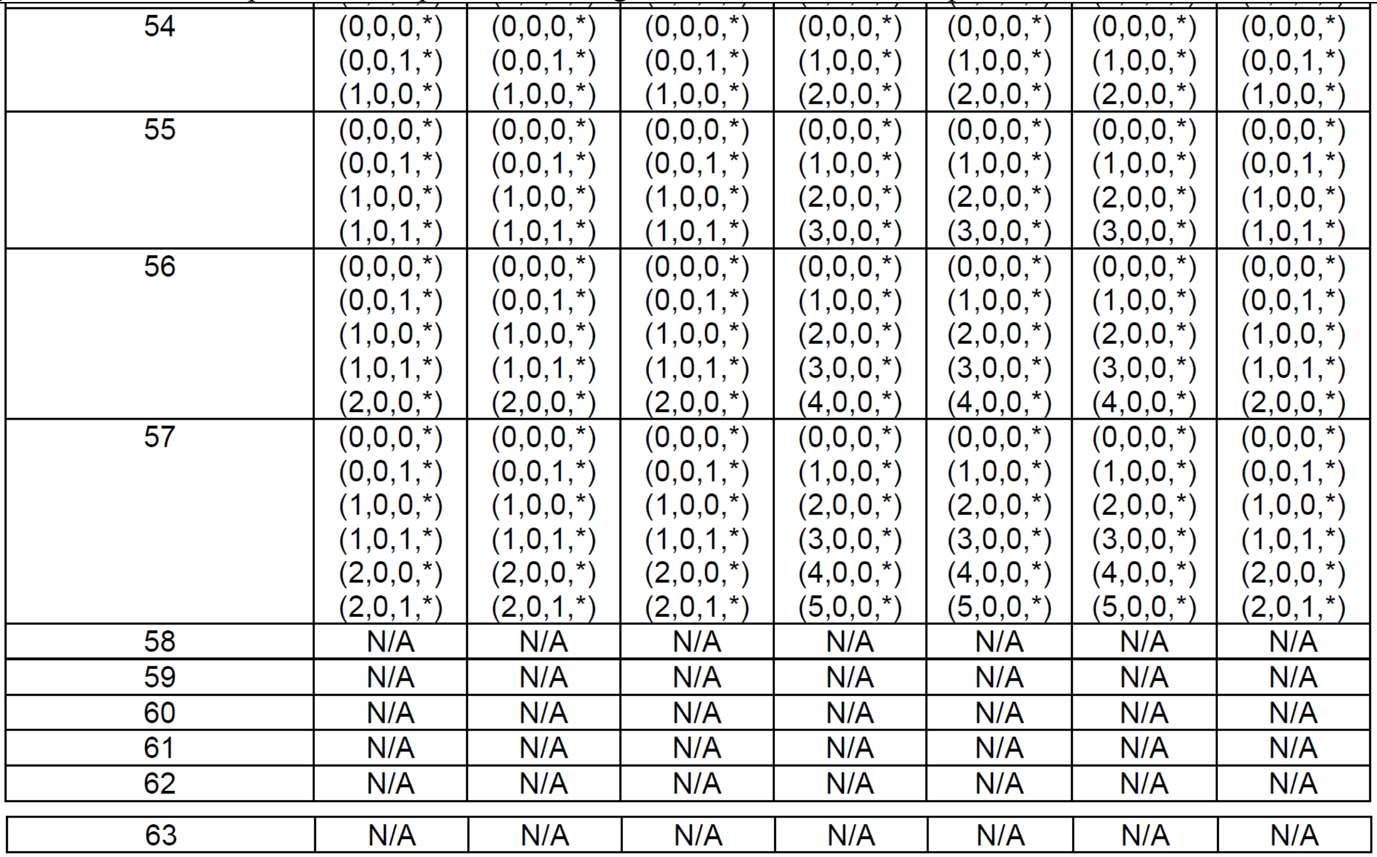
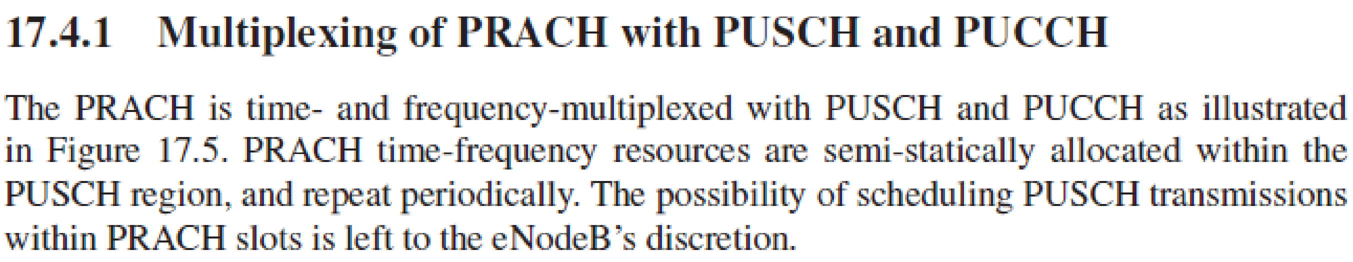


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

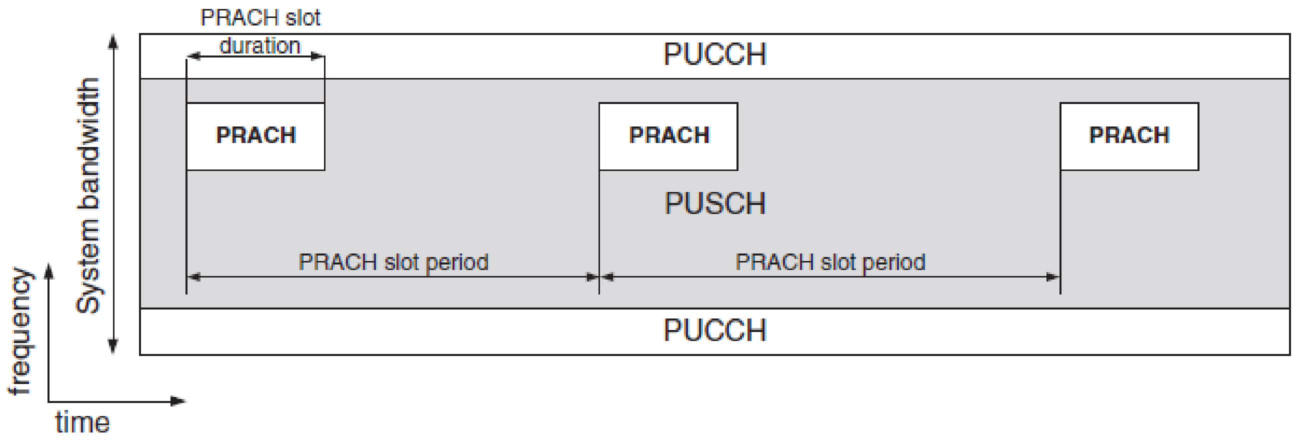
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

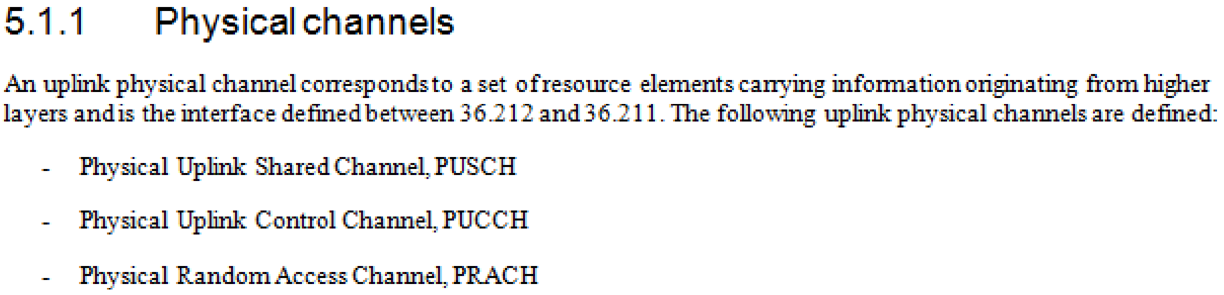
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

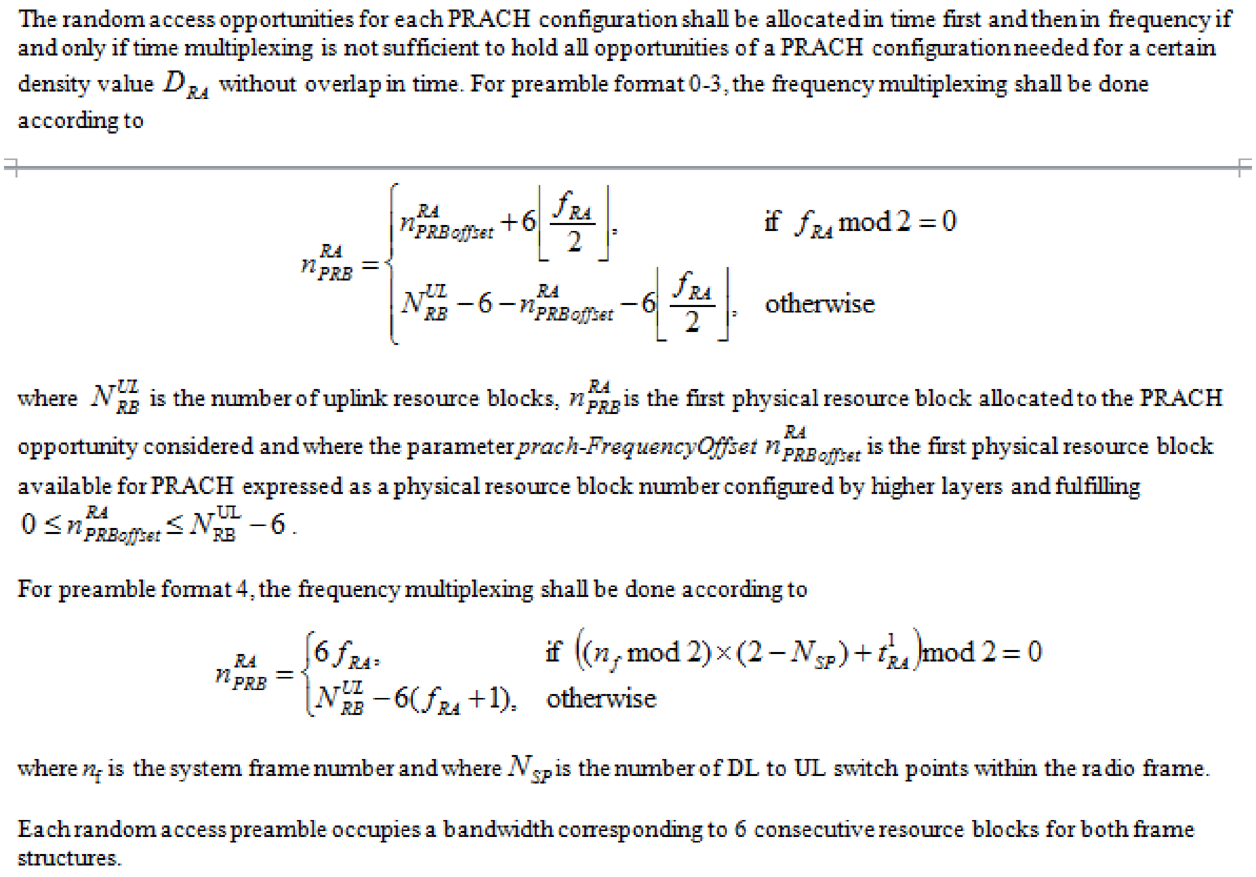
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

US Patent No. 10,833,908: Claim 28

“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with Volkswagen’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

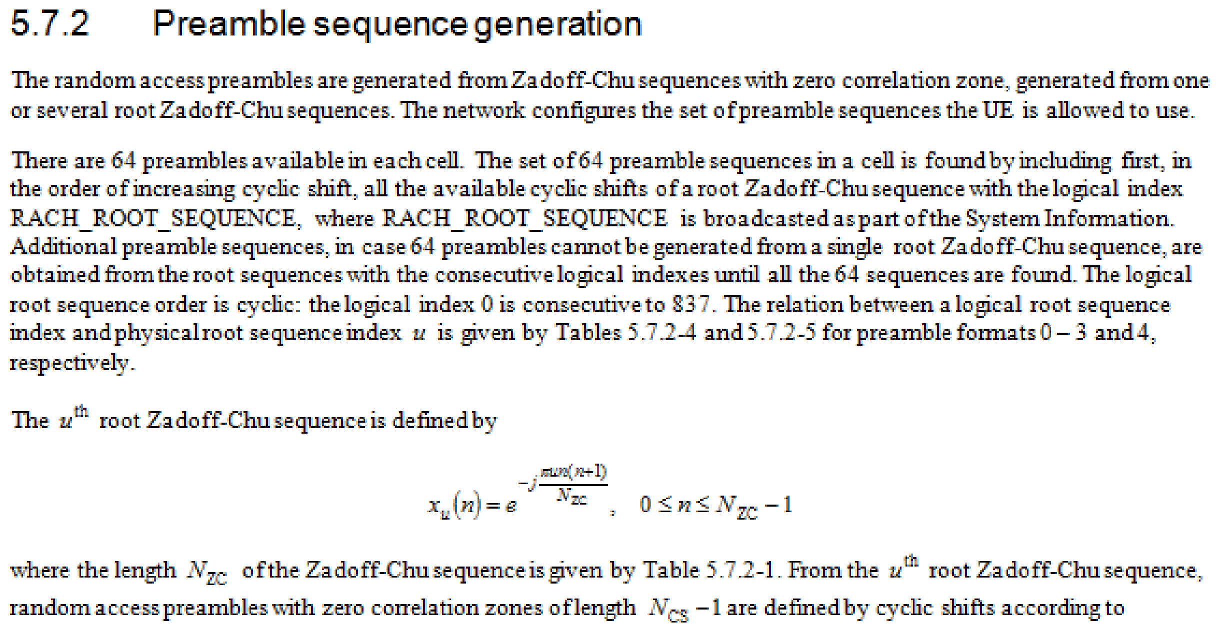
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

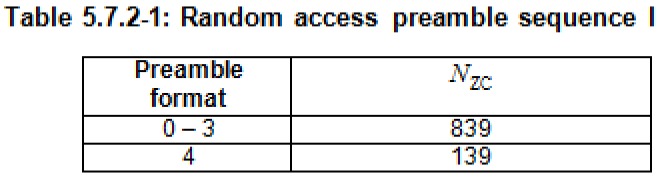
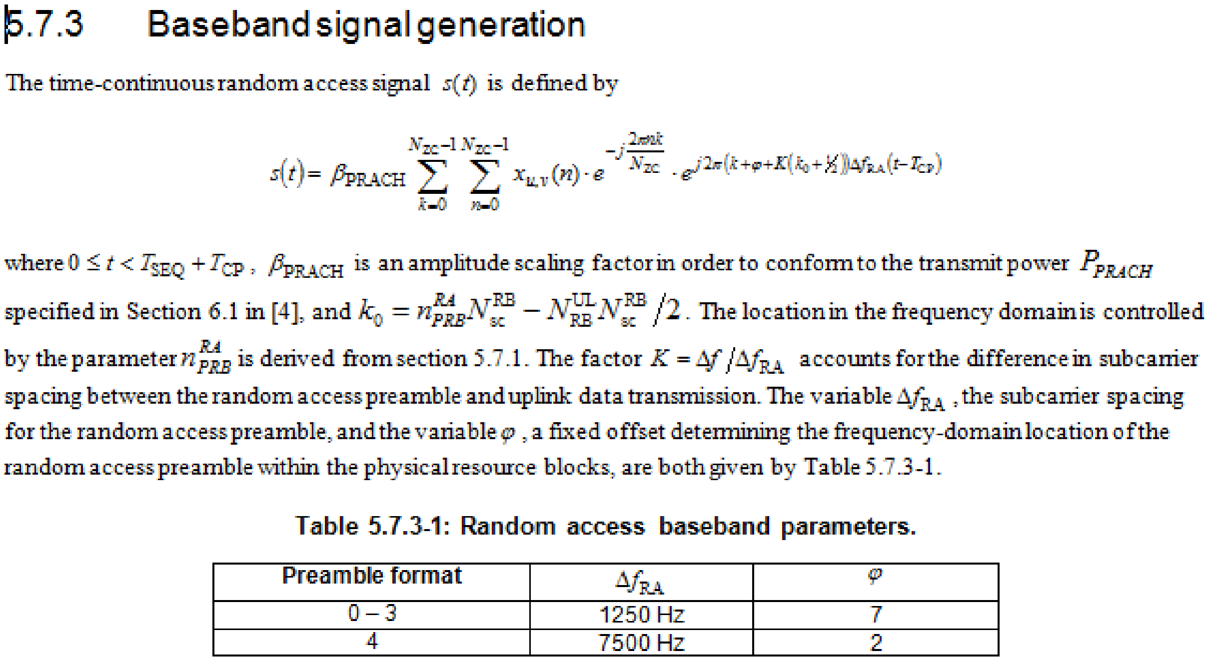


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t) = \beta_{\text{PRACH}} \sum_{k=0}^{N_{\text{ZC}}-1} \sum_{n=0}^{N_{\text{ZC}}-1} x_{u,v}(n) \cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}} \cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\text{RA}}\left(t-T_{\text{CP}}\right)}$$

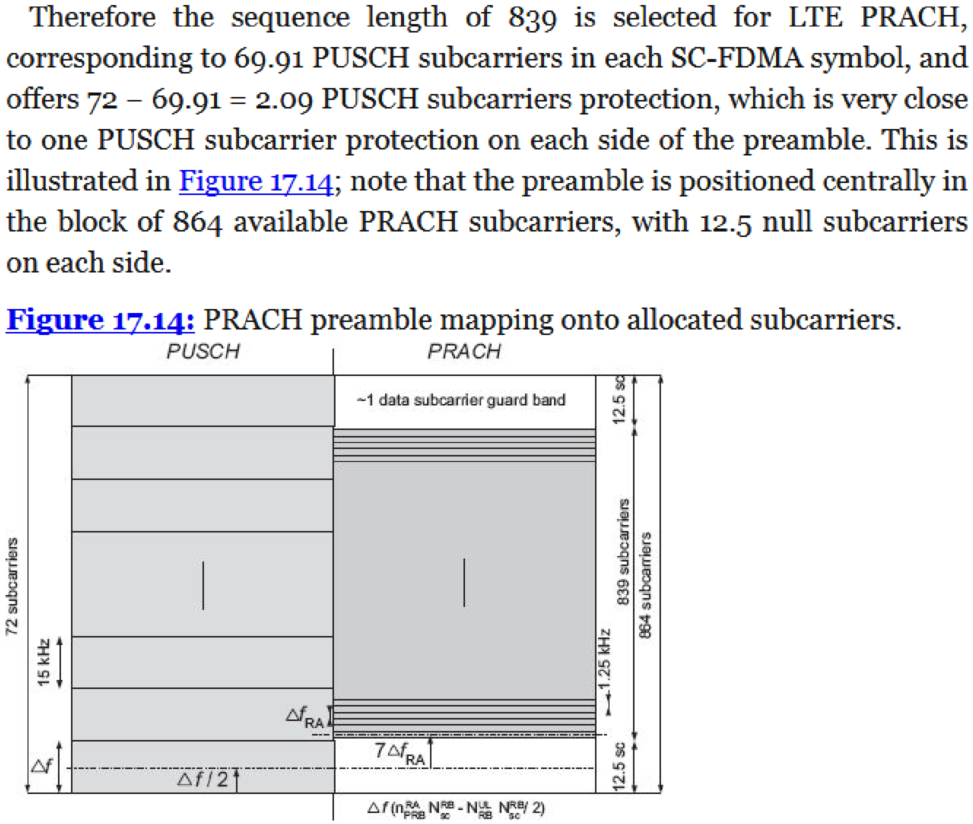
where $0 \le t < T_{\text{SEQ}} + T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\text{sc}}^{\text{RB}} - N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}} / 2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”

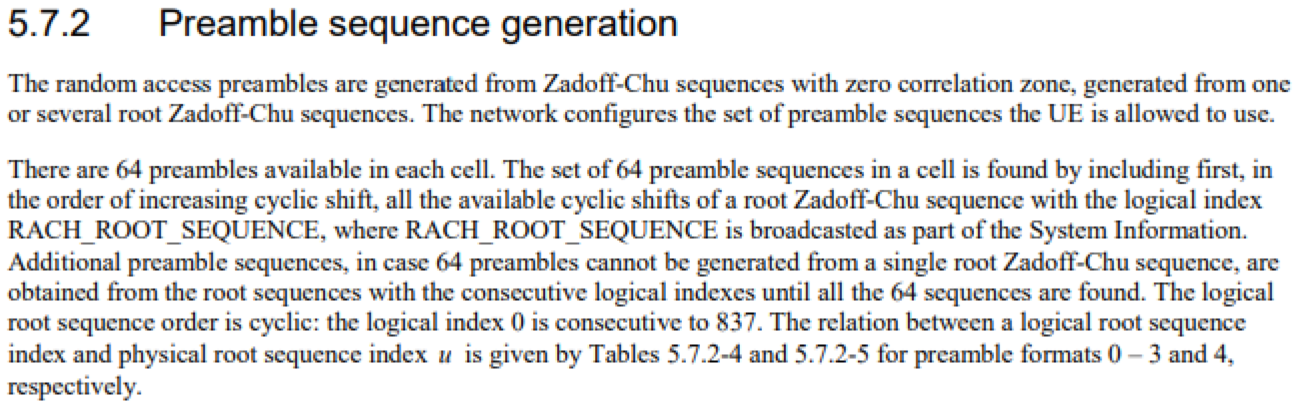
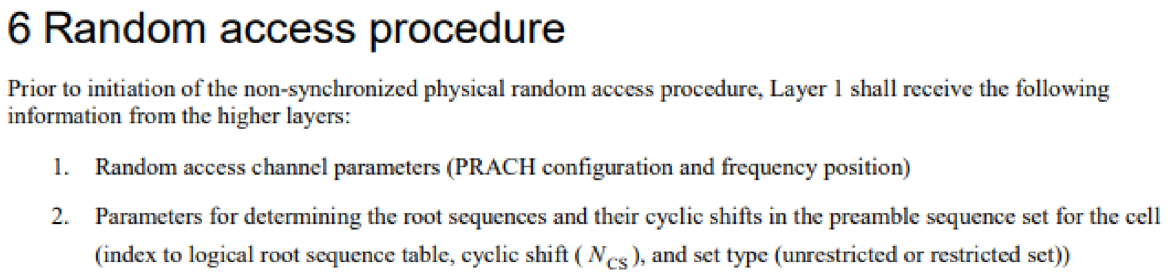


Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Volkswagen's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                            -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

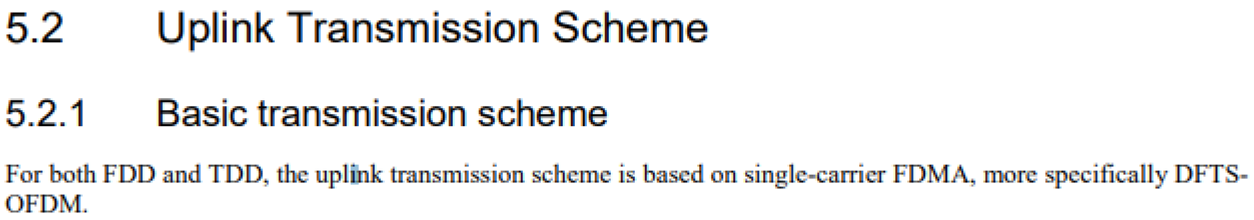
```
-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

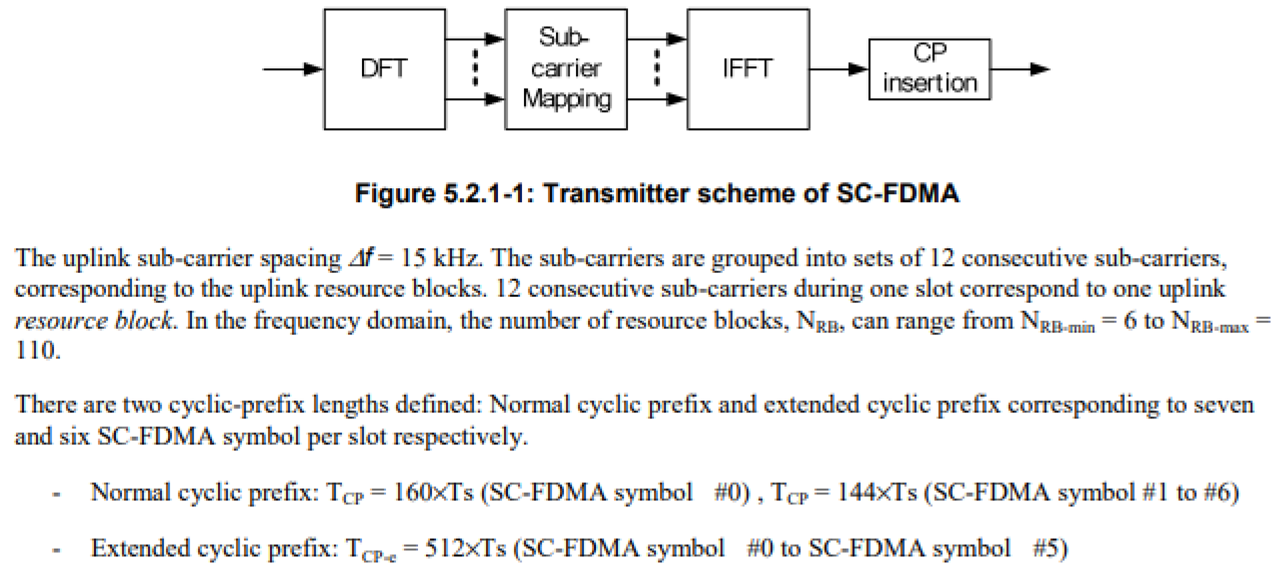
See also Claim 9.

US Patent No. 10,833,908: Claim 30
“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 Volkswagen’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Volkswagen’s Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

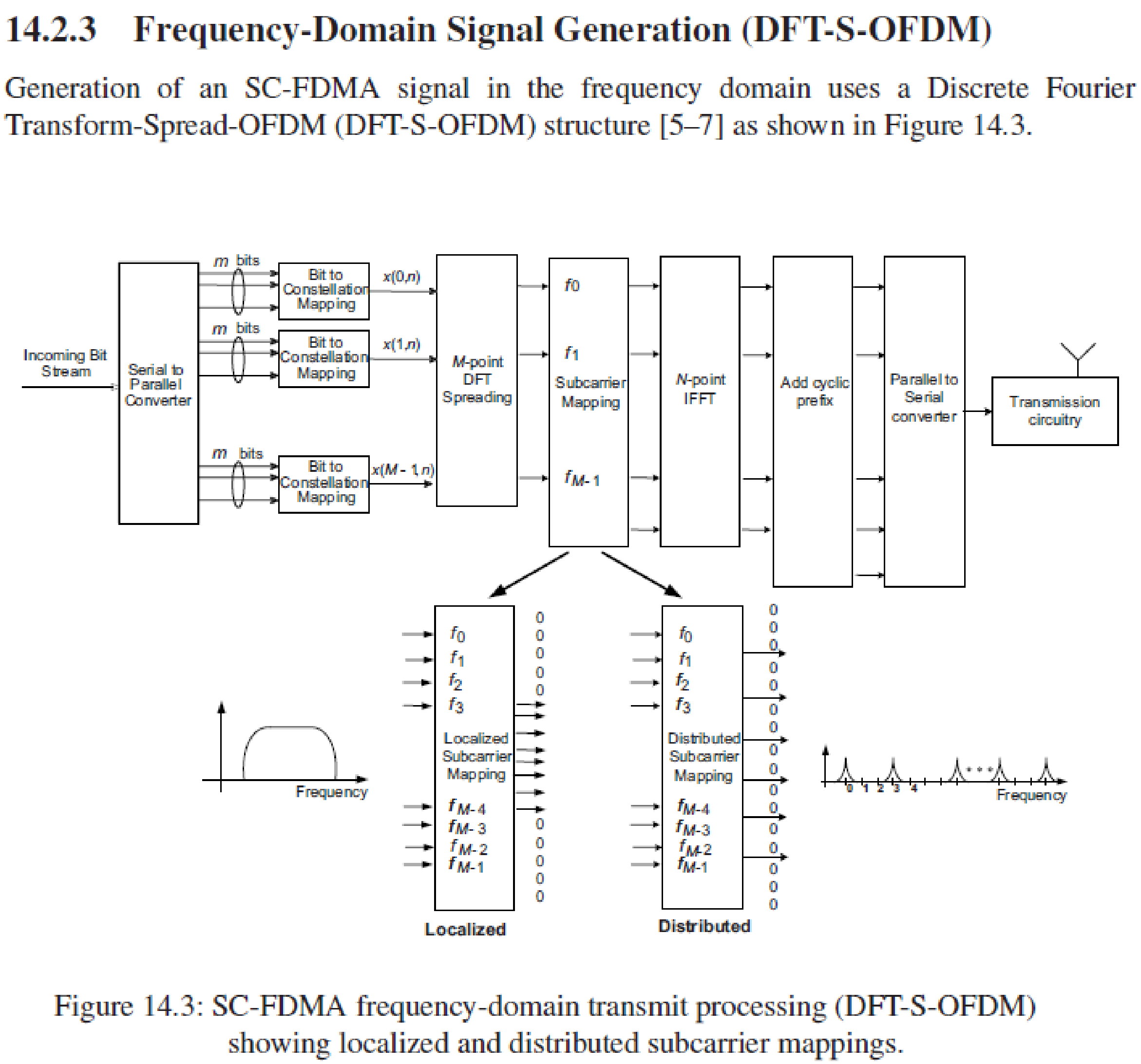
US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

	 **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

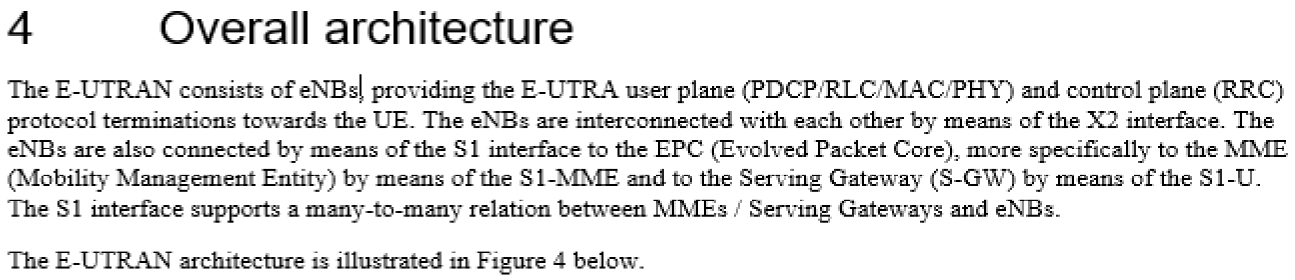
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

See also Claim 10.

Plaintiff's Infringement Contentions to Nissan

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, Nissan's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* Nissan's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Nissan offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

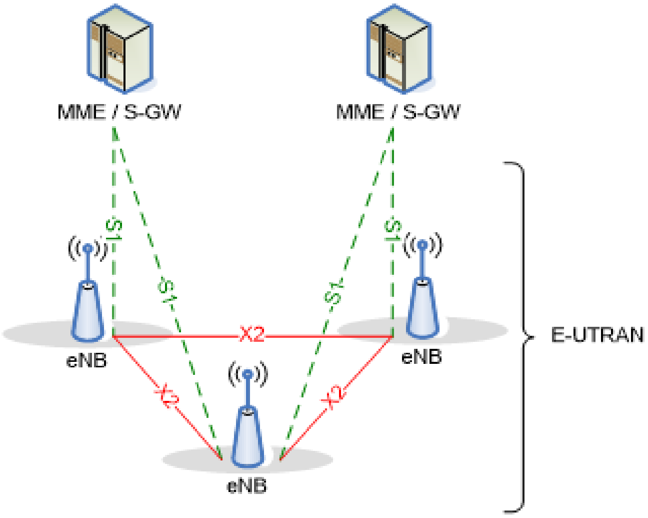


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

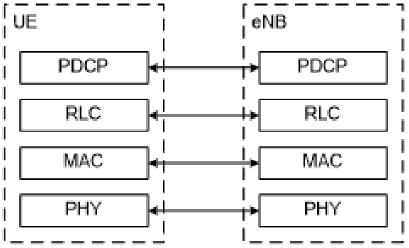


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

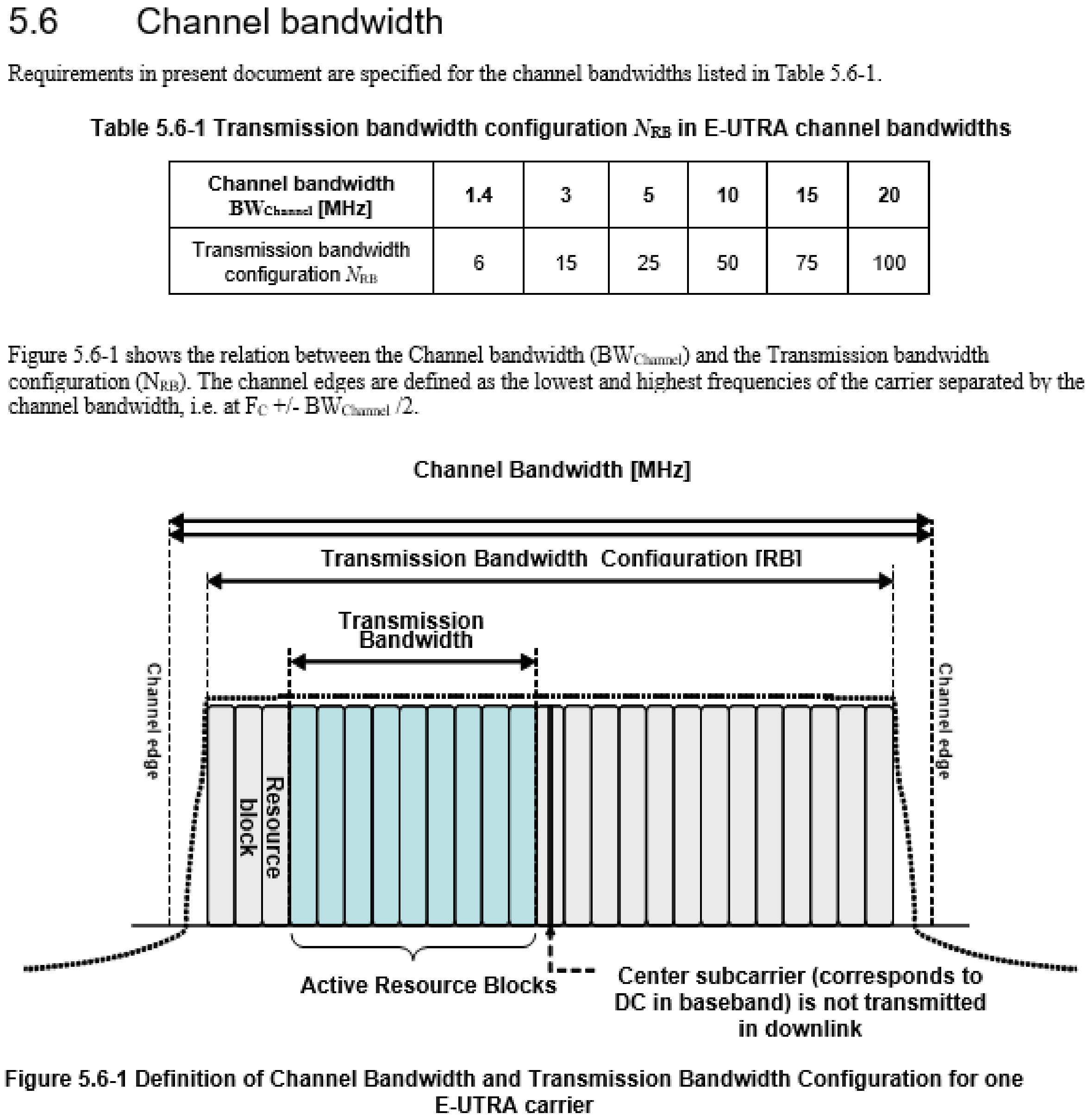
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Nissan’s Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, Nissan’s Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

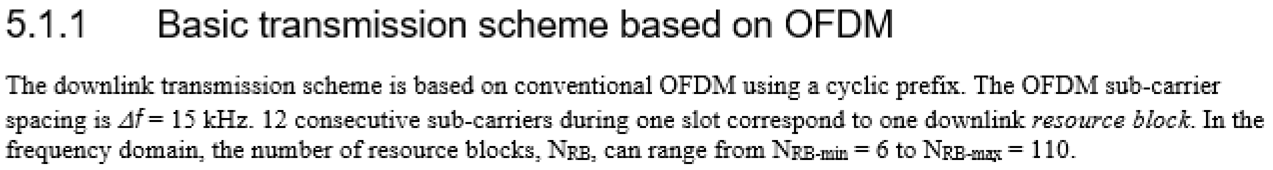
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

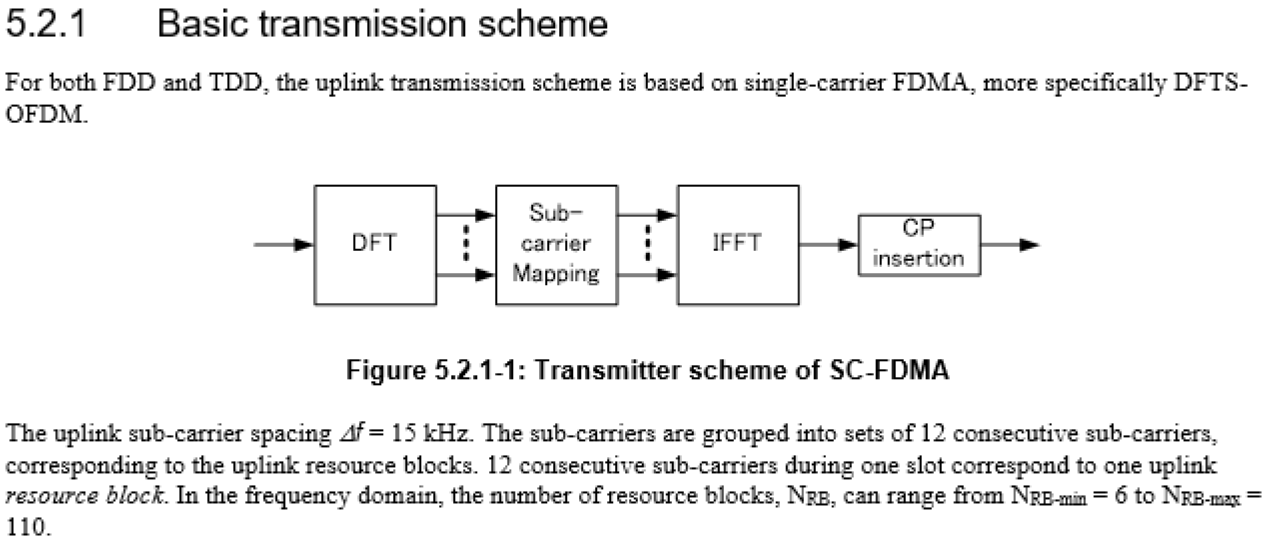
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

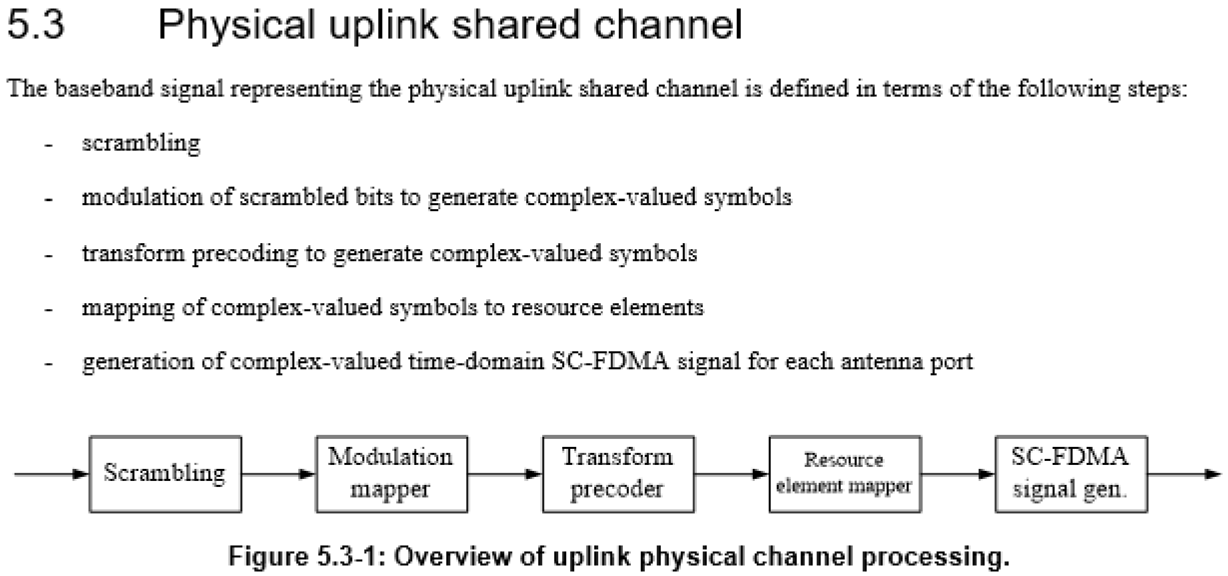
The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.3 Physical uplink shared channel

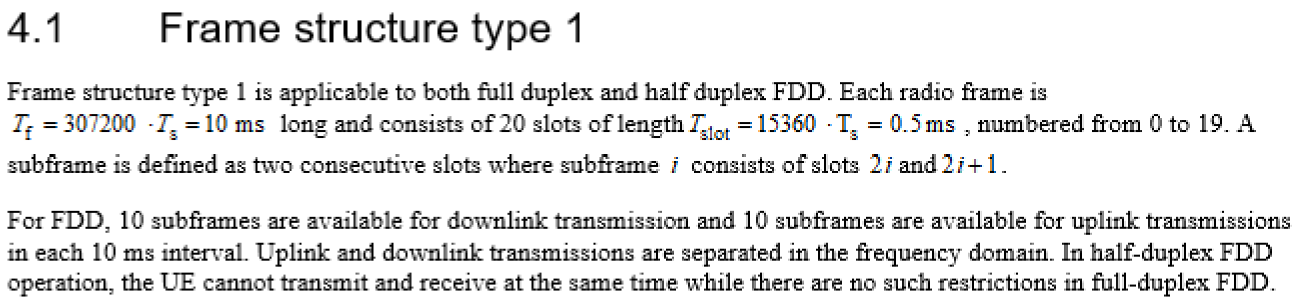
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

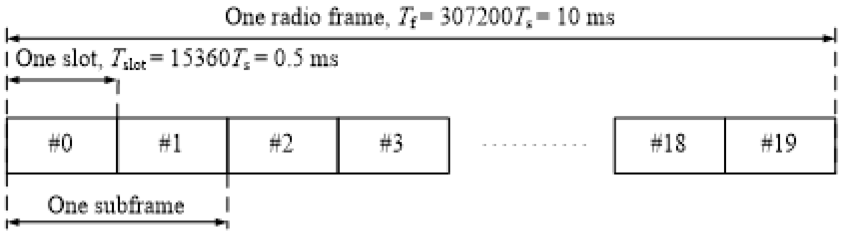
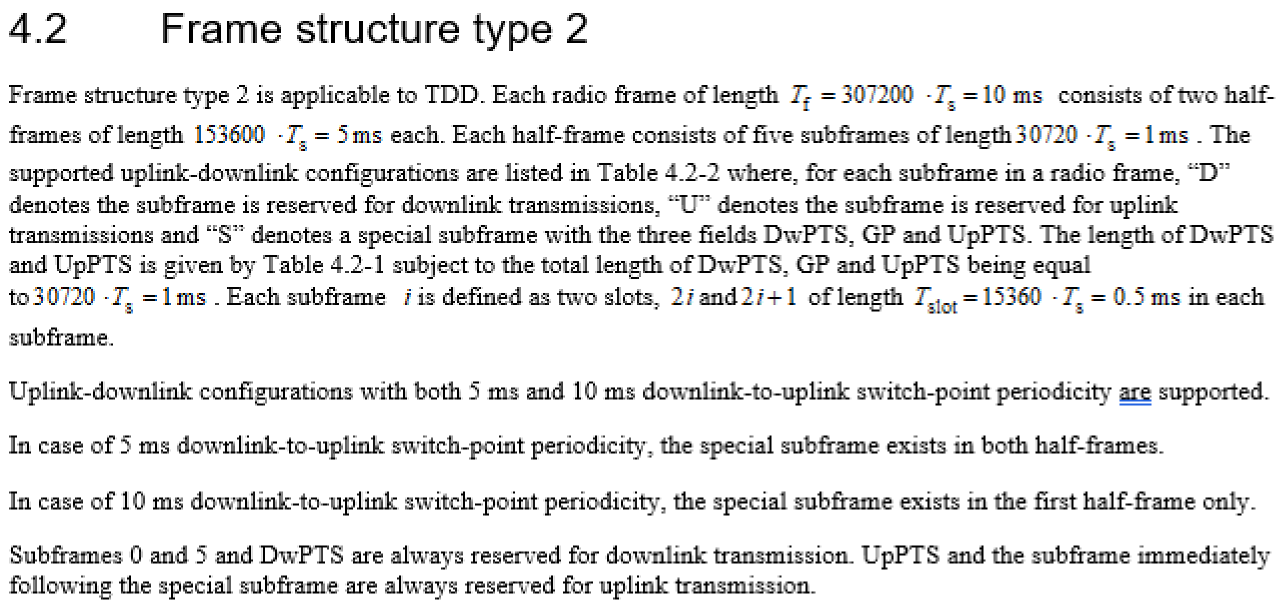


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms . The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms . Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

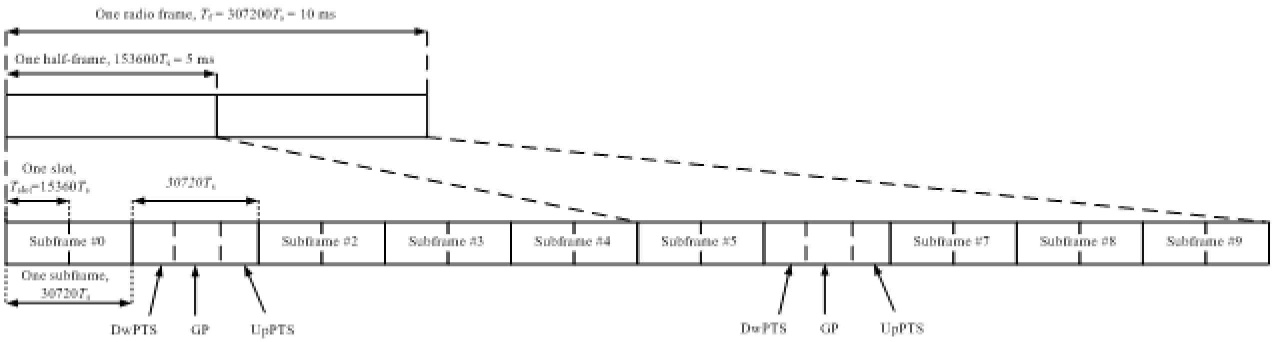
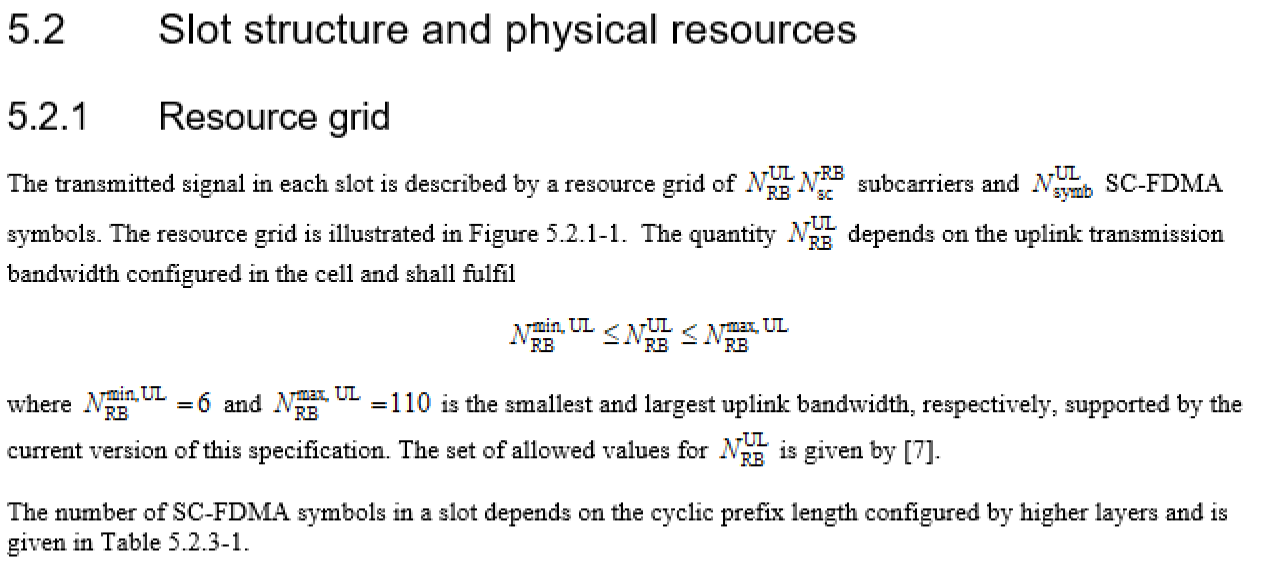


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

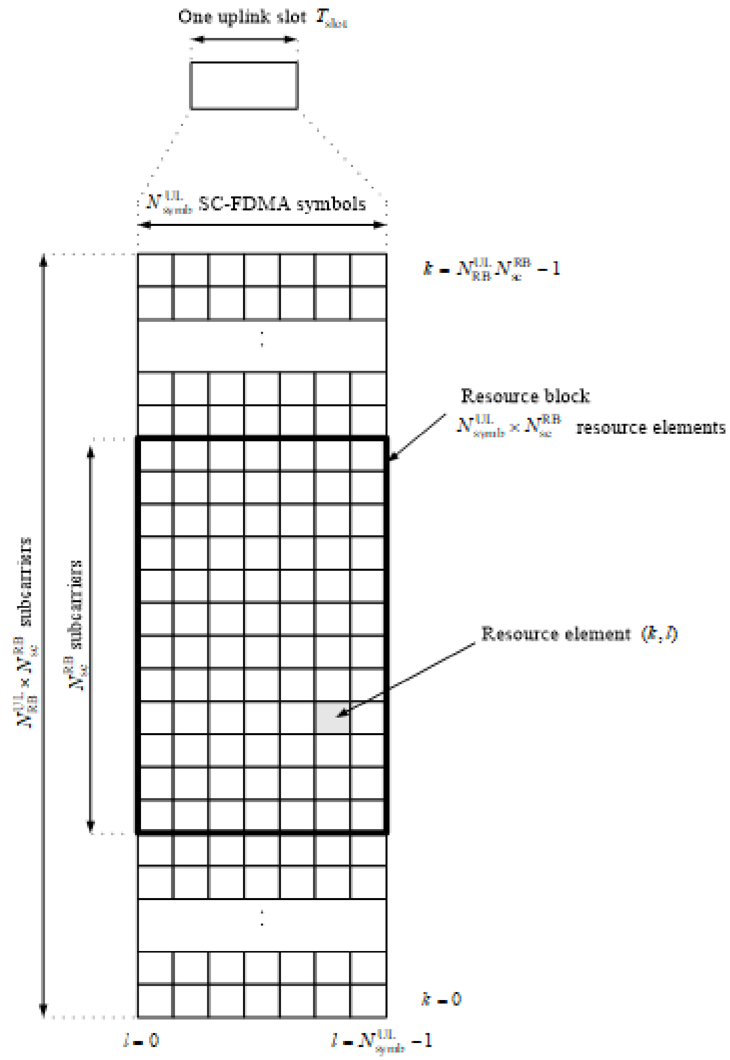
$$N_{\mathrm{RB}}^{\min,\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$$

where $N_{\mathrm{RB}}^{\min,\mathrm{UL}} = 6$ and $N_{\mathrm{RB}}^{\max,\mathrm{UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

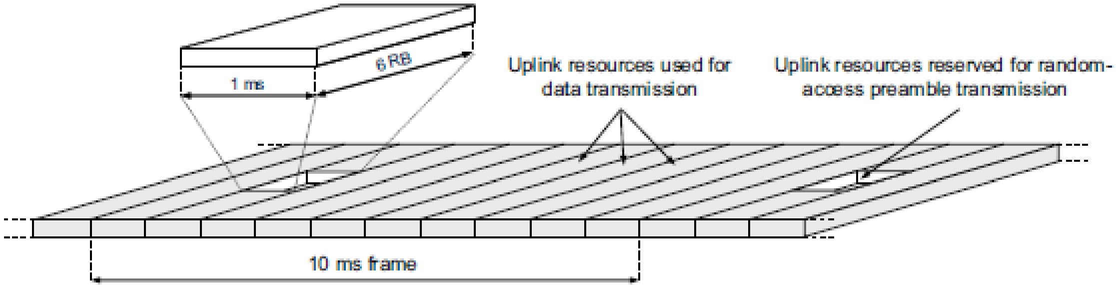
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 1(b)

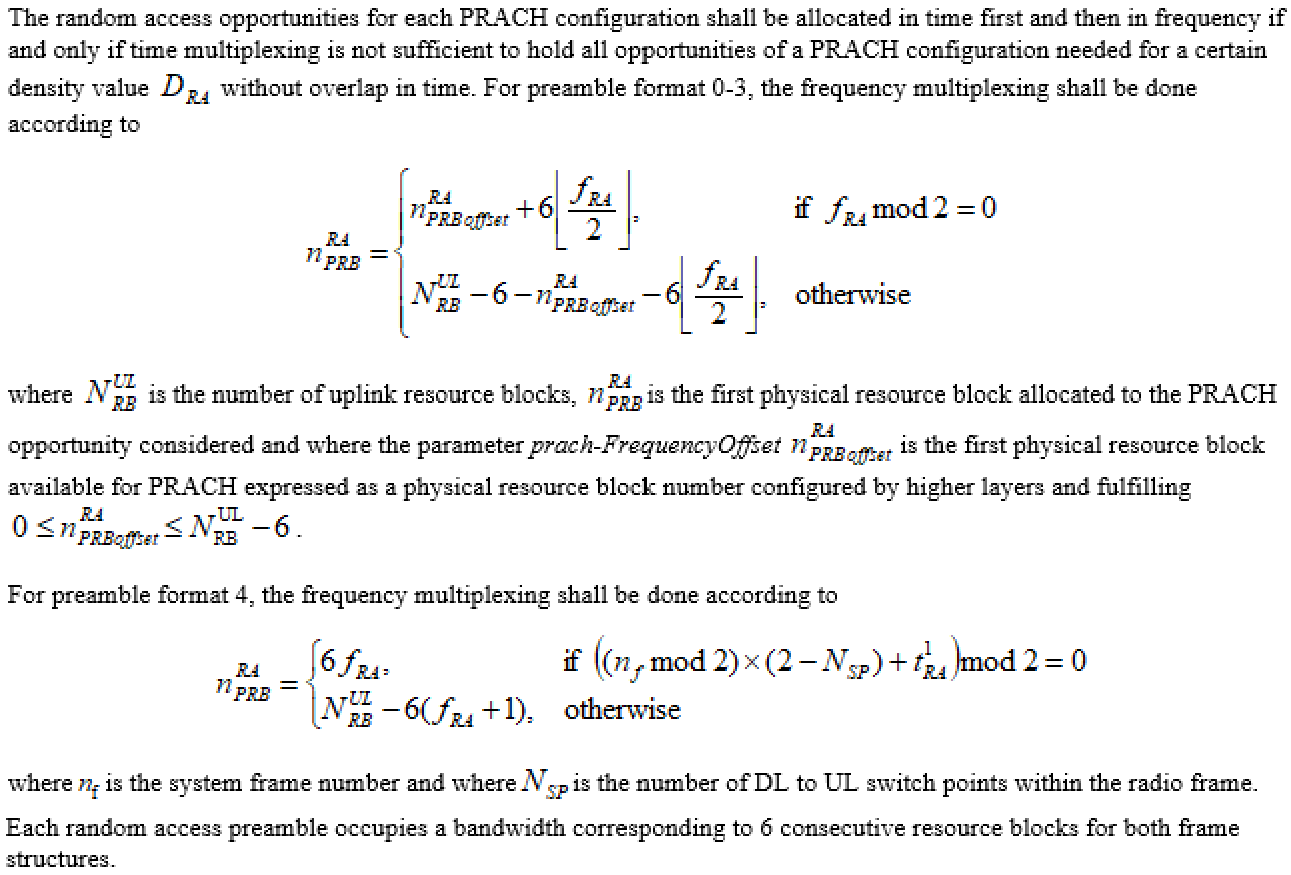
"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

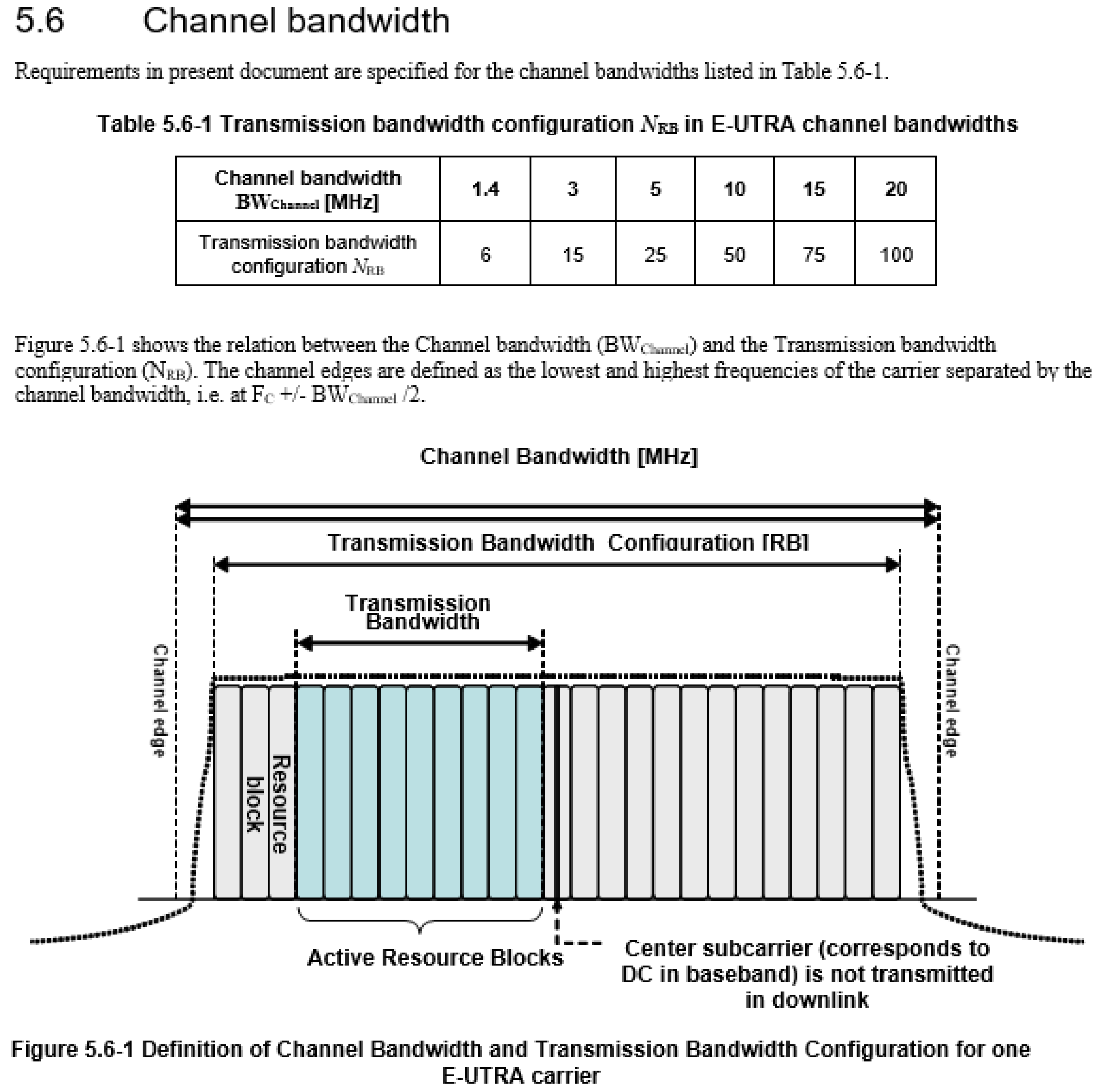
US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	Nissan's Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

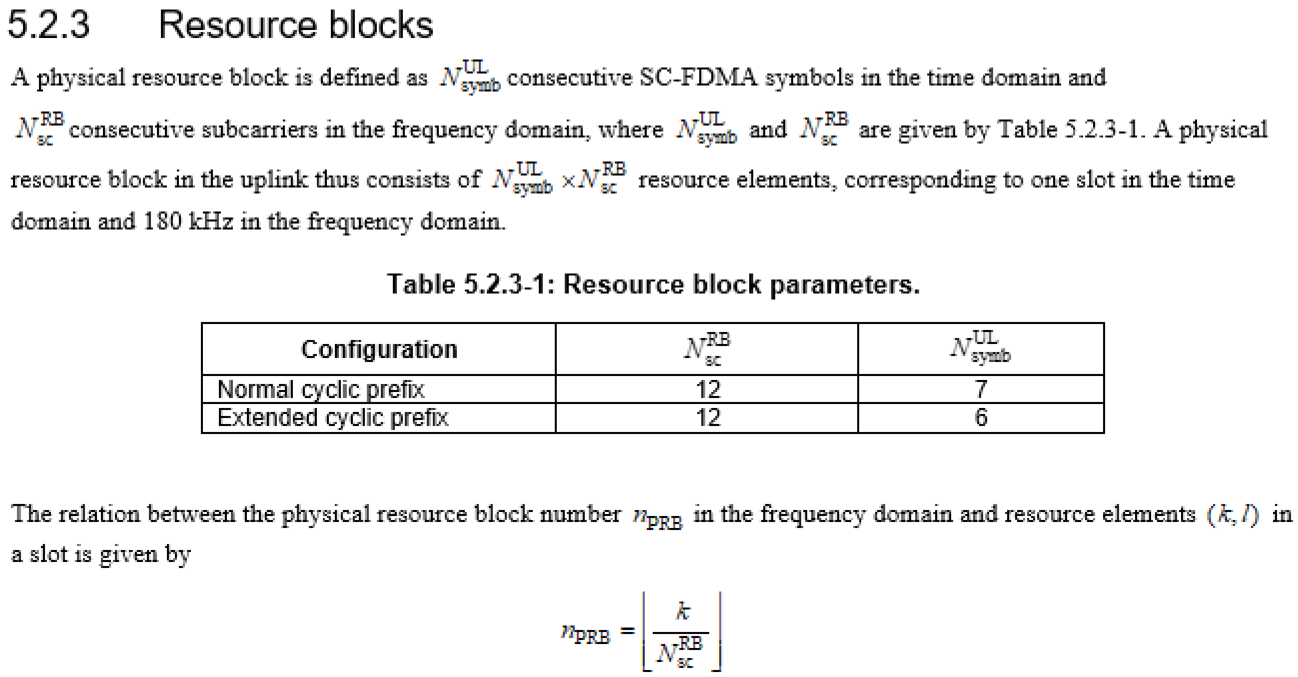
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

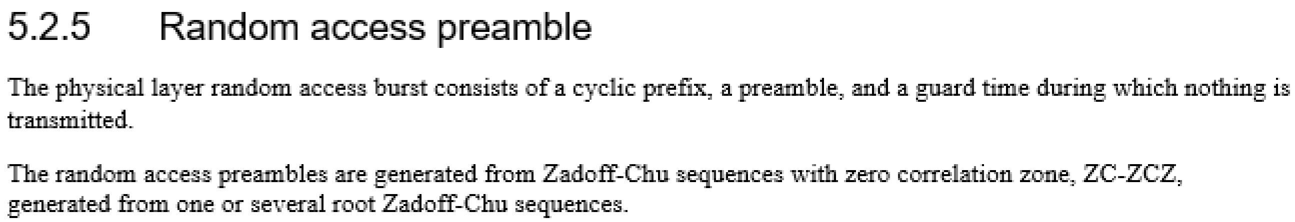
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

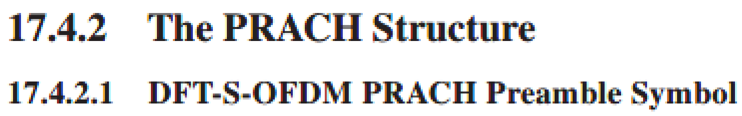


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

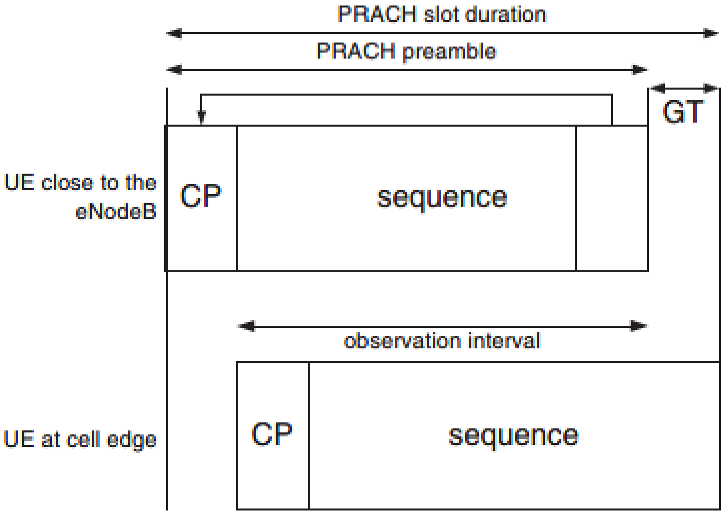


17.4.2 The PRACH Structure

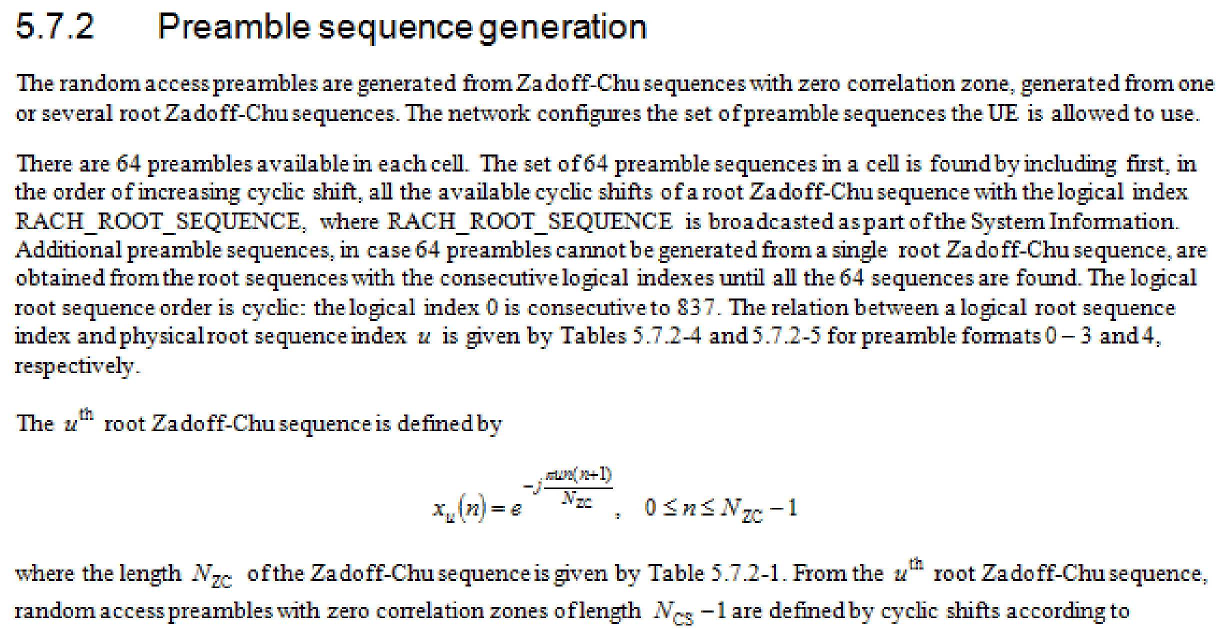
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible.  Figure 17.6: PRACH preamble received at the eNodeB. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

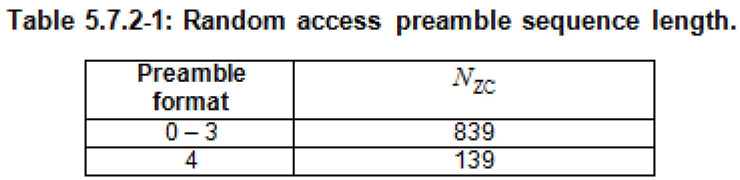
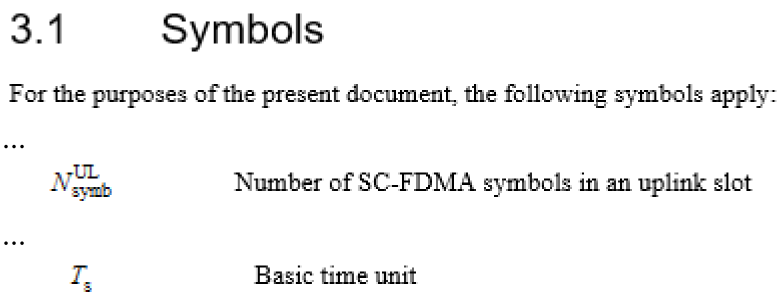
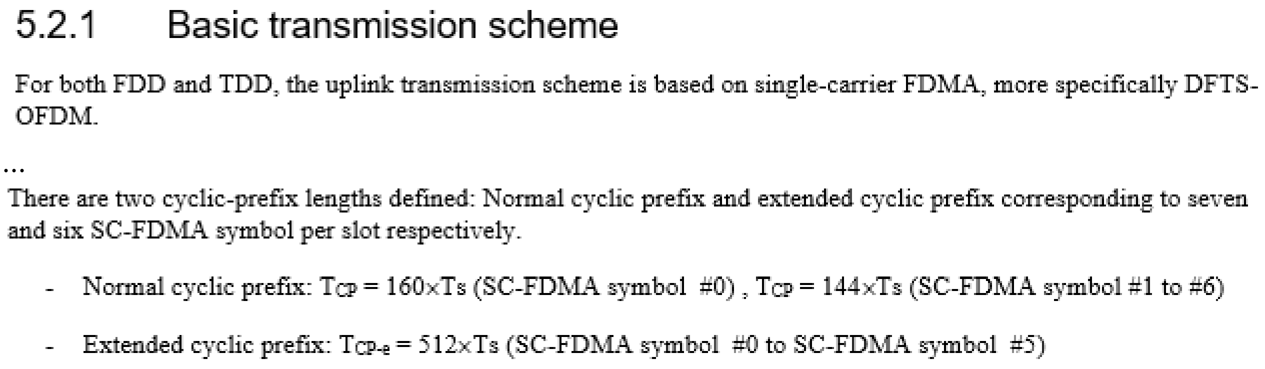


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using Nissan's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\mathrm{symb}}^{\mathrm{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_{s} Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

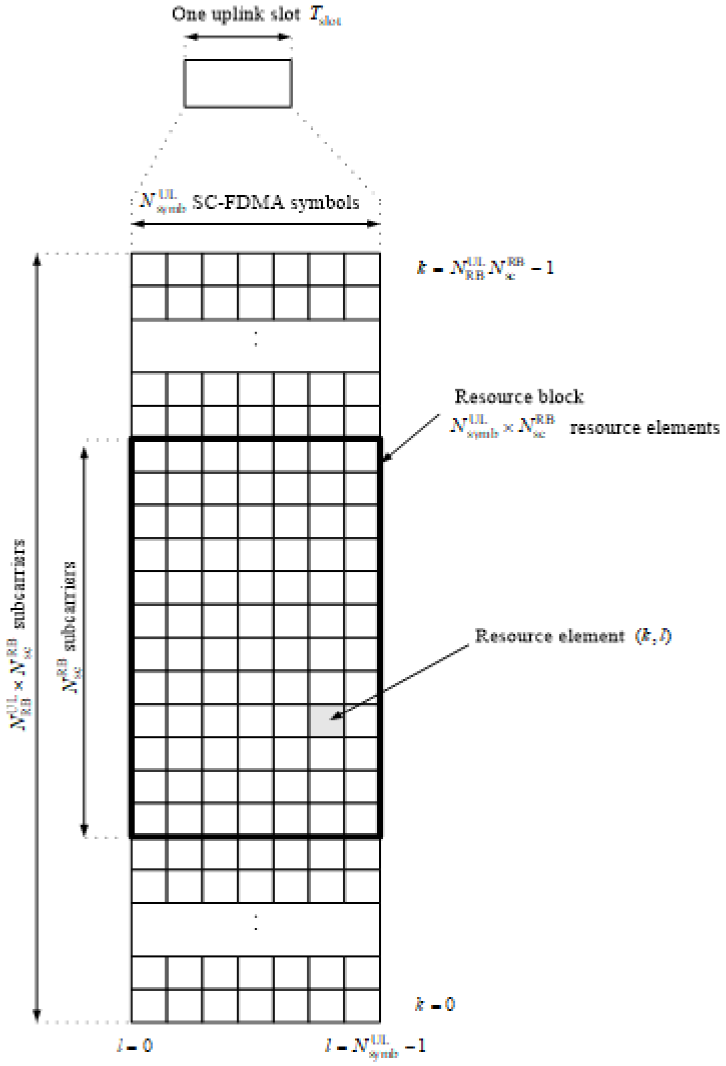
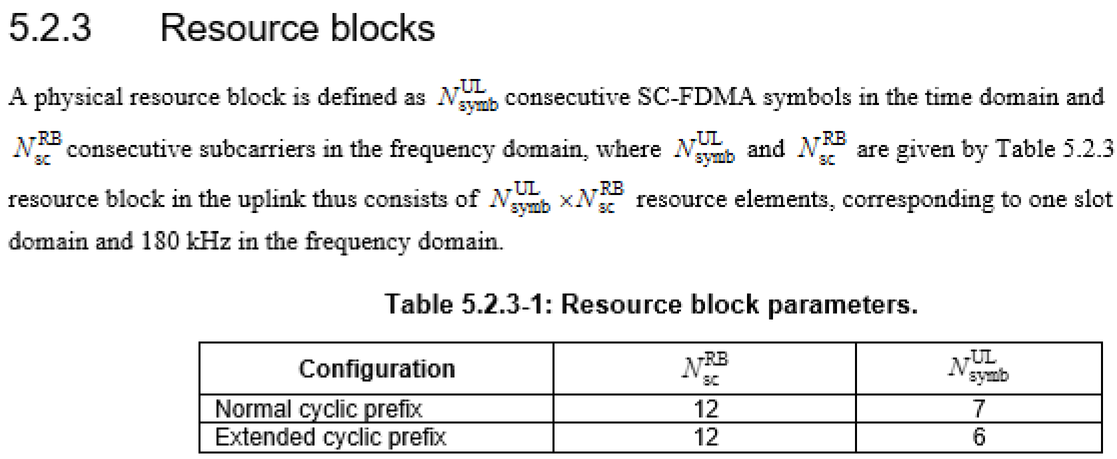


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

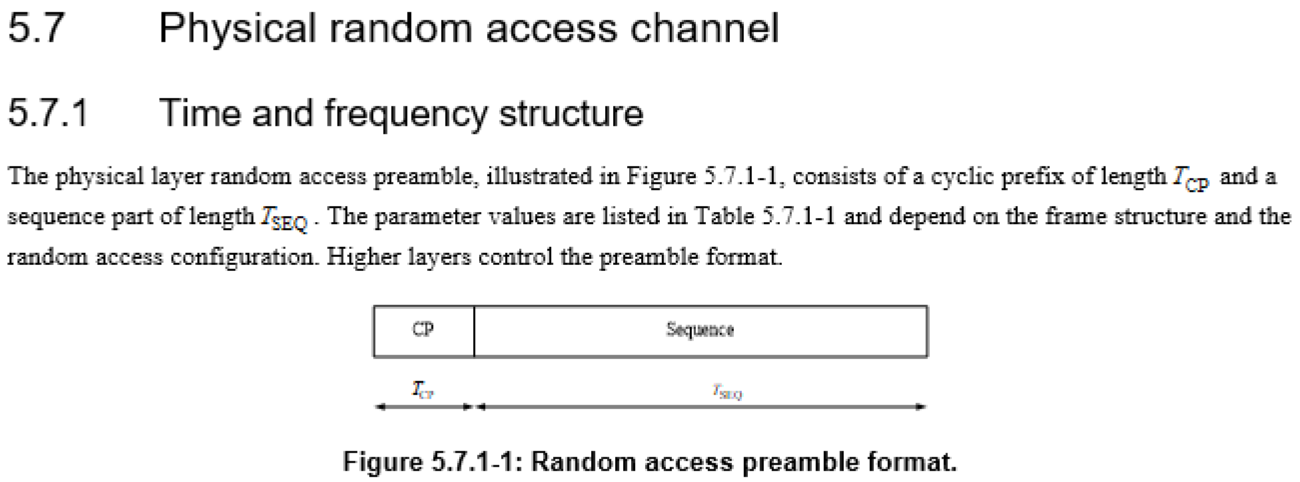
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

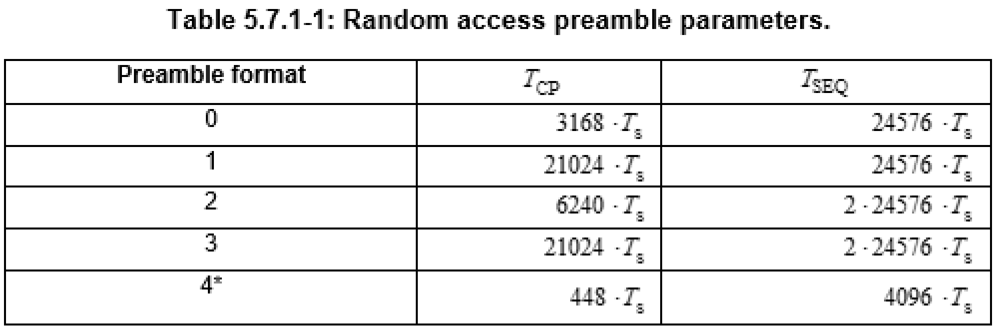
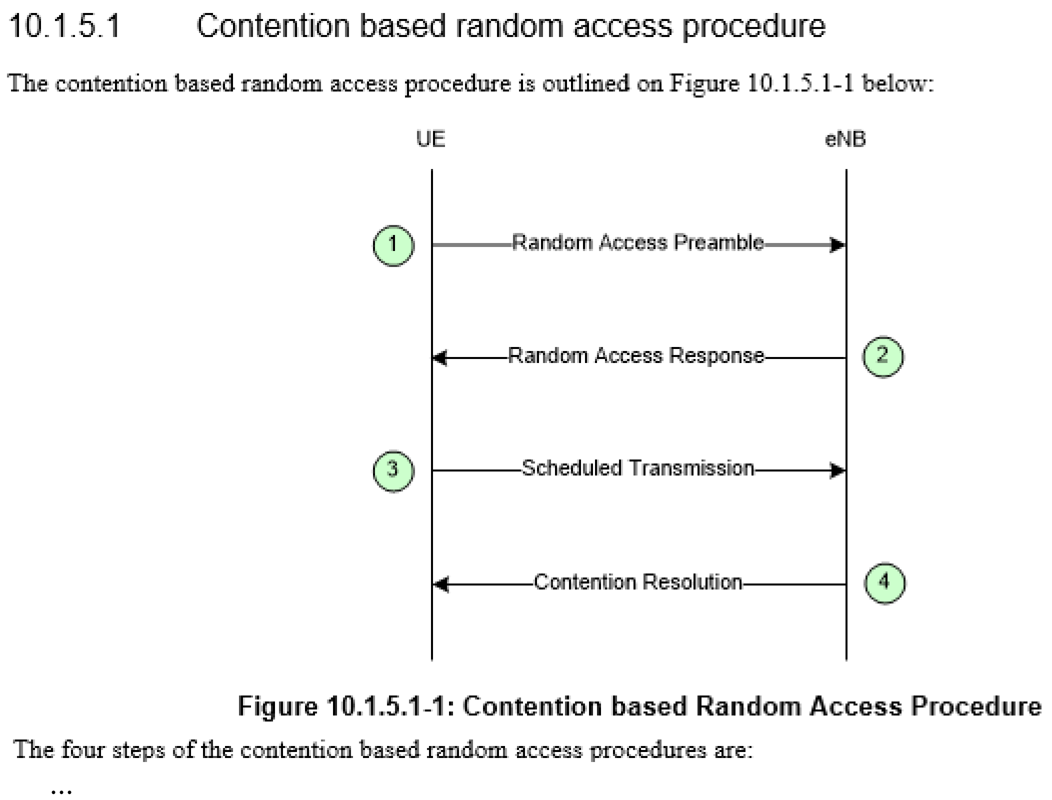


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

a receiver configured to receive, from the base station, a response message.	Nissan's Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

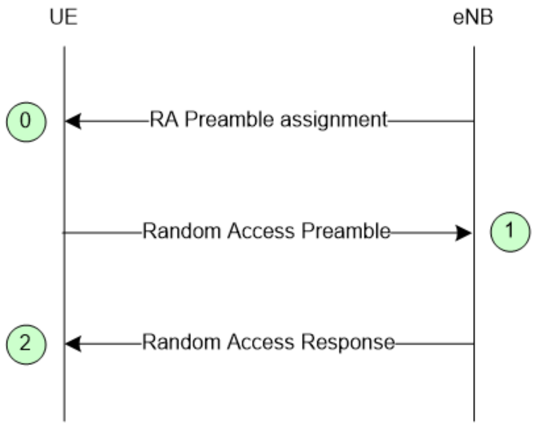
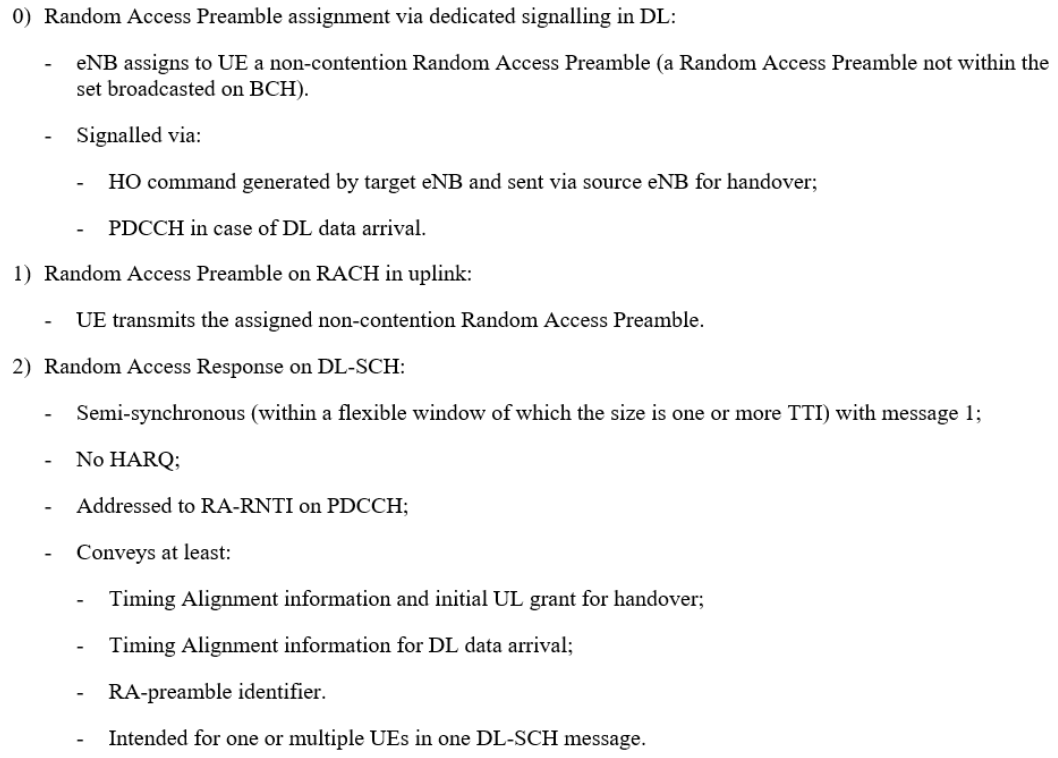


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

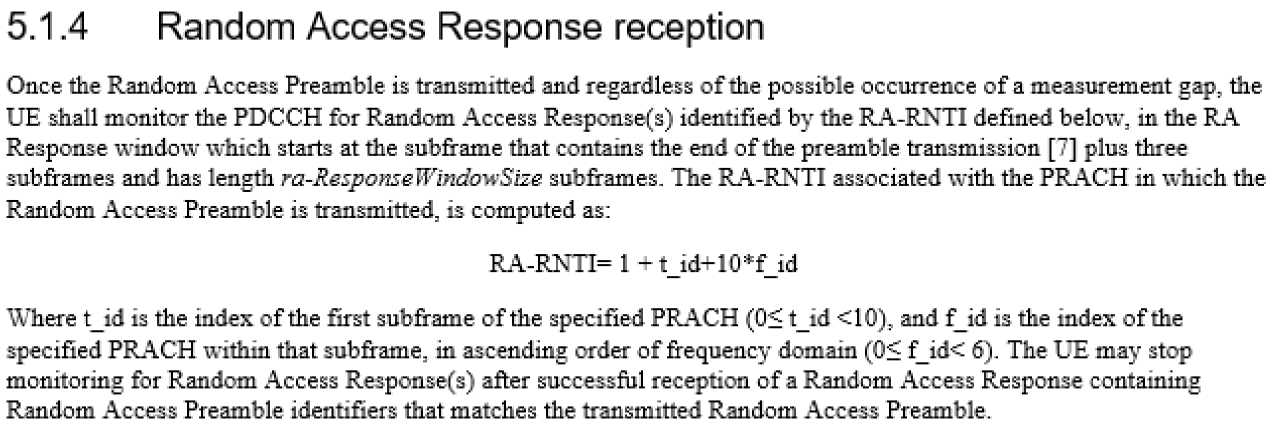


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

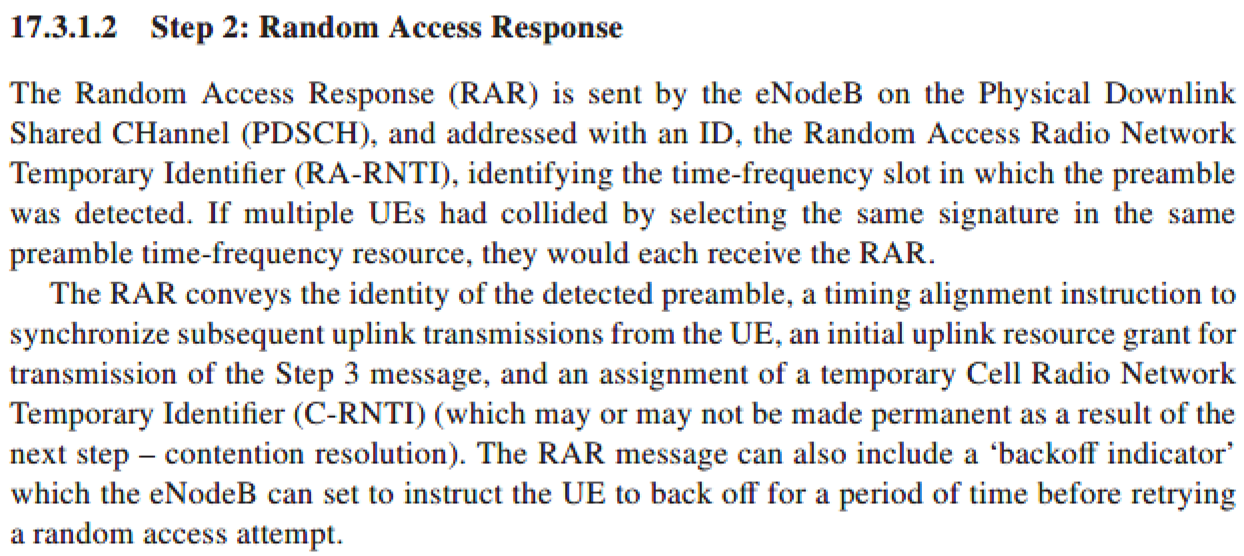
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

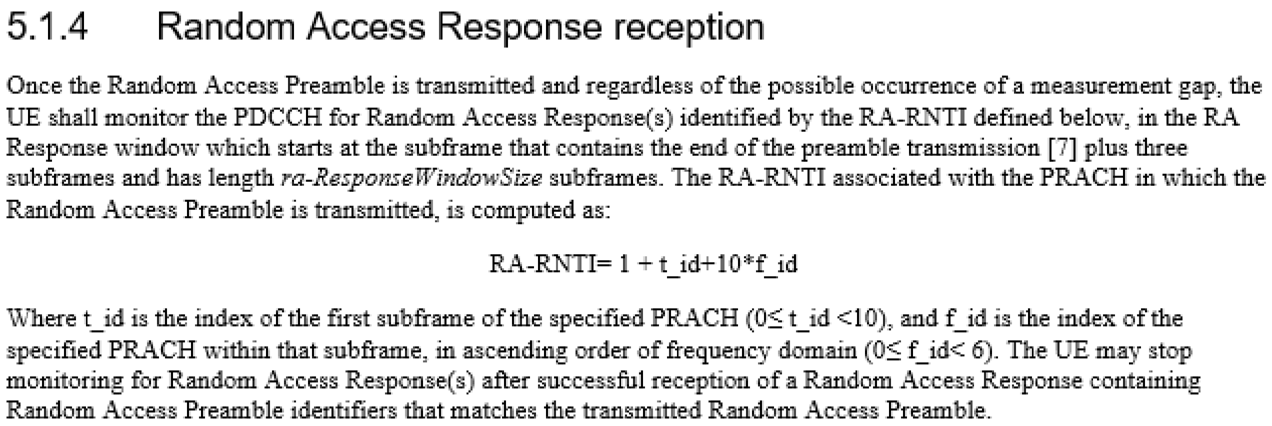
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

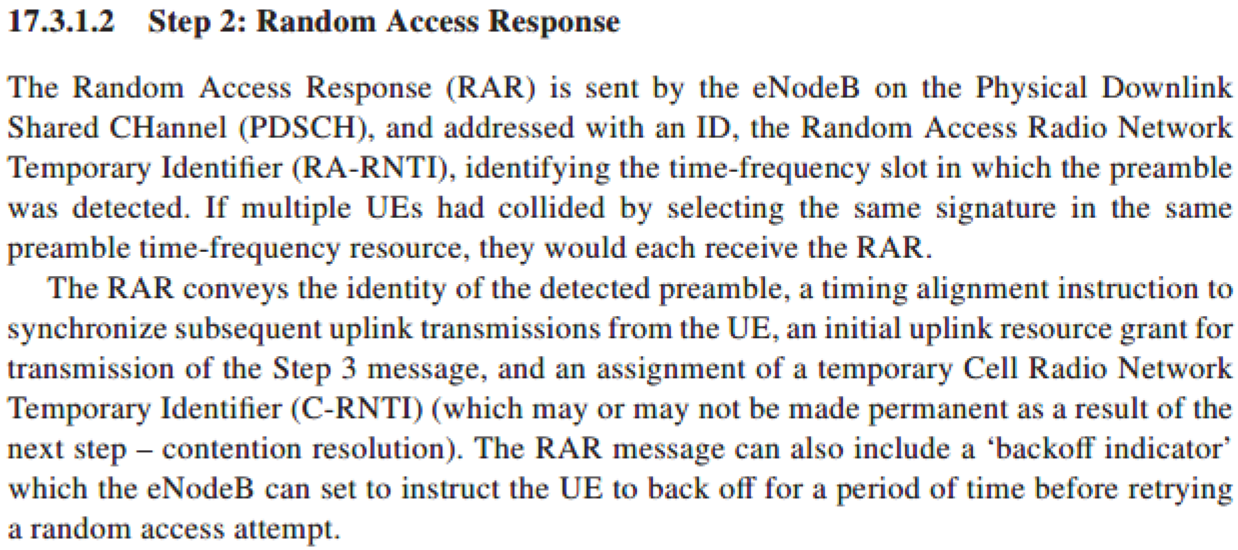
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

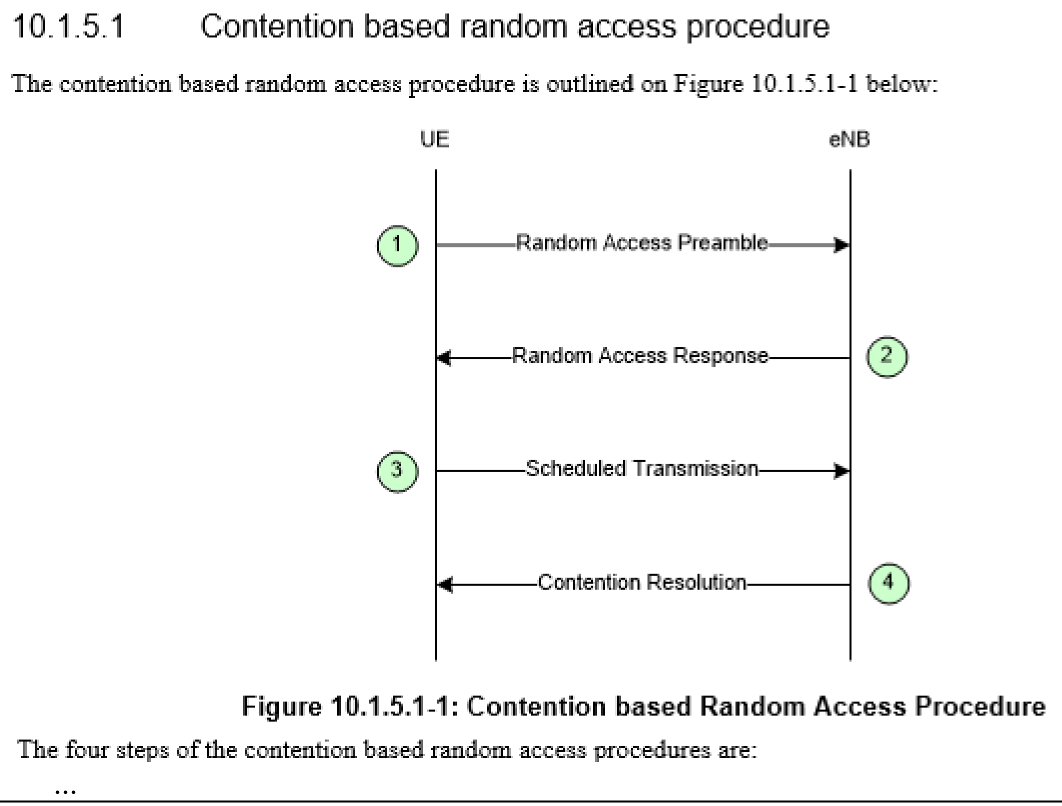
US Patent No. 10,833,908: Claim 2(b)
"the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and"

the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of Nissan's Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  **5.1.4 Random Access Response reception** Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

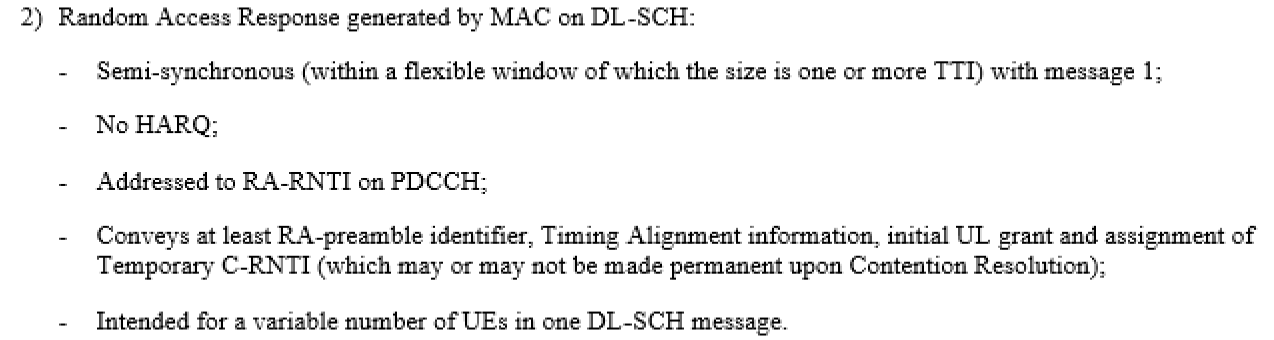
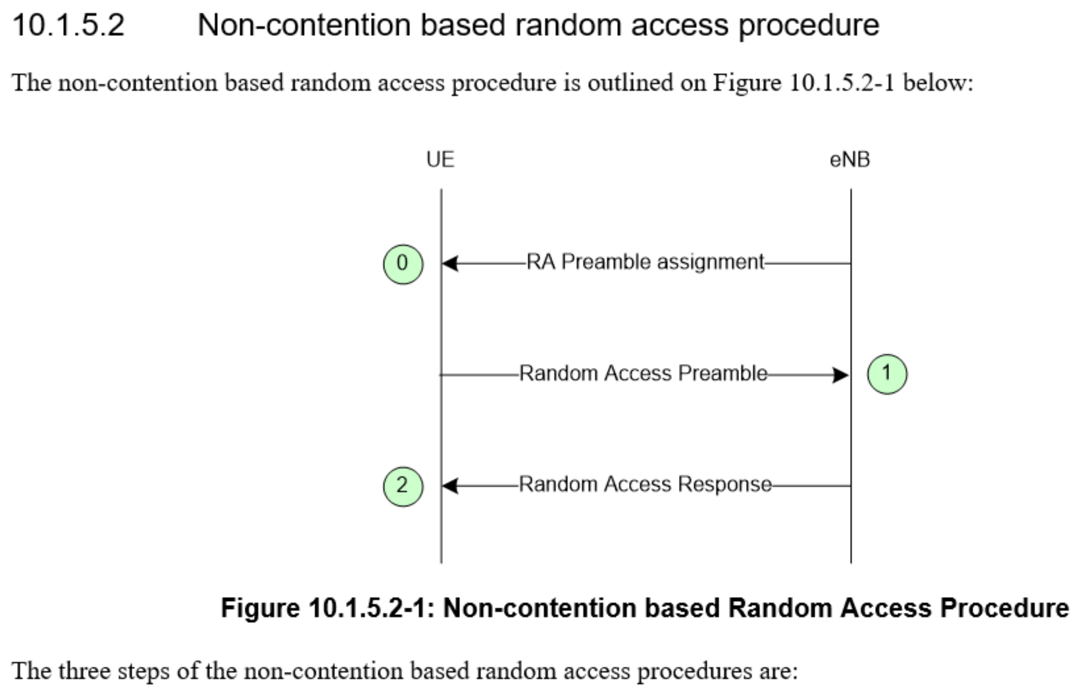
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

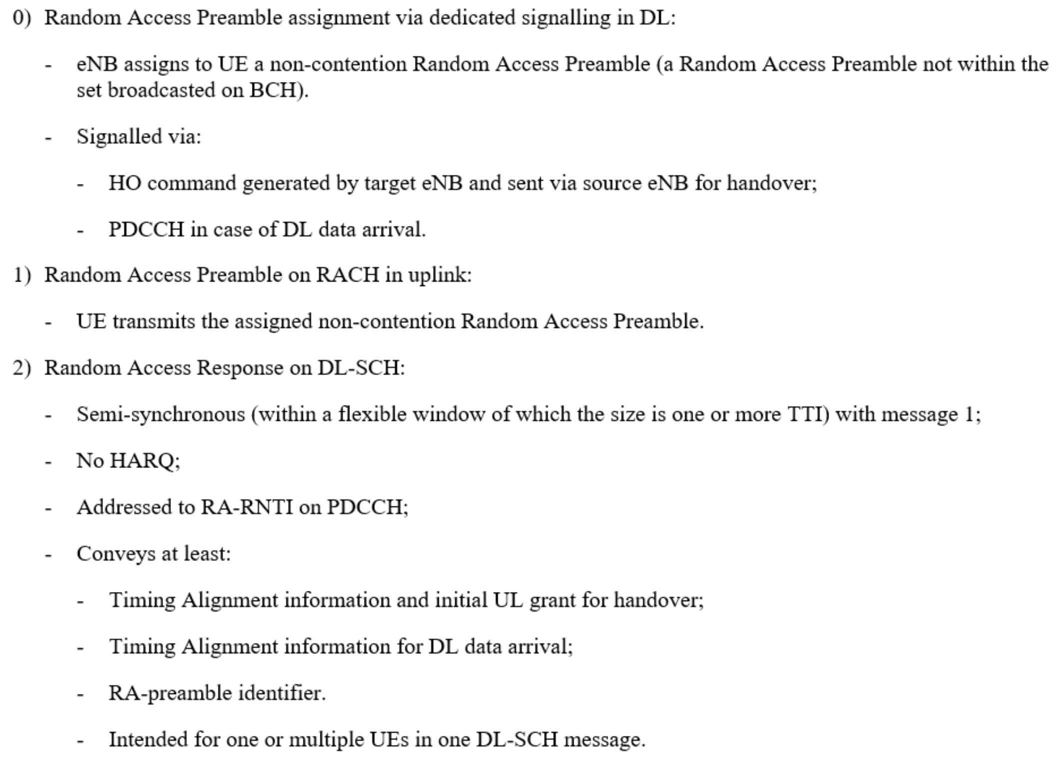
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in Nissan’s Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.*, When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

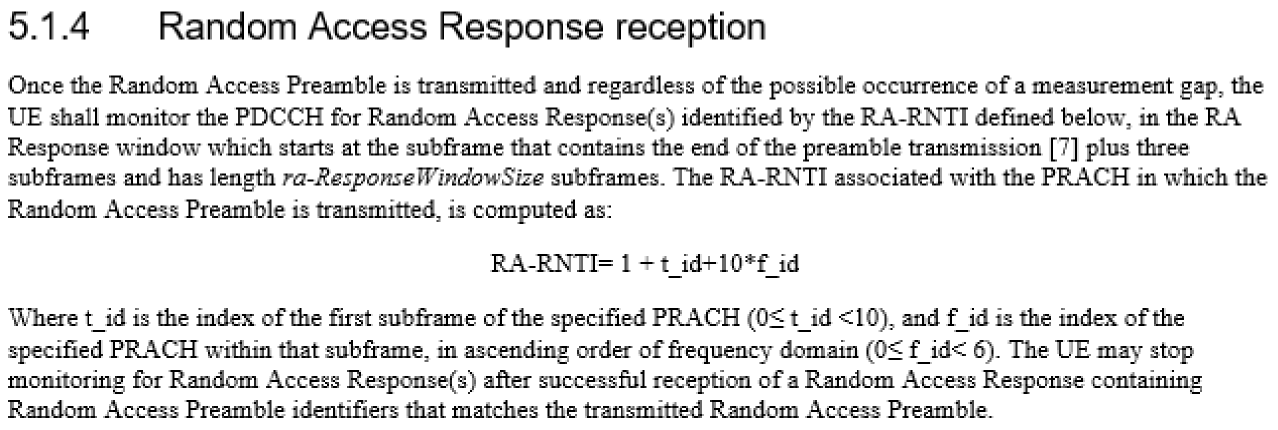
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

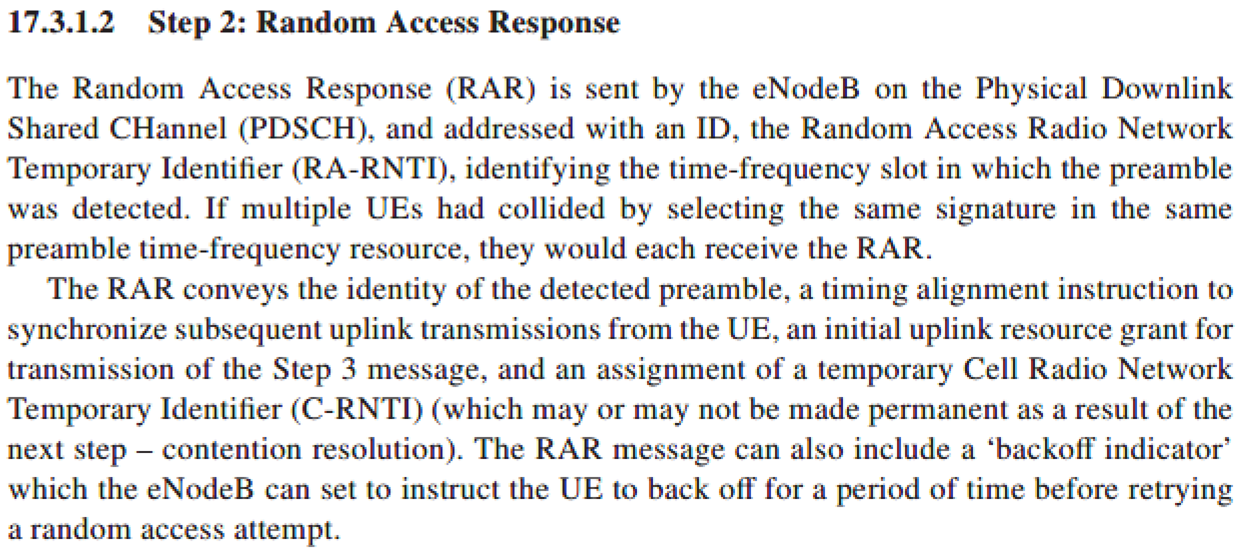
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”



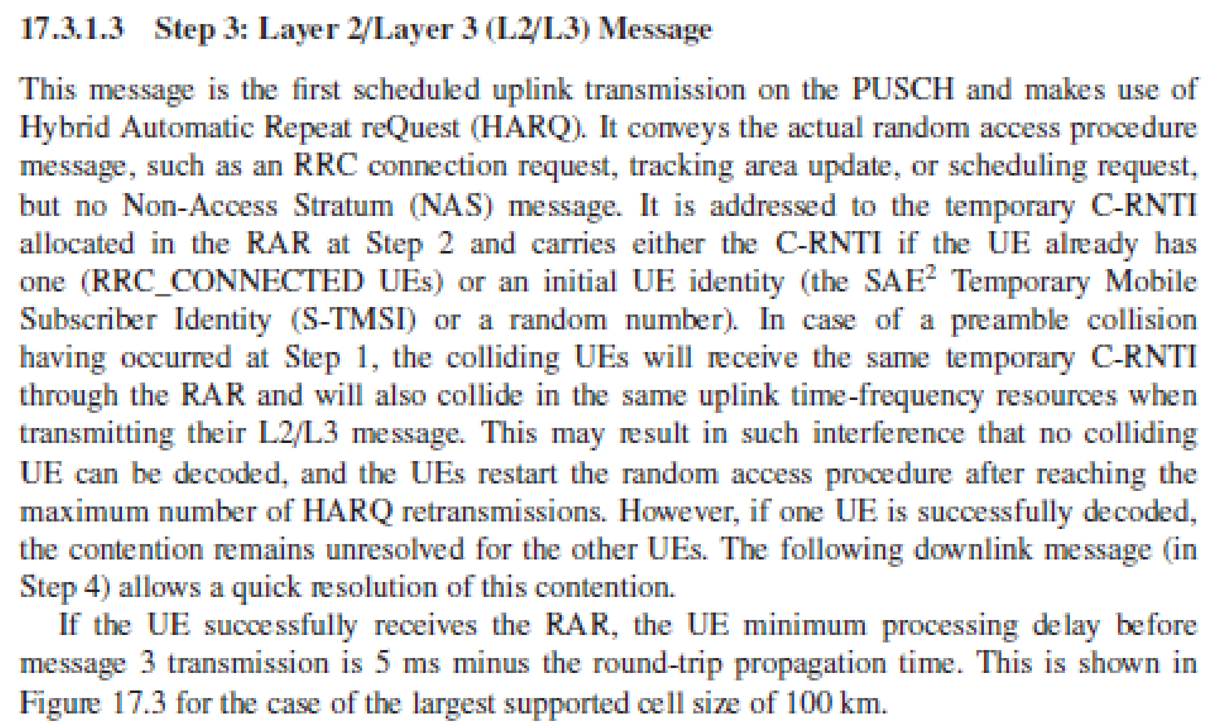
17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

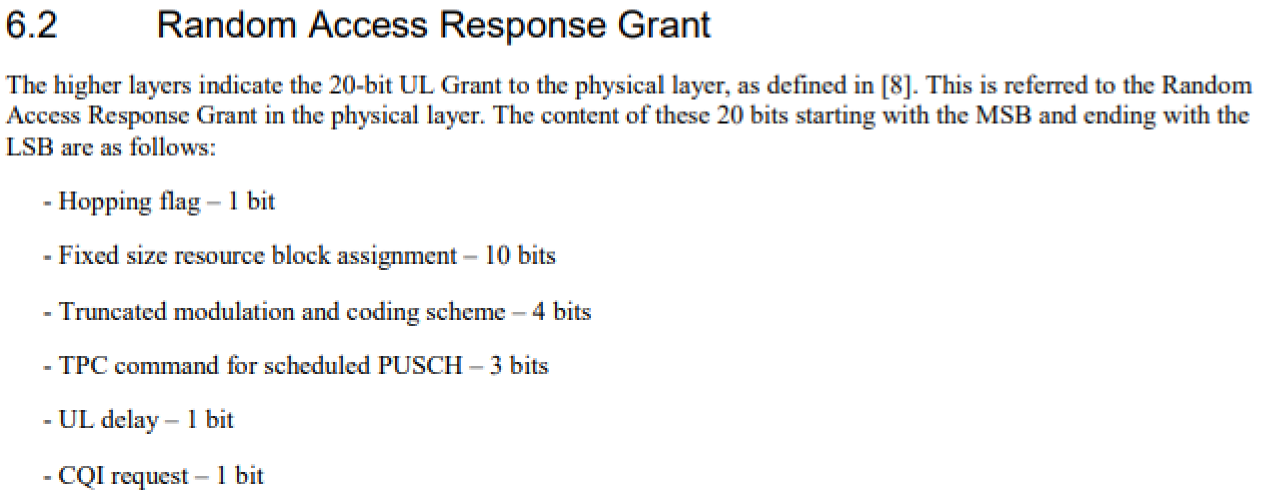
The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

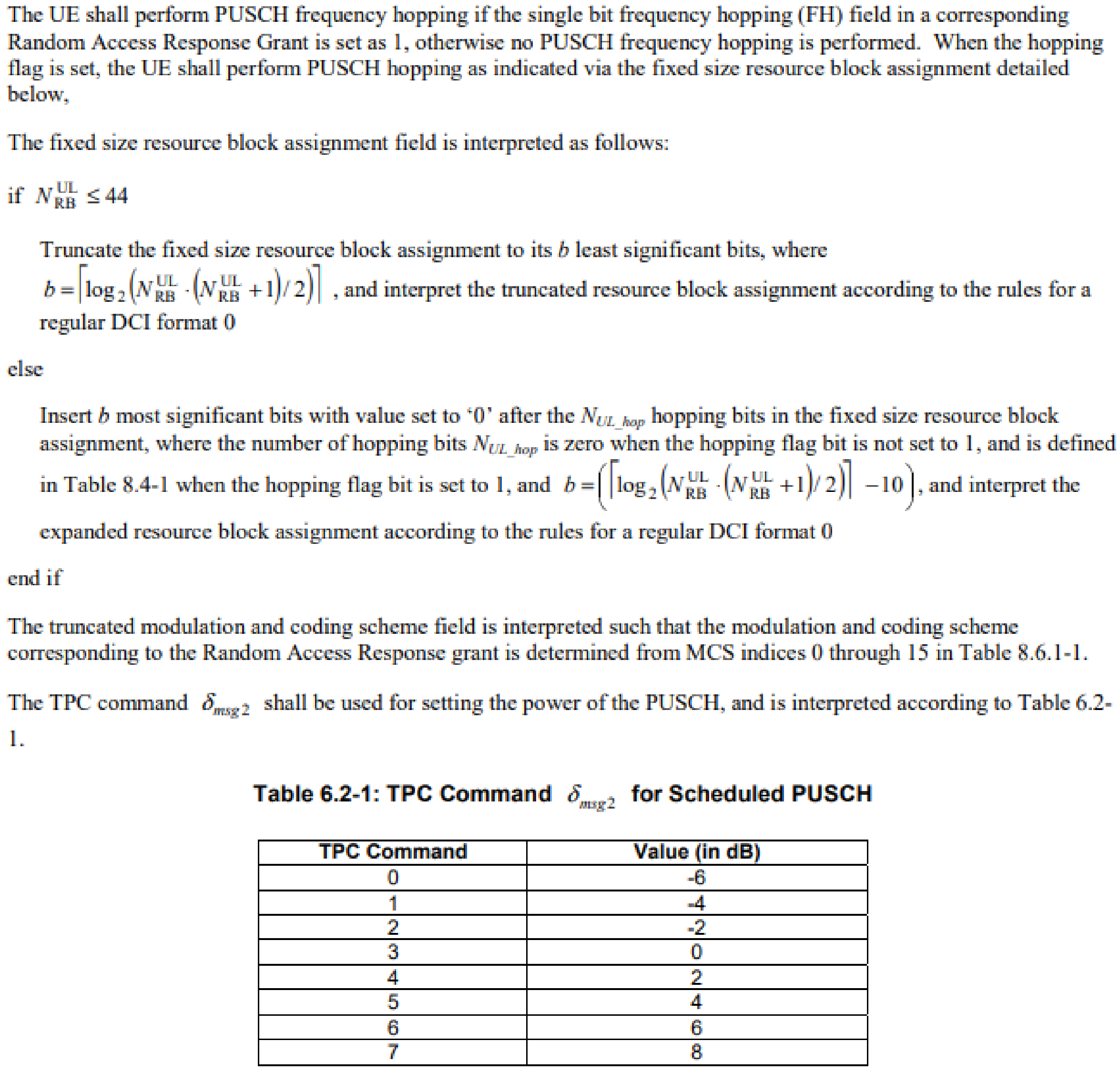
	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE^2 Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
“The mobile station of claim 2, wherein the response message includes power adjustment information and”

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of Nissan’s Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)

“The mobile station of claim 2, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

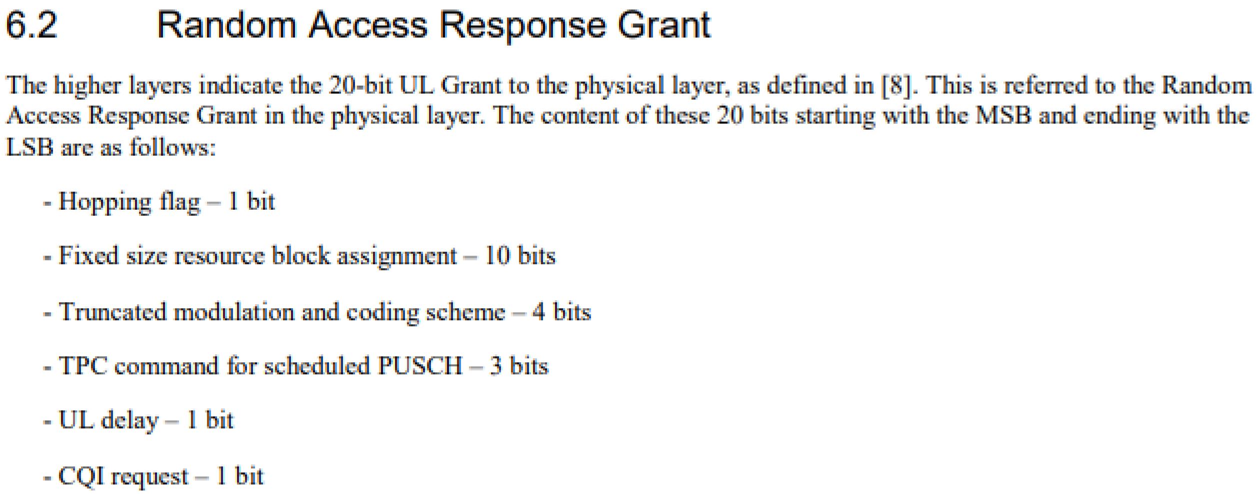
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

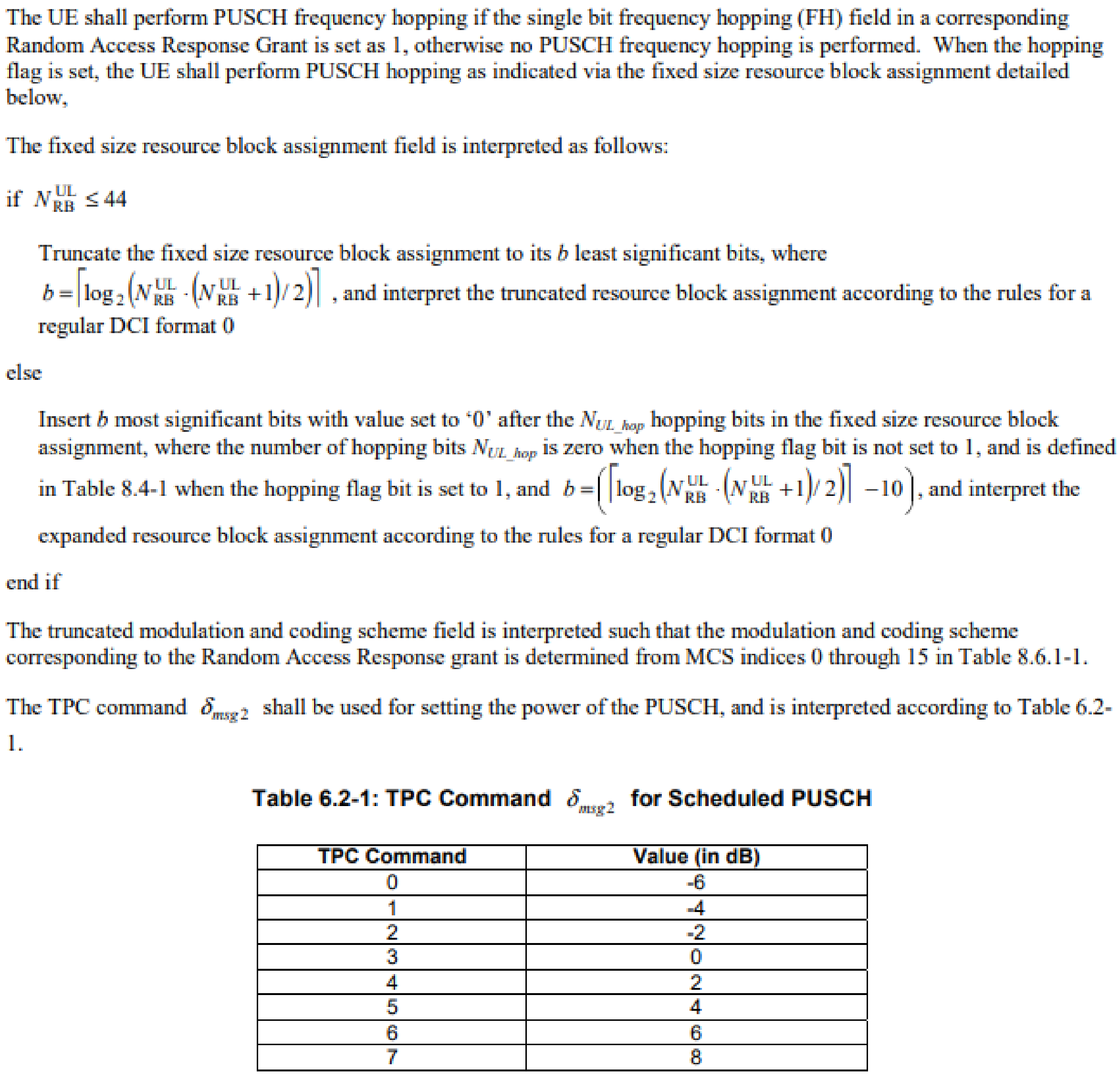
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of Nissan’s Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

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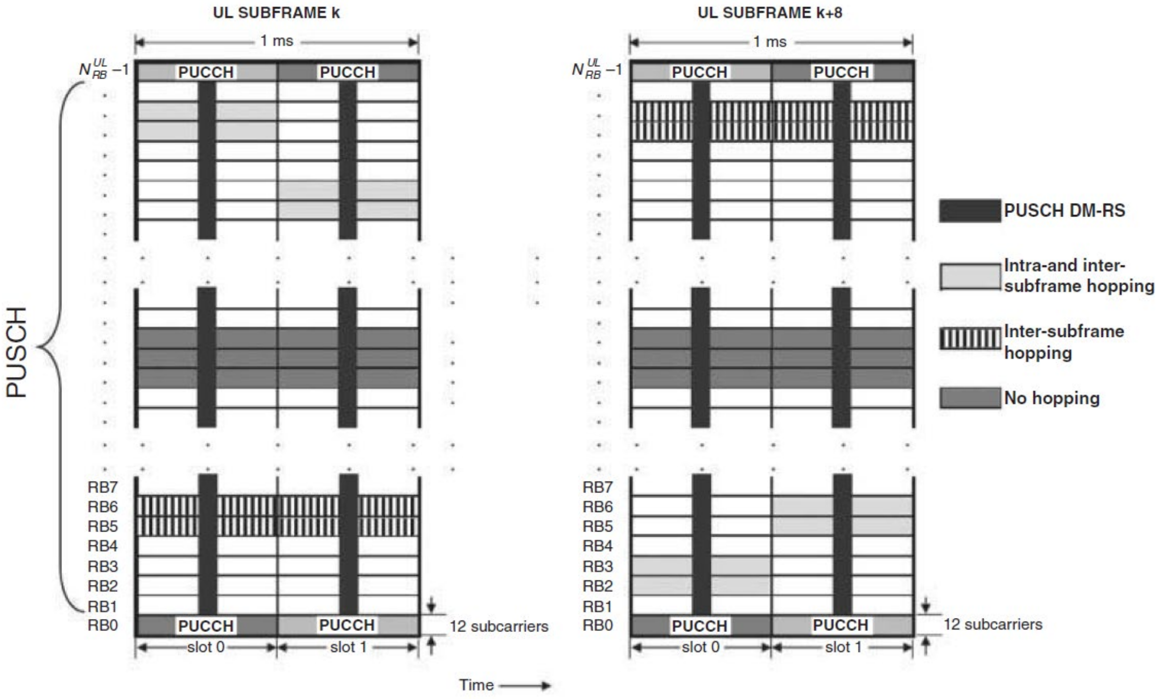
3	0
4	2
5	4
6	6
7	8

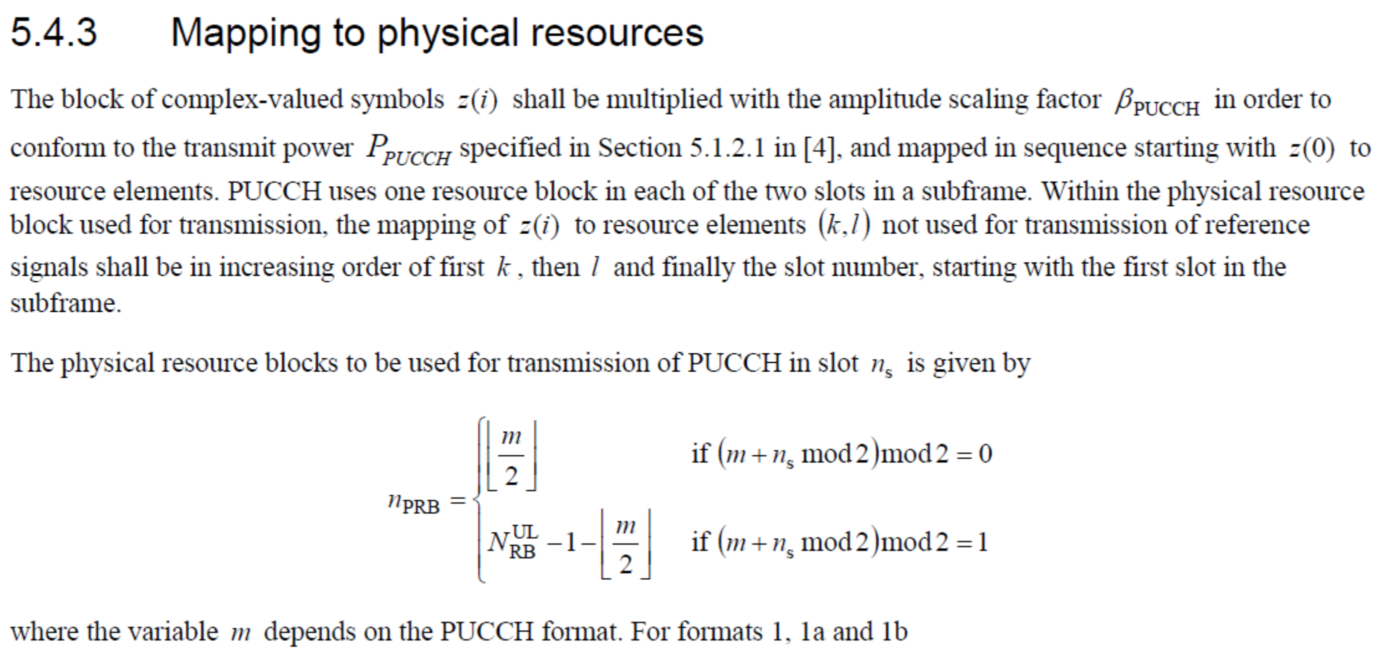
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of Nissan's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure"). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

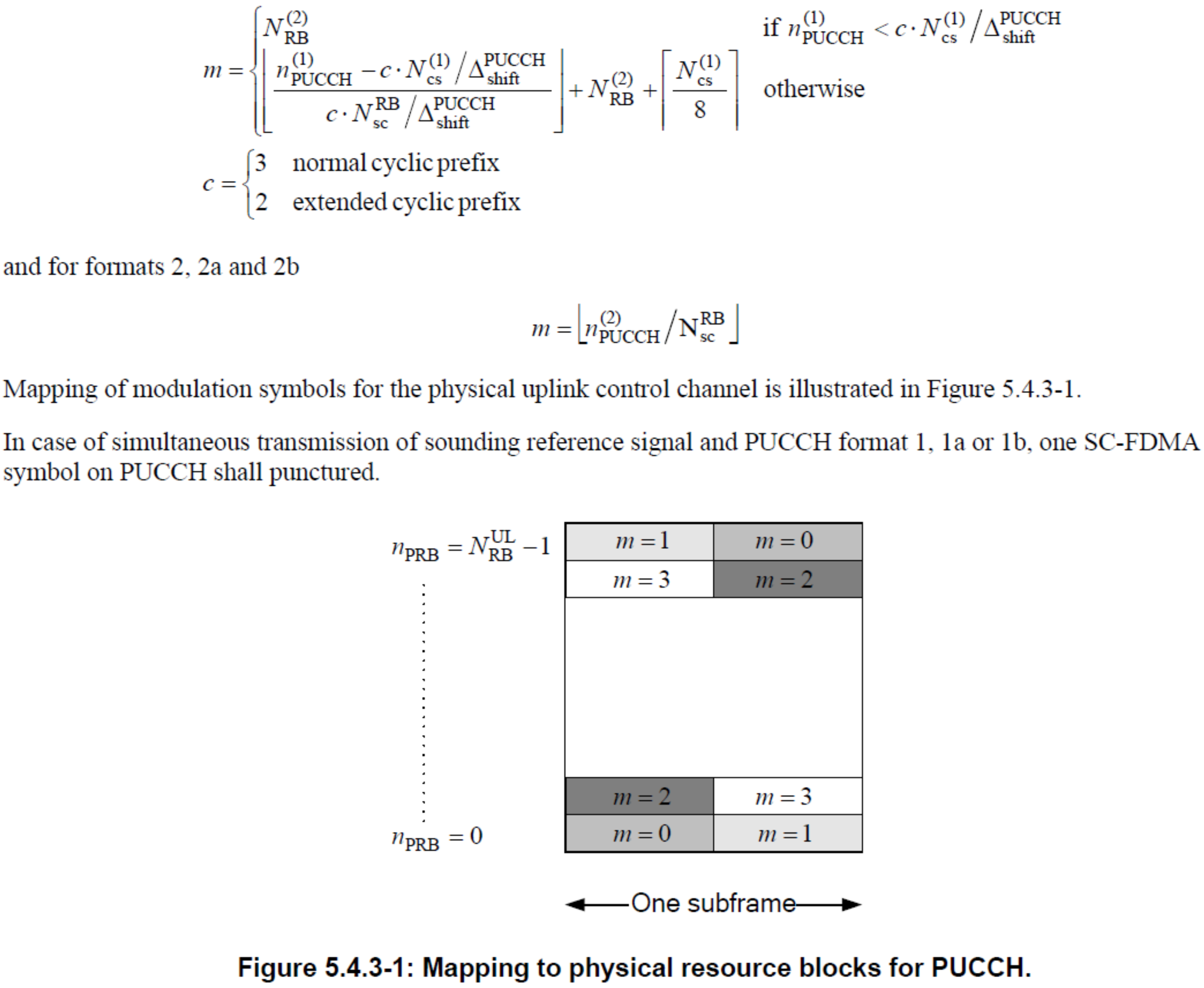
The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

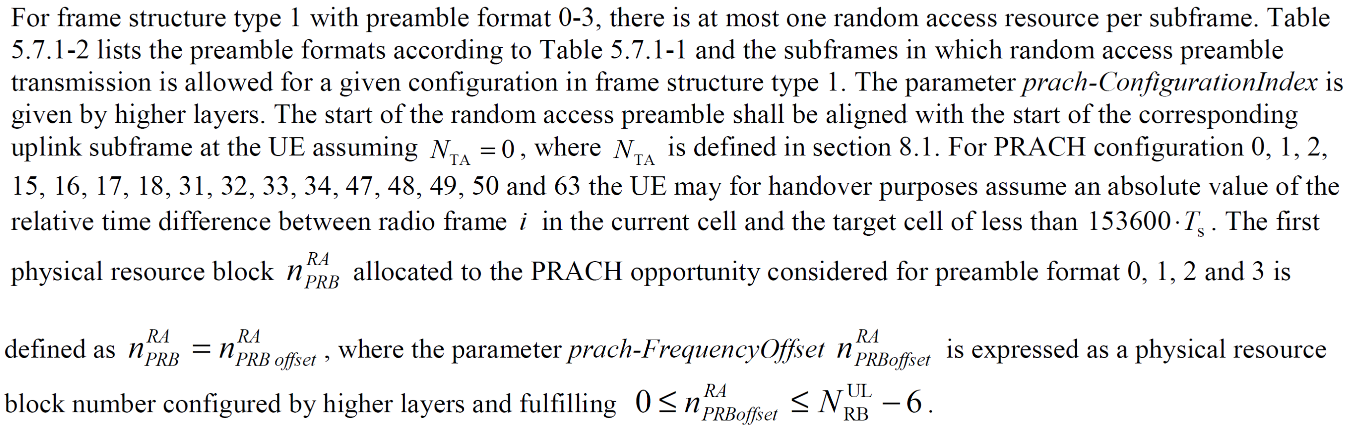
US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

...



For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\text{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\text{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\ offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \leq n^{RA}_{PRBoffset} \leq N^{\text{UL}}_{\text{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

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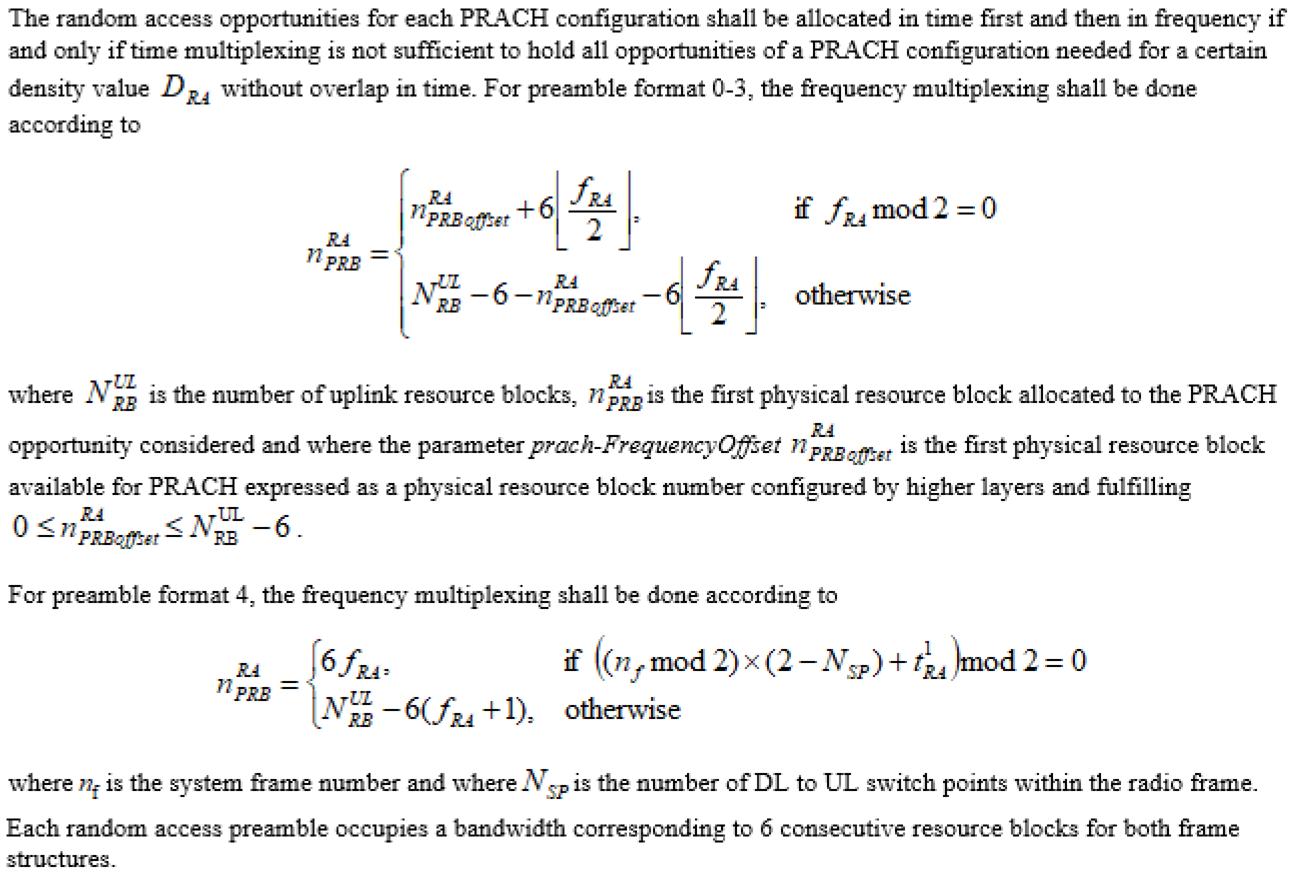

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.
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US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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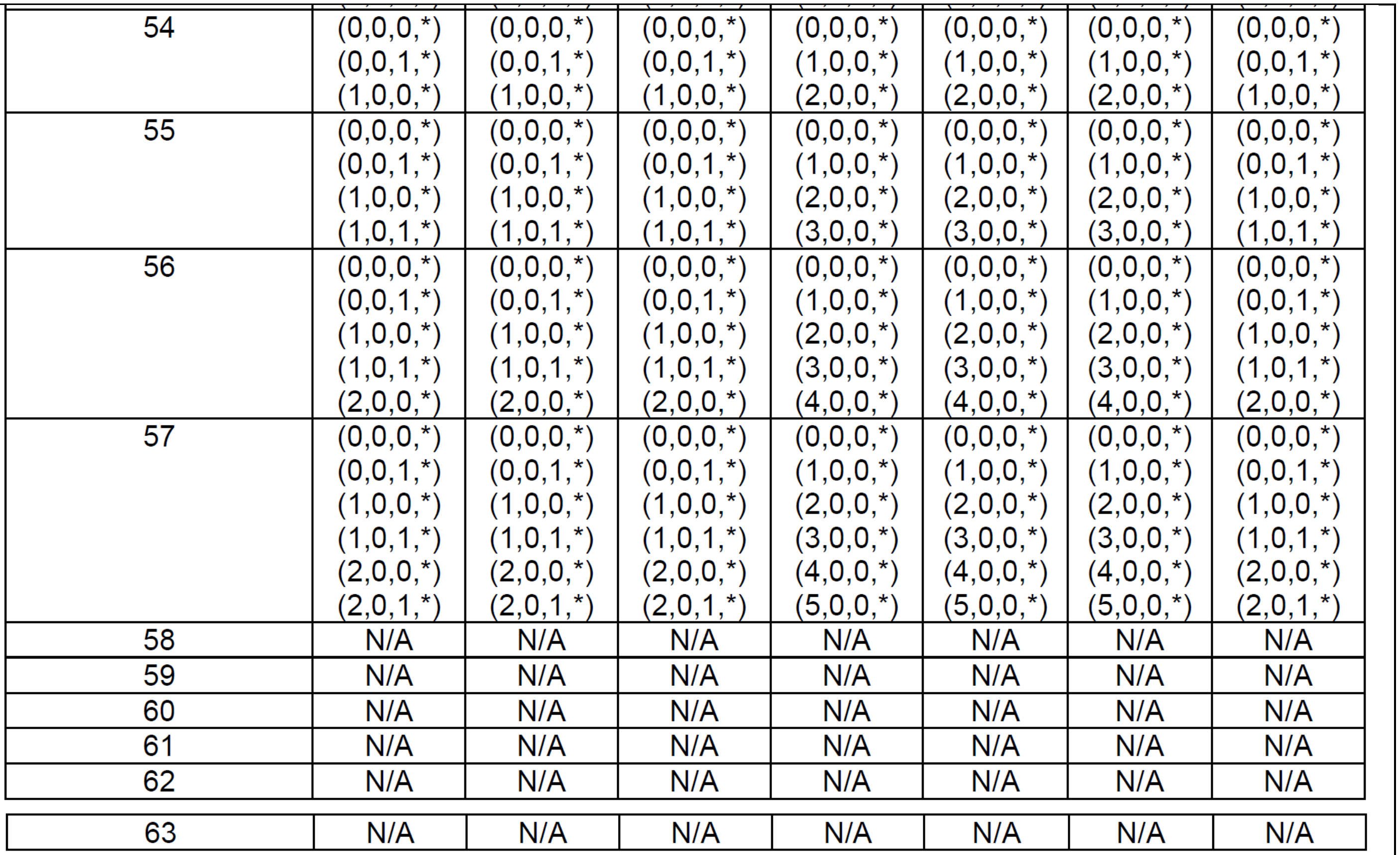
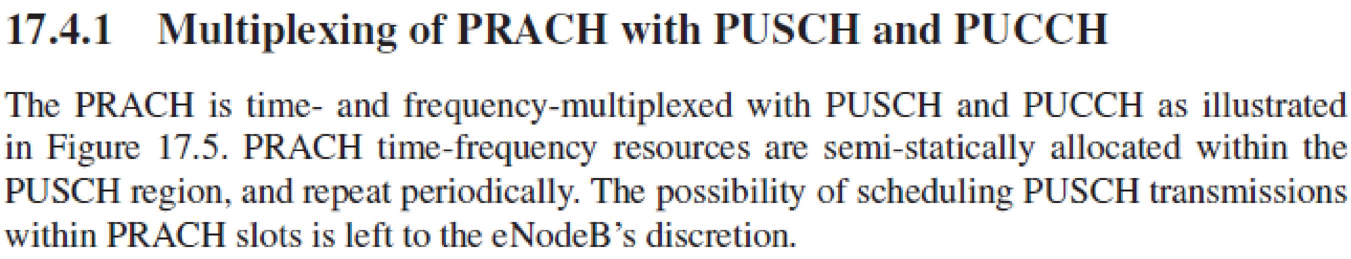


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

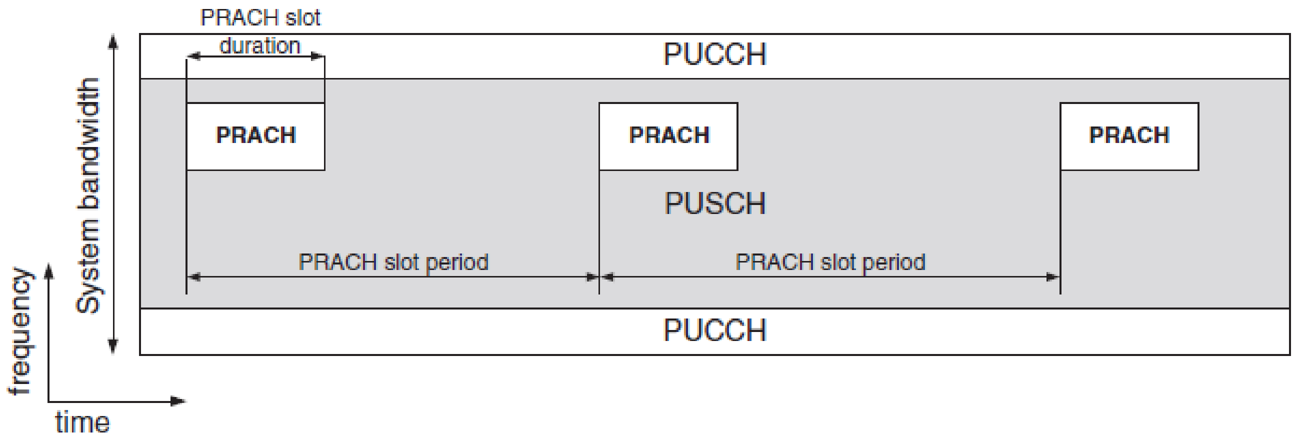
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

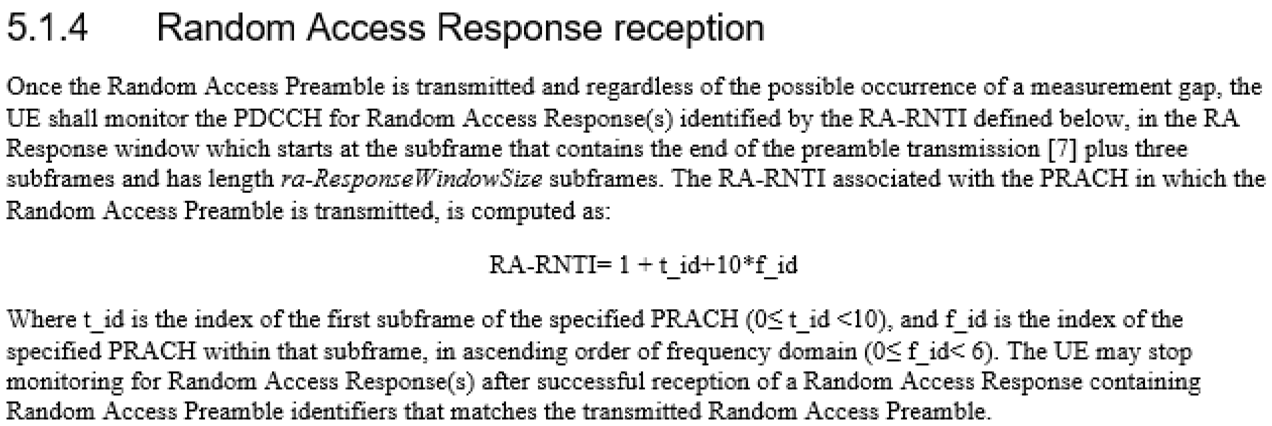
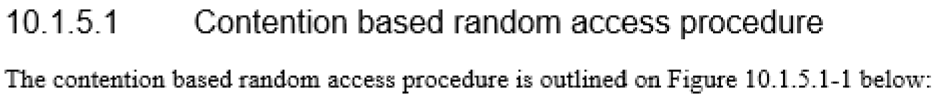
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 4
“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

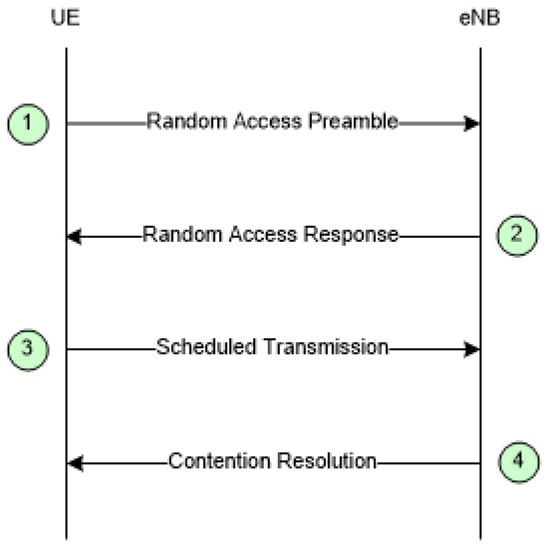
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5.

US Patent No. 10,833,908: Claim 5

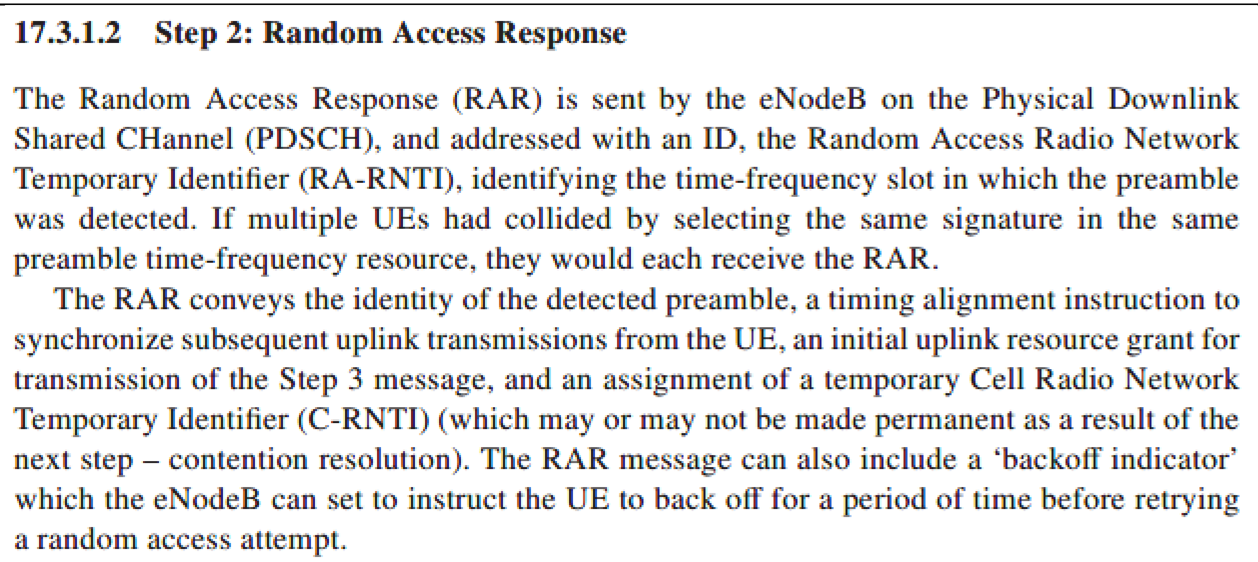
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Nissan's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."



17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

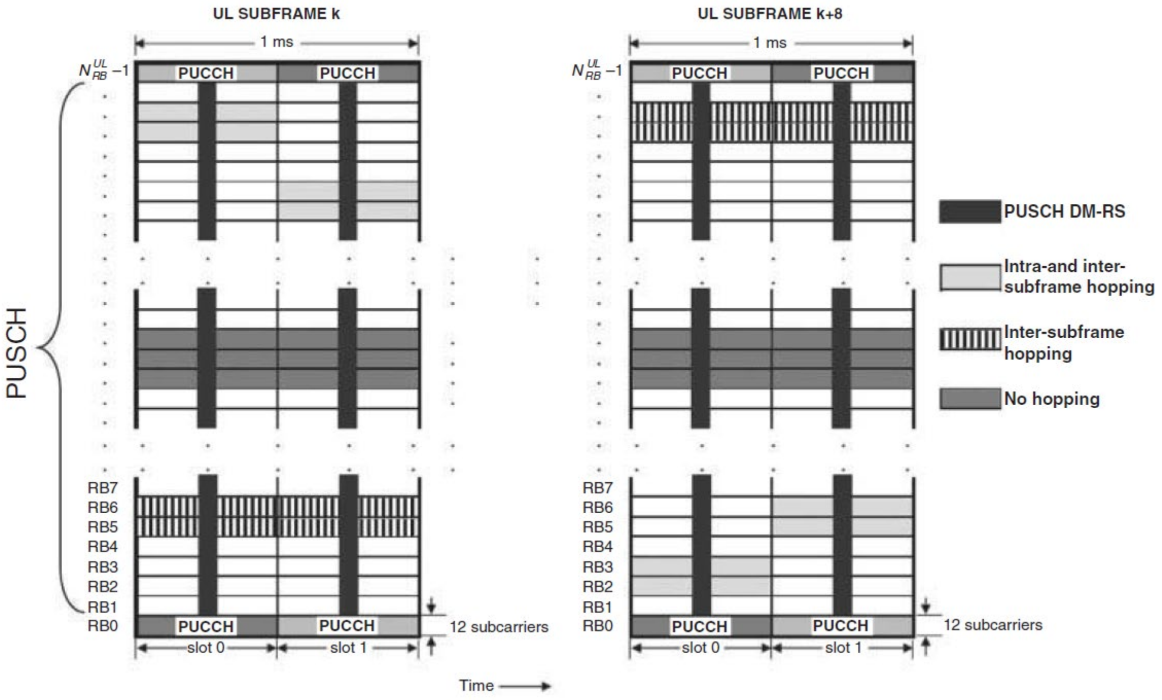
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 6
"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Nissan's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 7

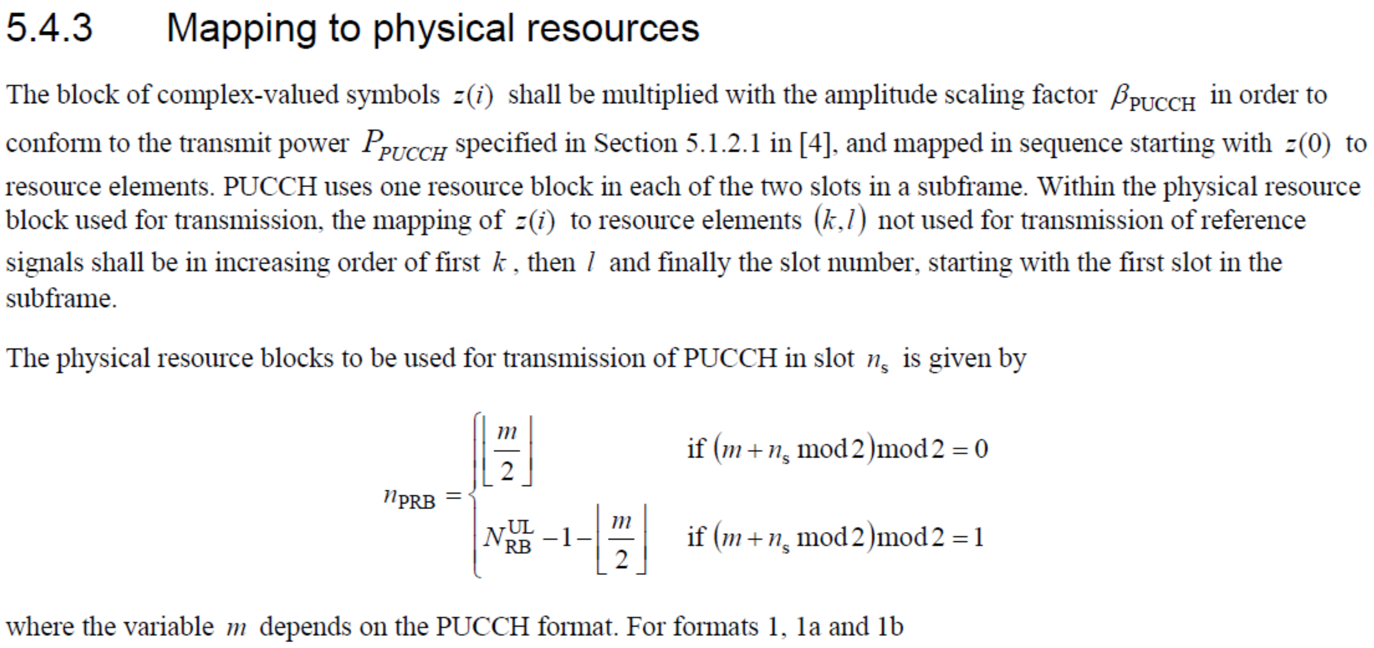
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Nissan's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

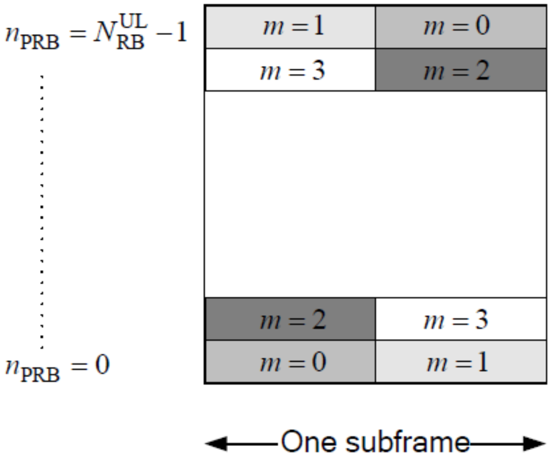


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

...

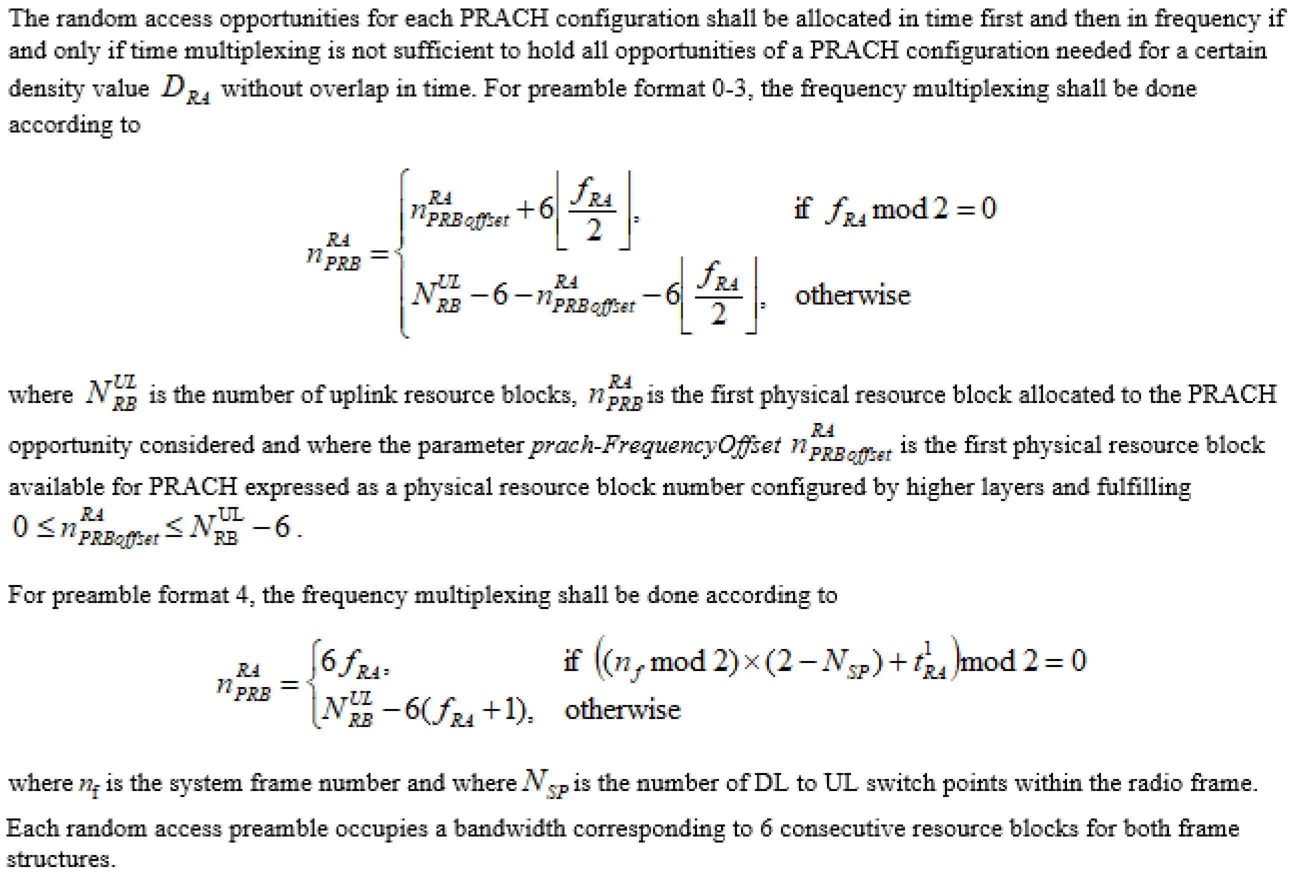
For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is

defined as $n^{RA}_{PRB} = n^{RA}_{PRB\ offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

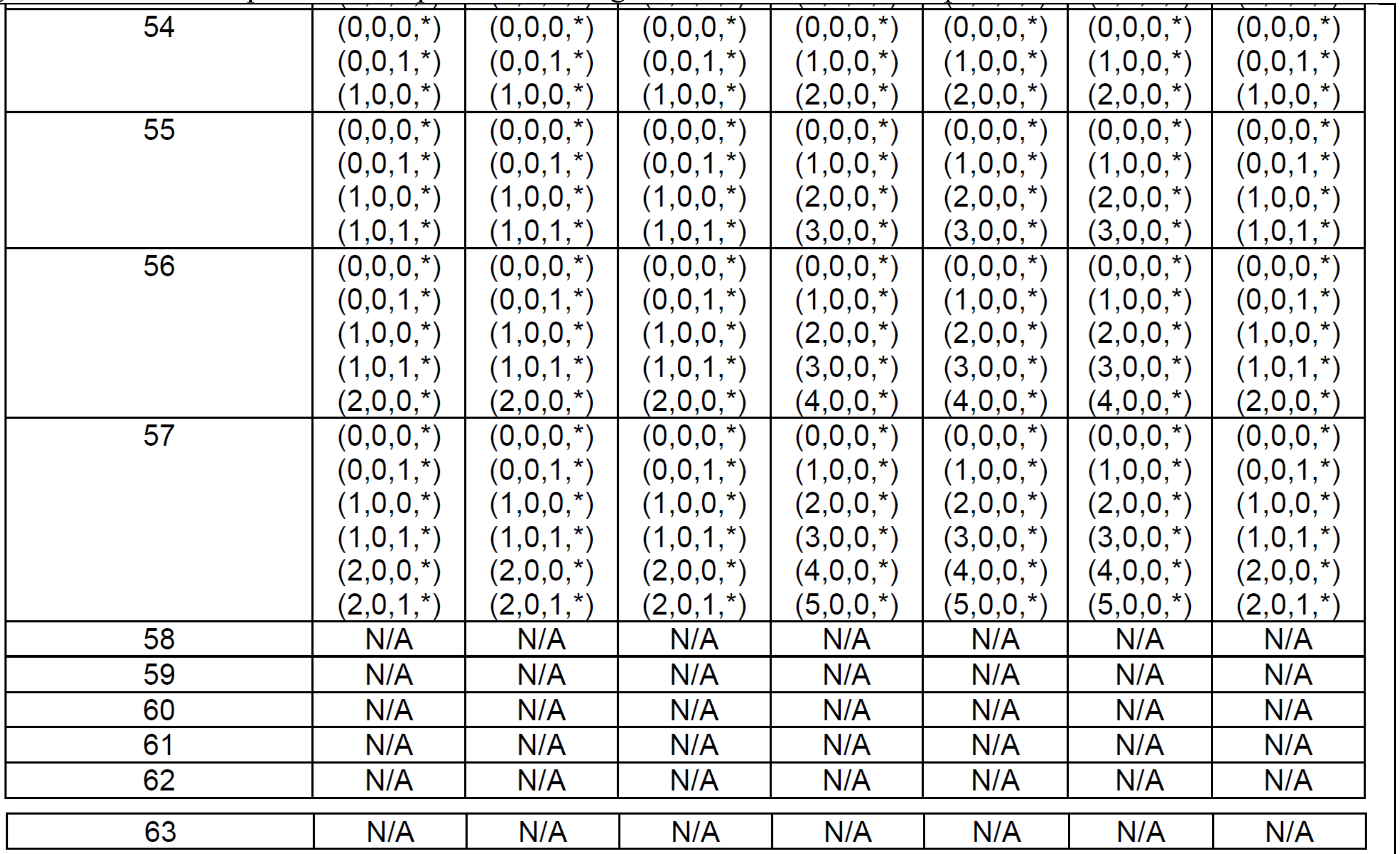
Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.
.
.

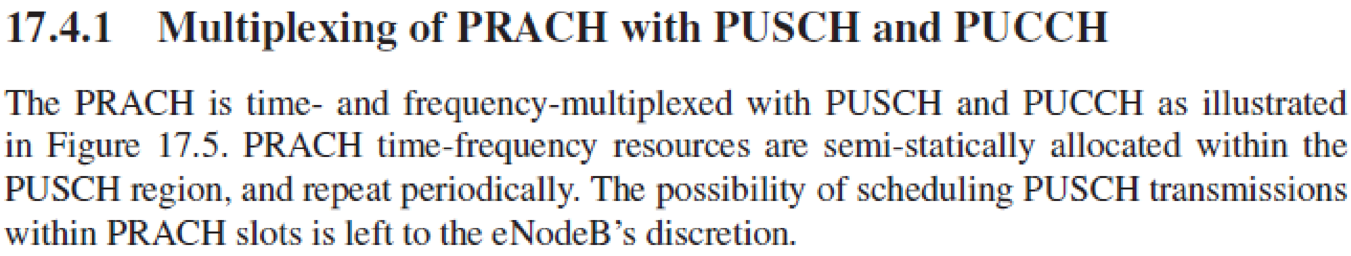
US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

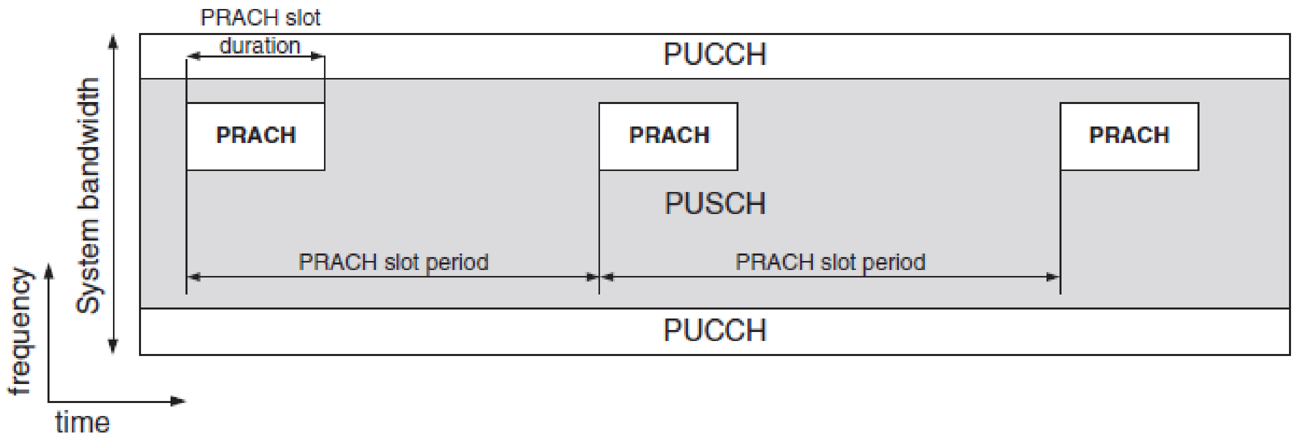


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

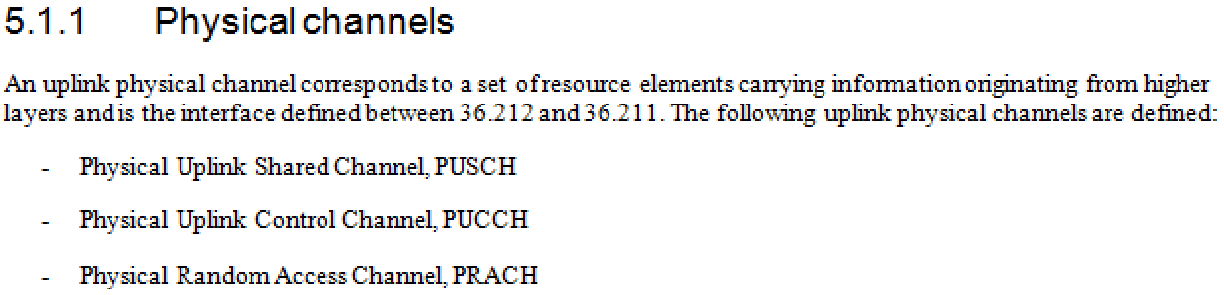
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 7

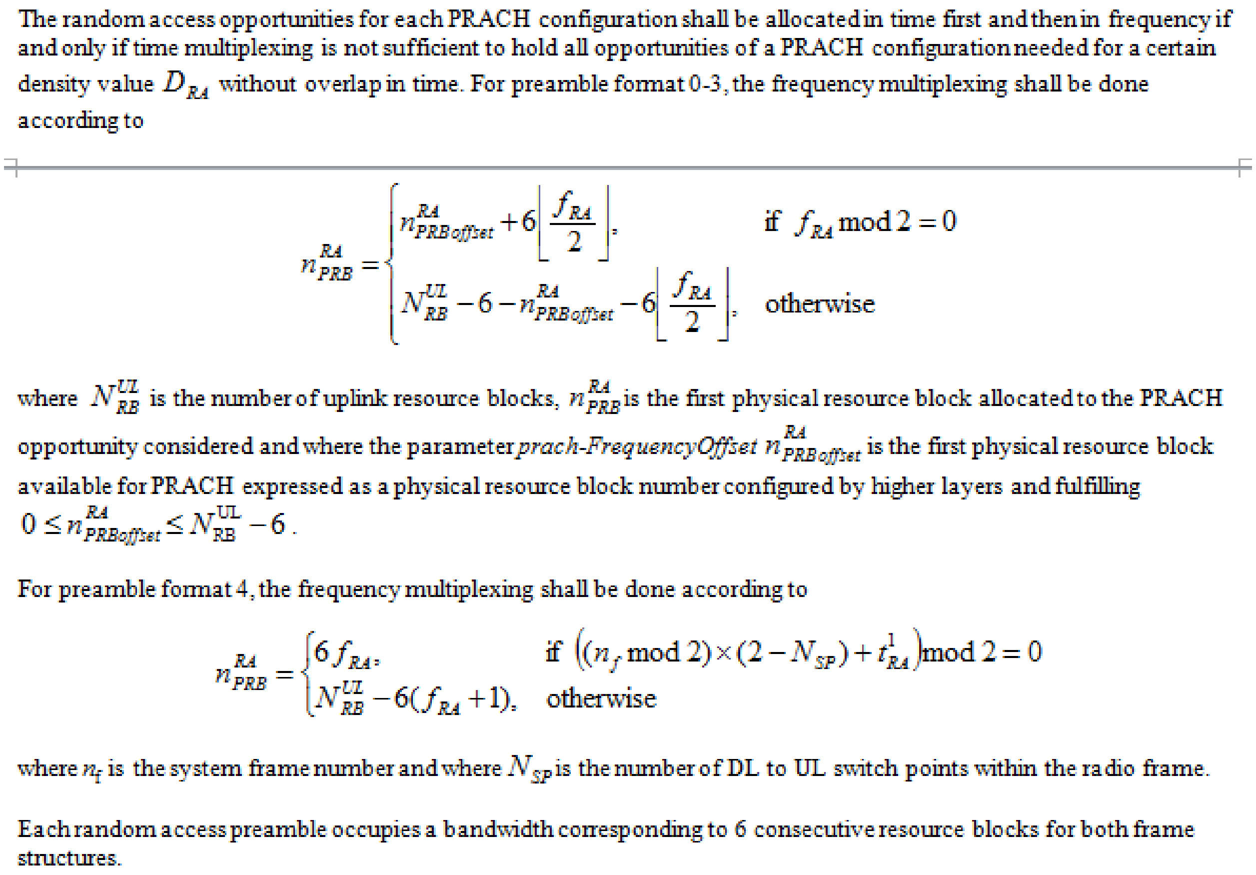
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Nissan's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB. 5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

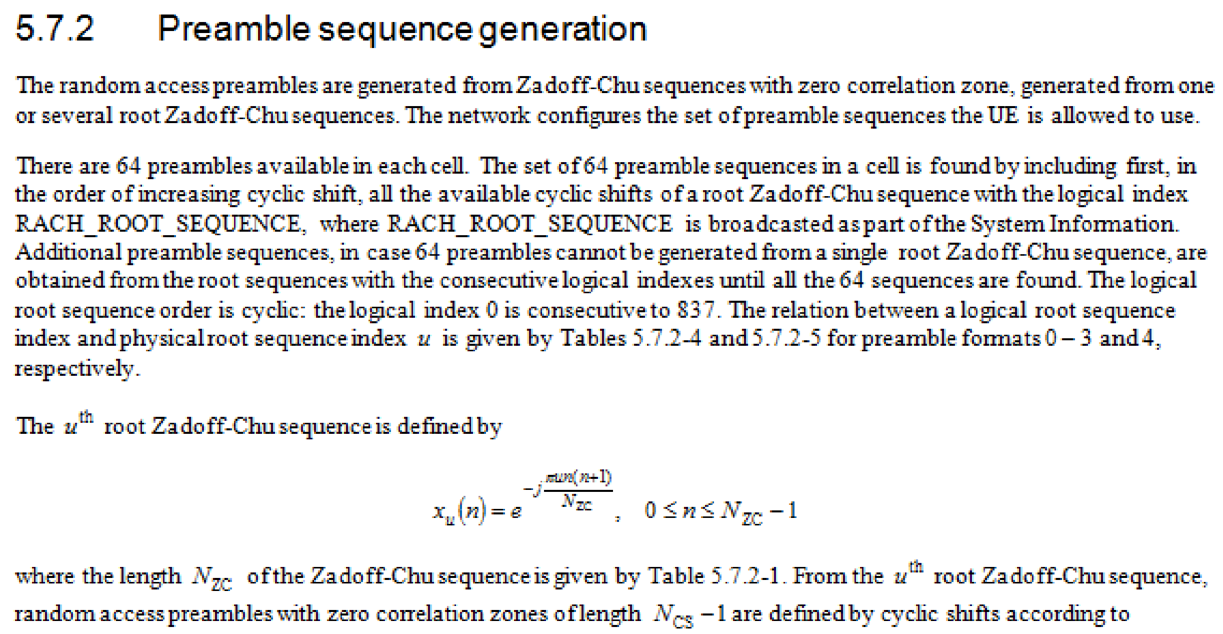
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

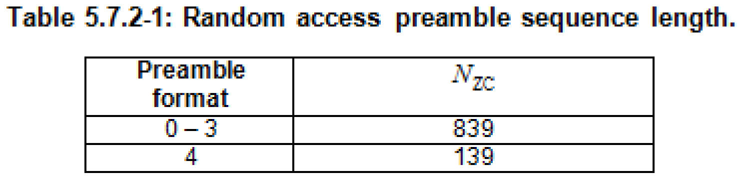
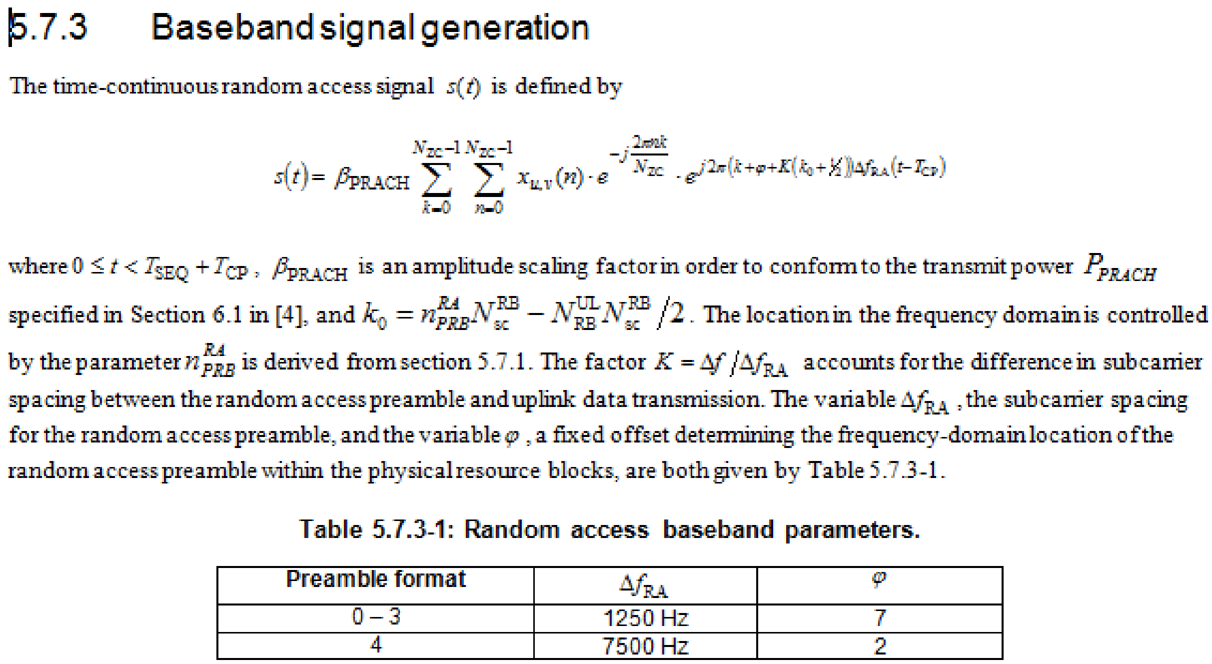


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\text{RA}}\left(t-T_{\text{CP}}\right)}$$

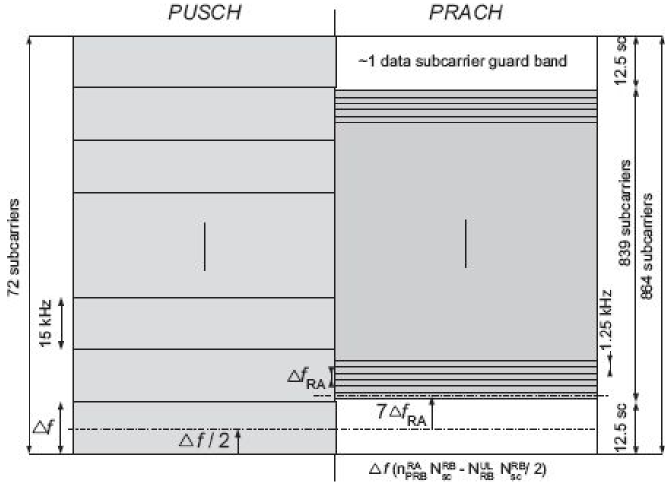
where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

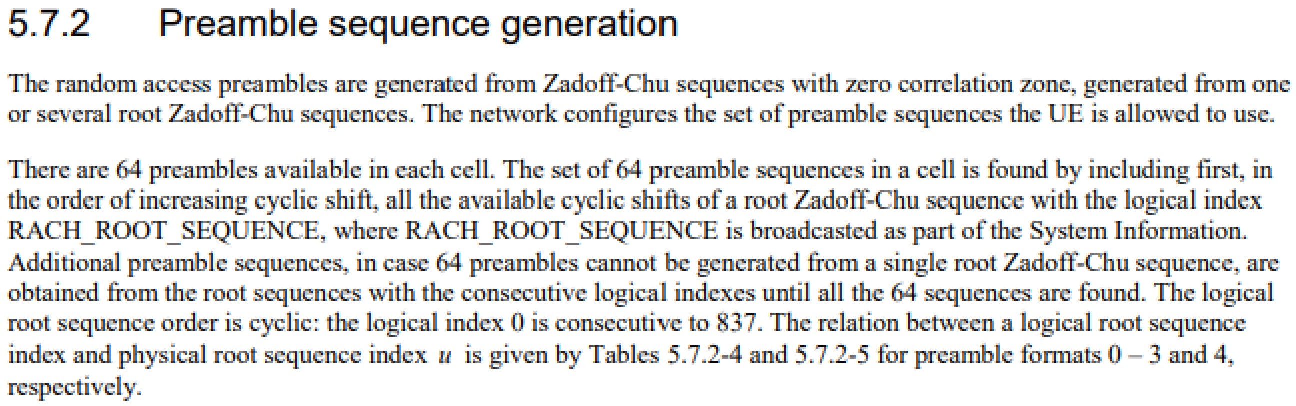
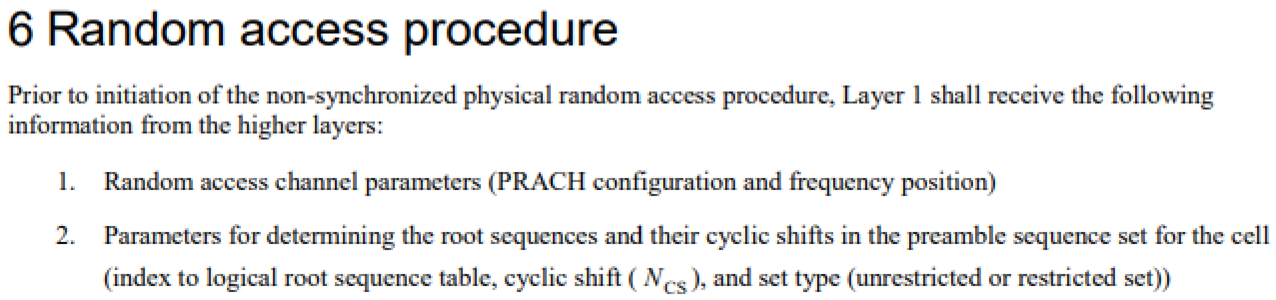
See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Nissan's Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information. **5.7.2 Preamble sequence generation** The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39. **6 Random access procedure** Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

```
-- ASN1STOP
```

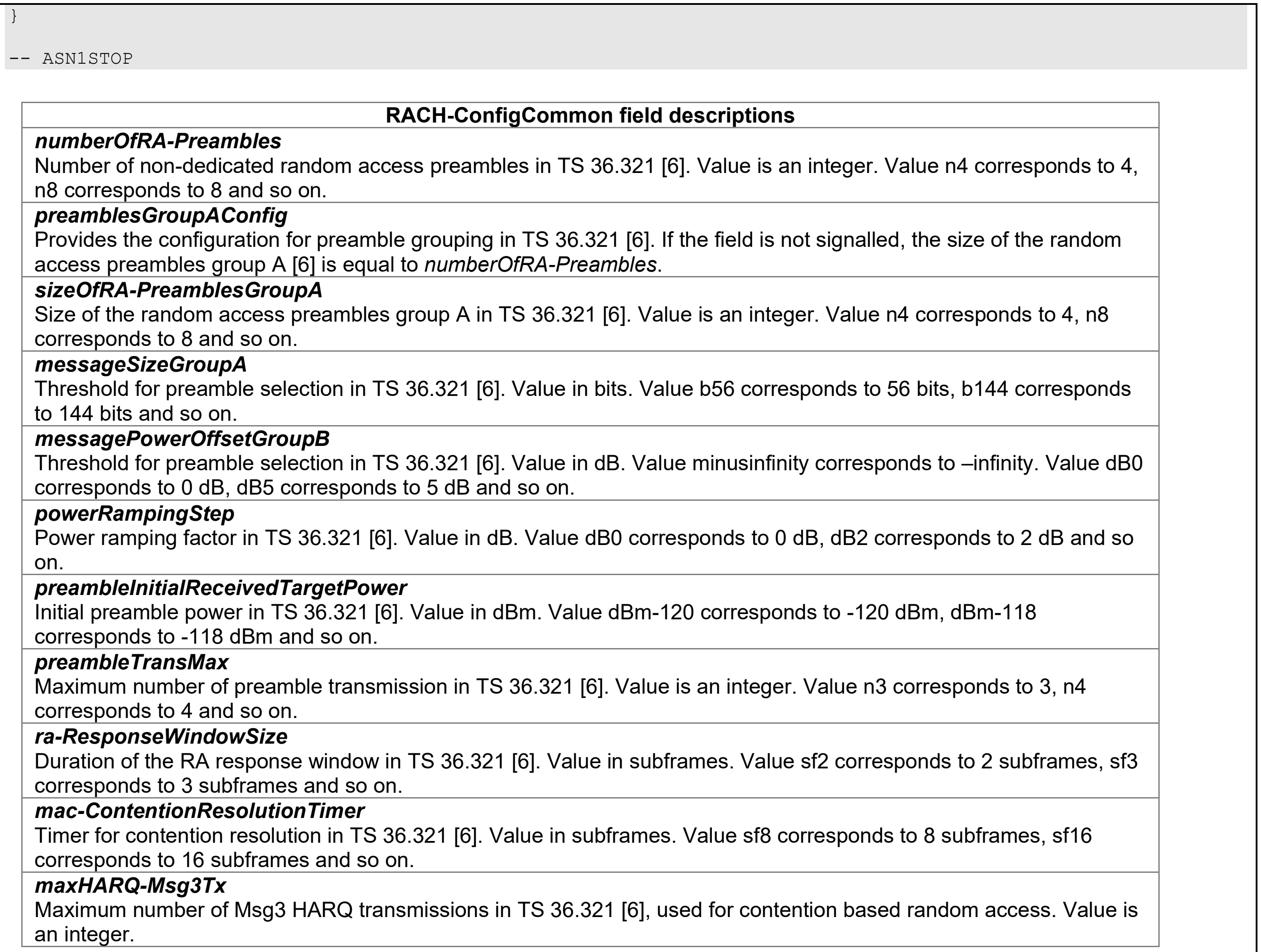
See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                        -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```



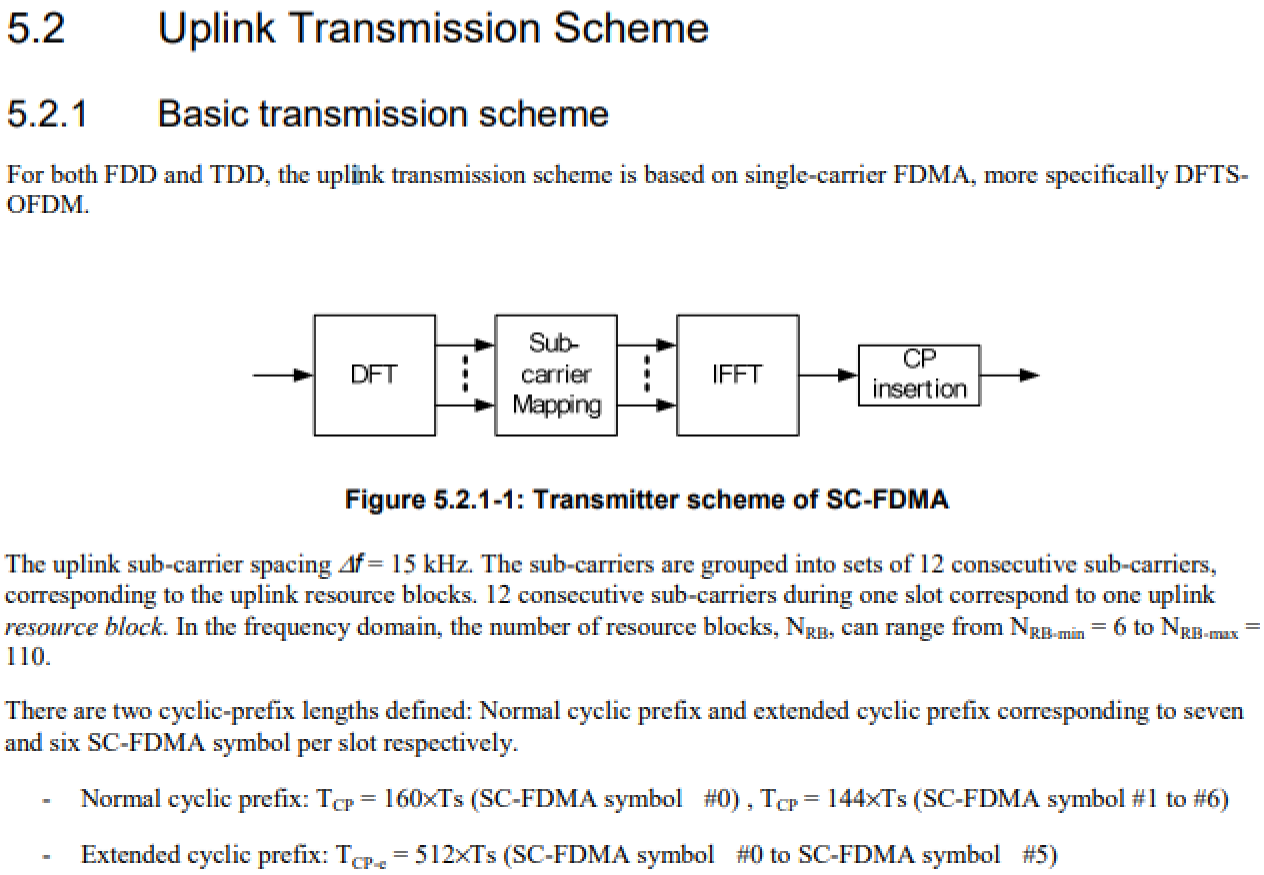
```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

US Patent No. 10,833,908: Claim 10

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 1. Nissan's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Nissan's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

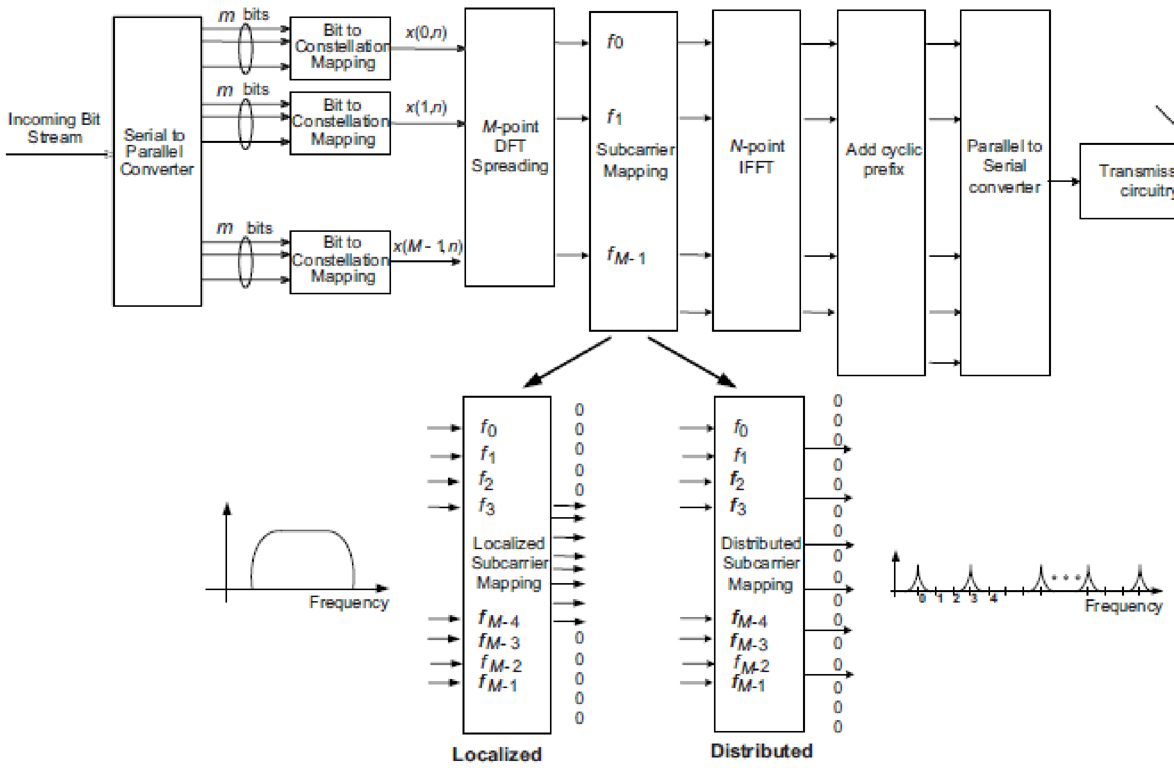
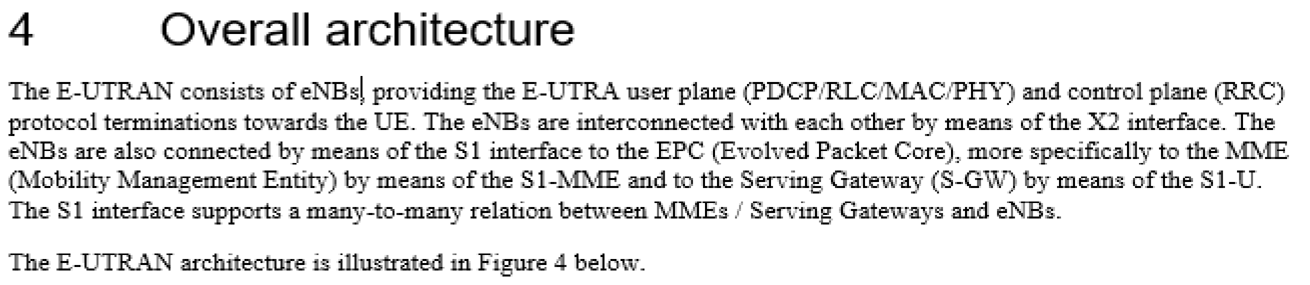


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, Nissan's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* Nissan's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Nissan offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

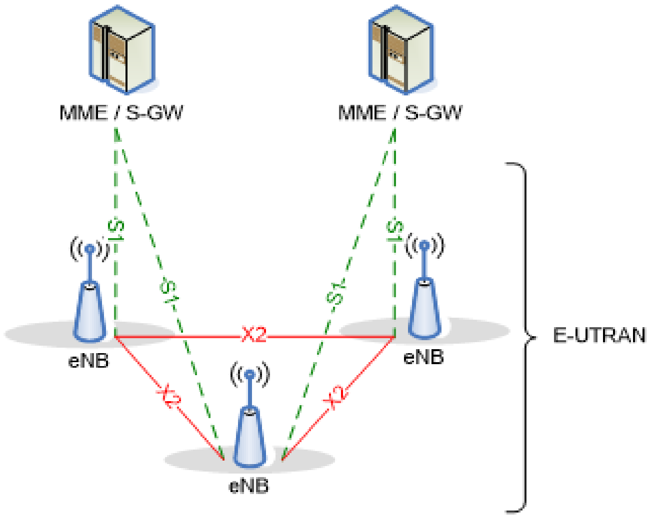
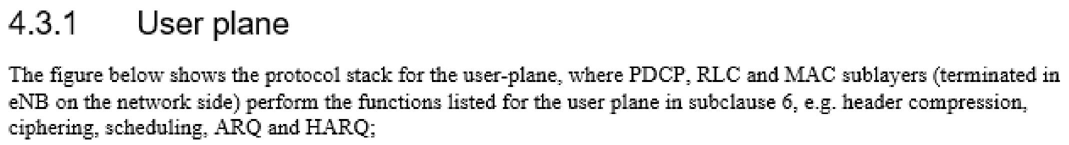


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

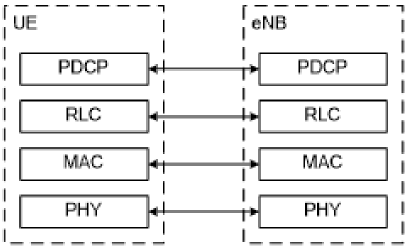


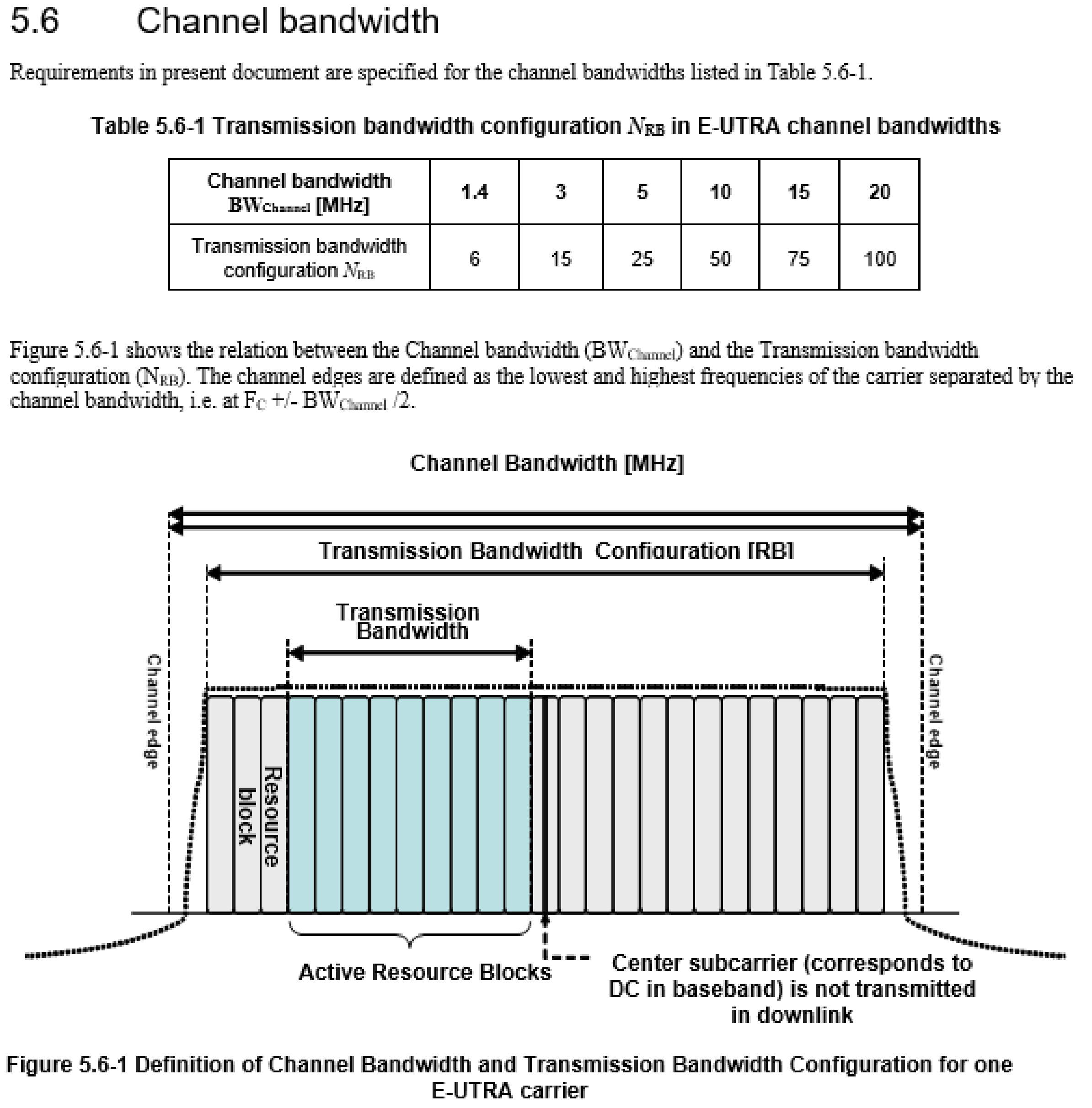
Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Nissan’s Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

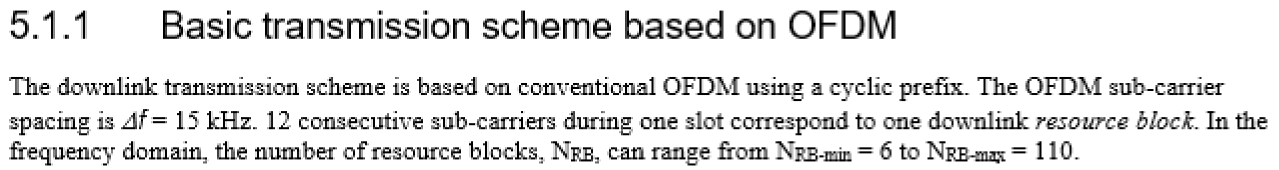
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

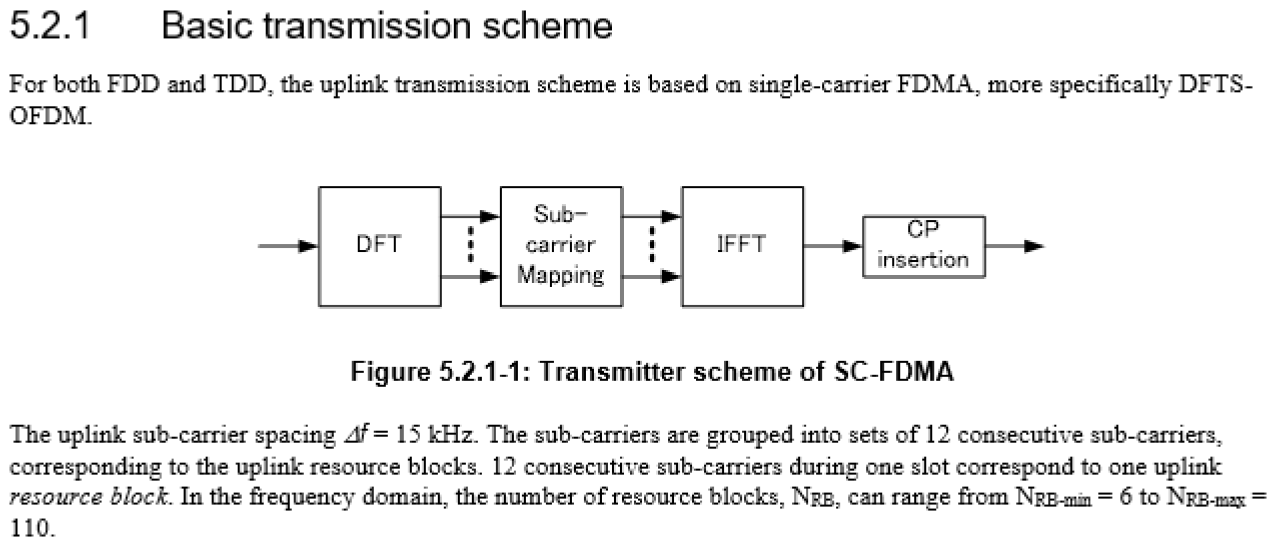
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

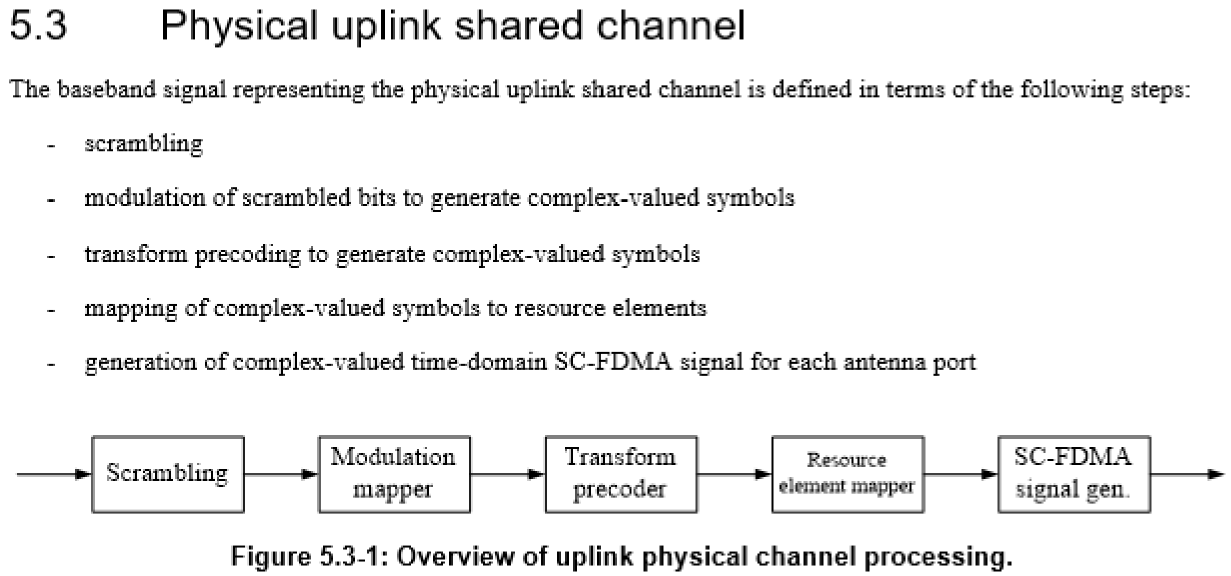
The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

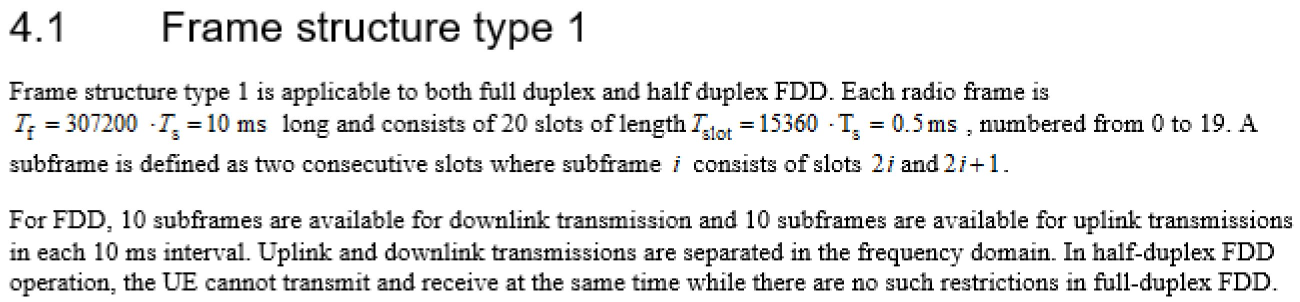
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

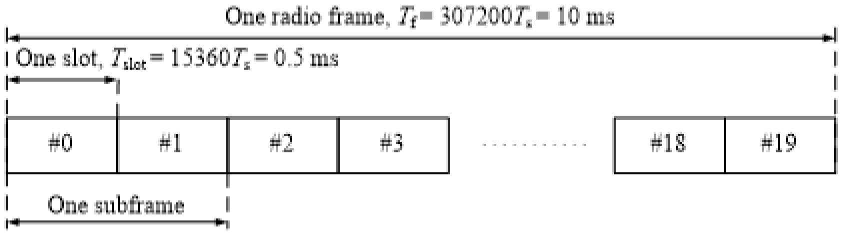
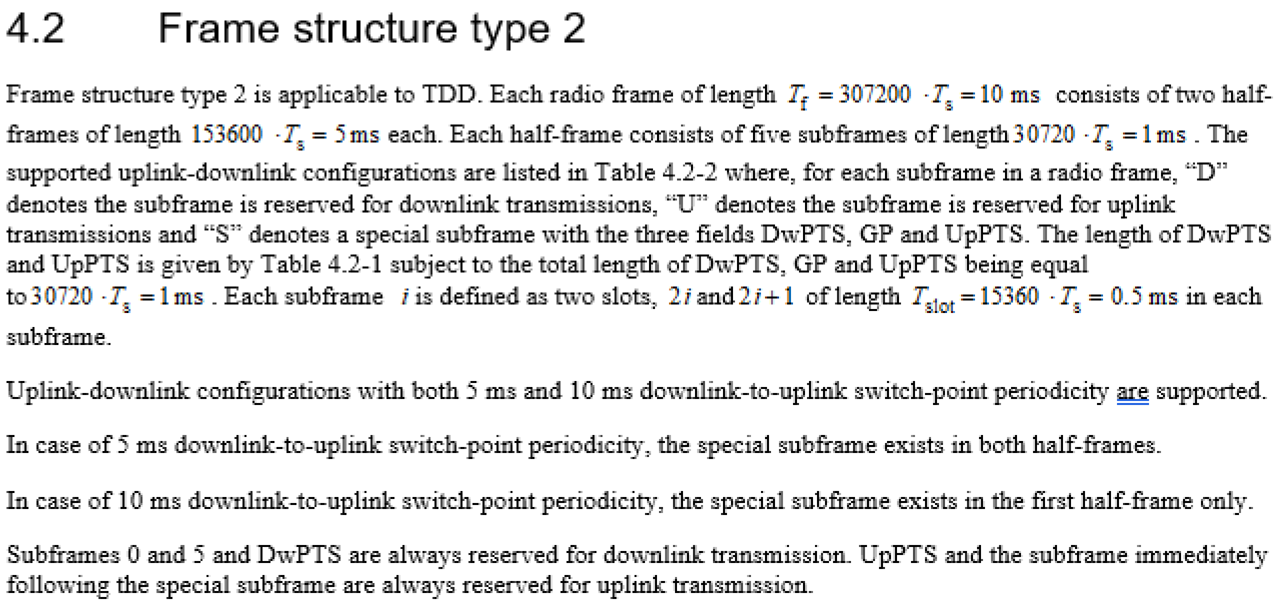


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

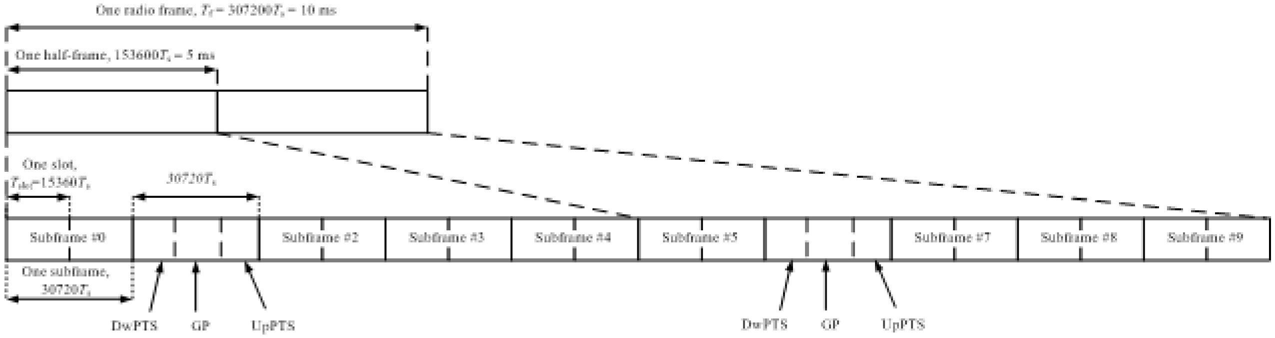
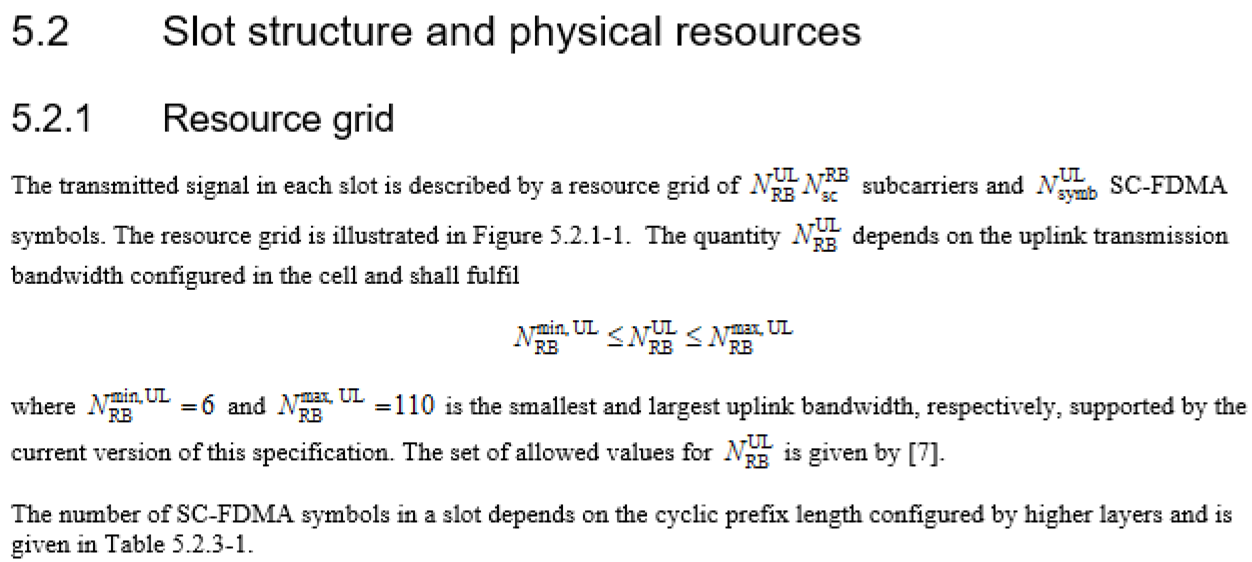


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}}$ subcarriers and $N_{\text{symb}}^{\text{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\text{RB}}^{\text{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

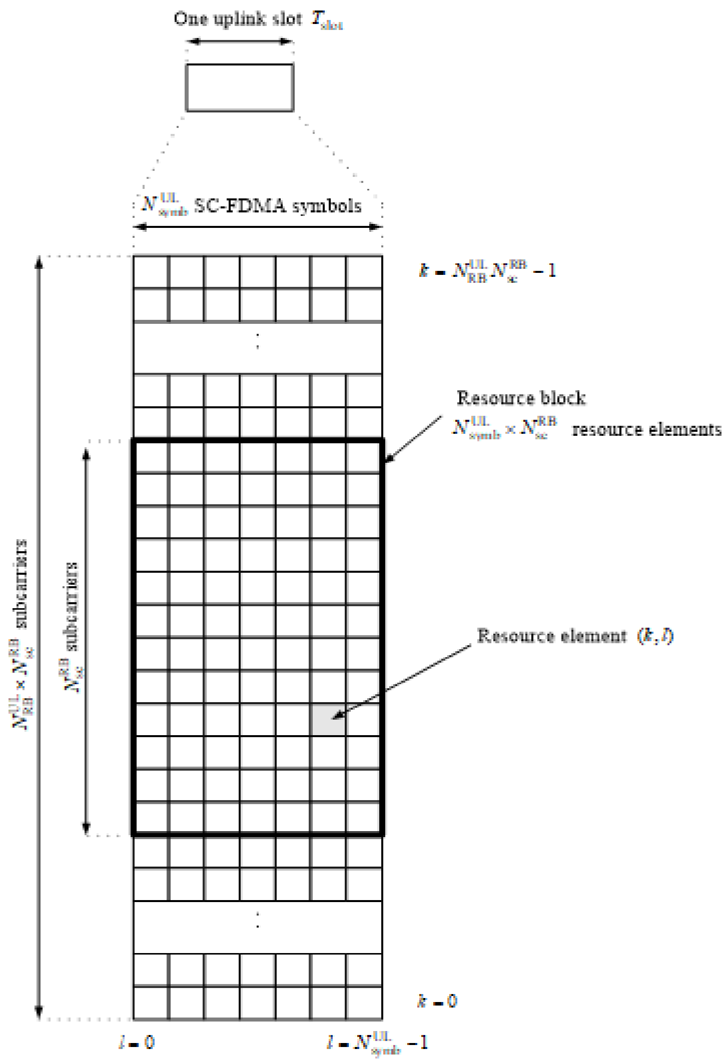
$$N_{\text{RB}}^{\text{min, UL}} \leq N_{\text{RB}}^{\text{UL}} \leq N_{\text{RB}}^{\text{max, UL}}$$

where $N_{\text{RB}}^{\text{min,UL}} = 6$ and $N_{\text{RB}}^{\text{max, UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\text{RB}}^{\text{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

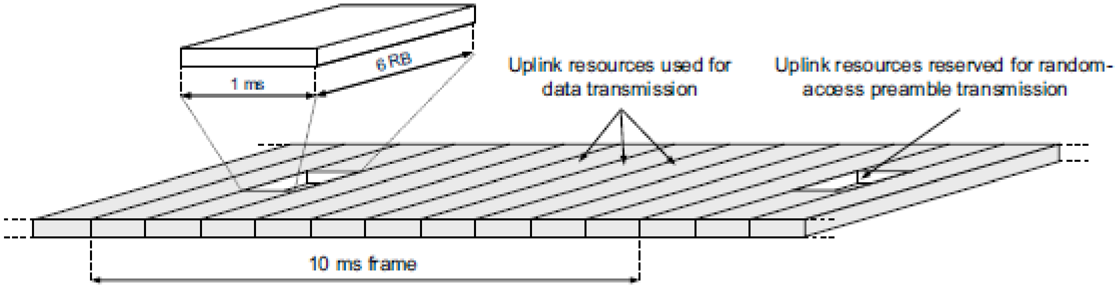
US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

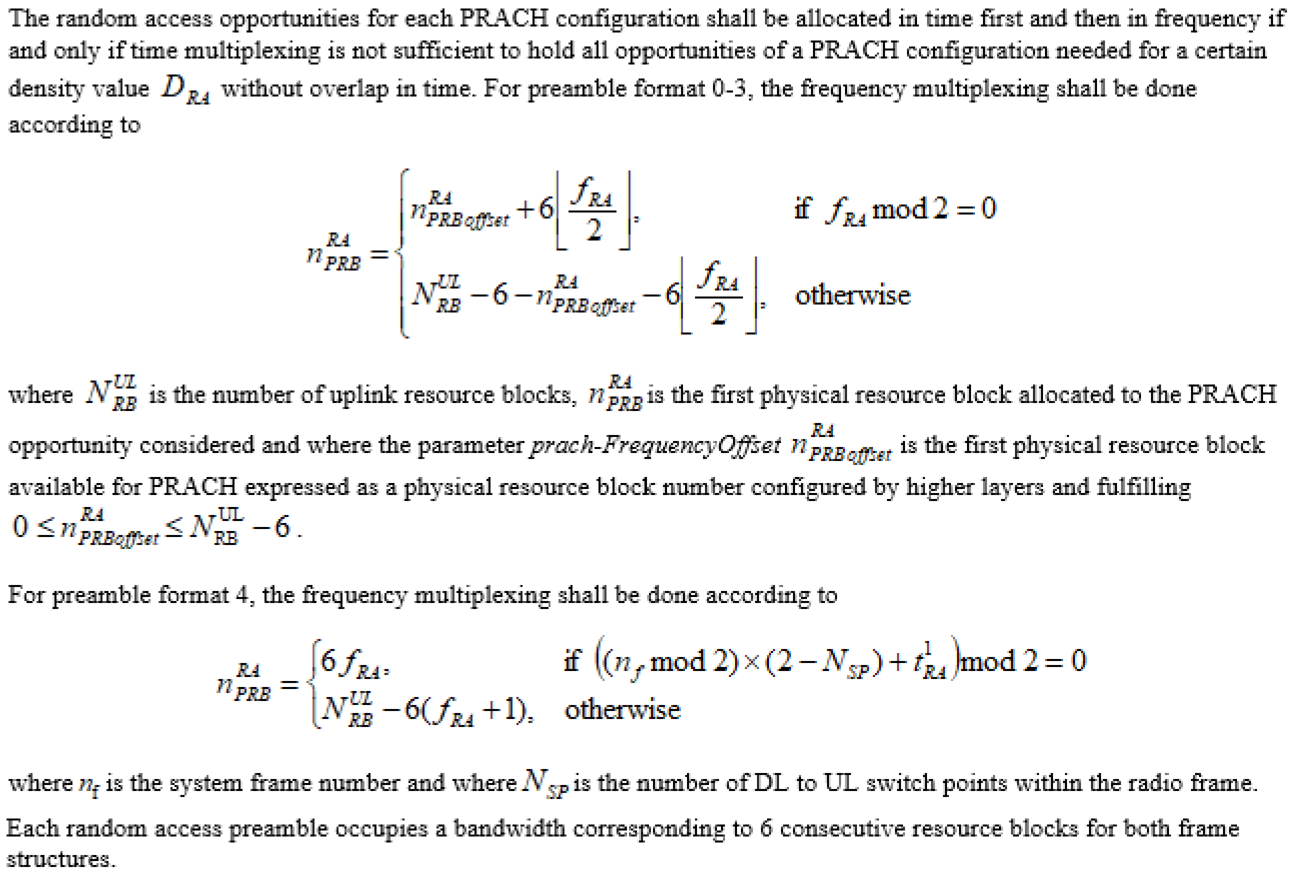
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)

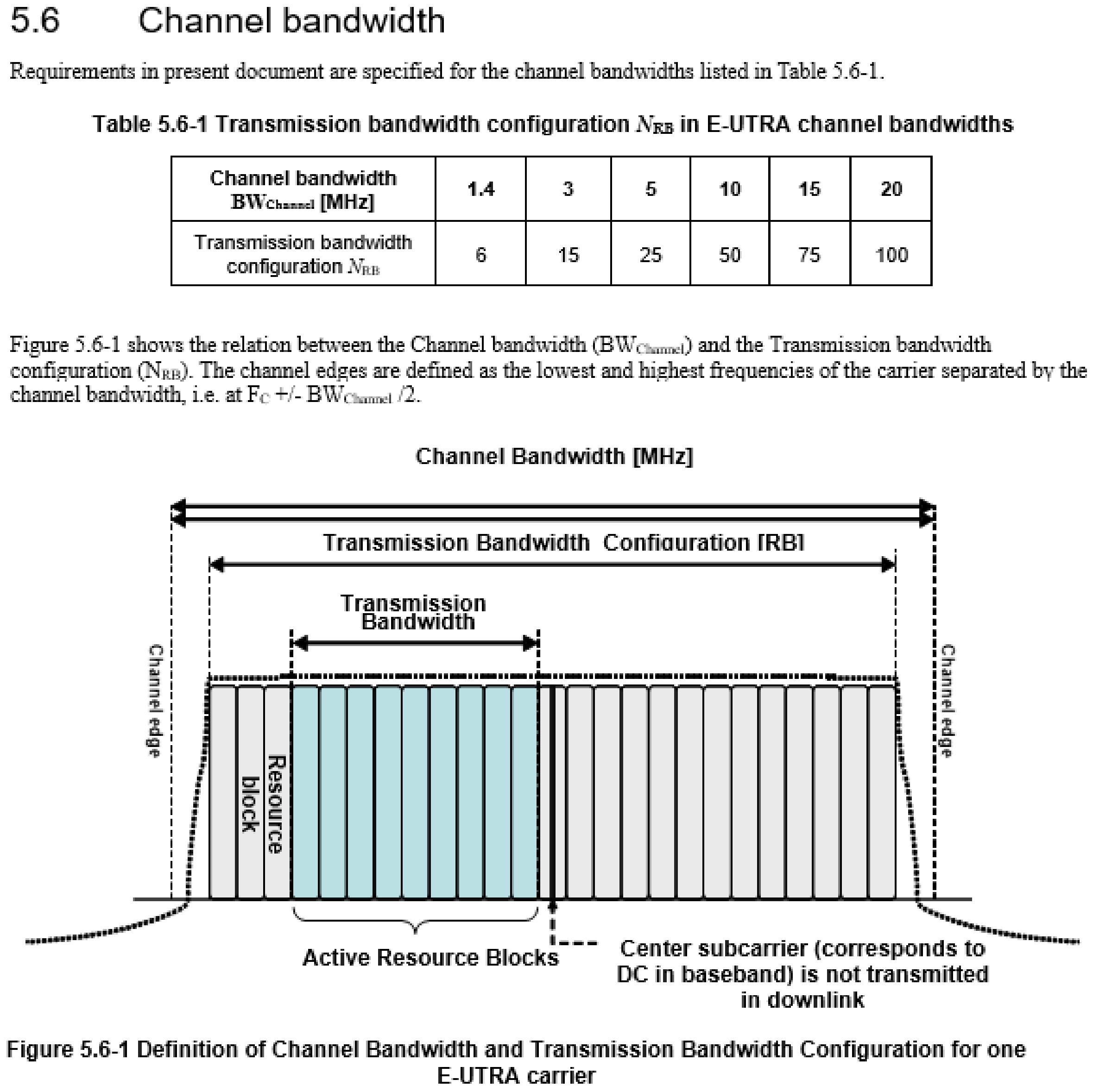
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	Nissan’s Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

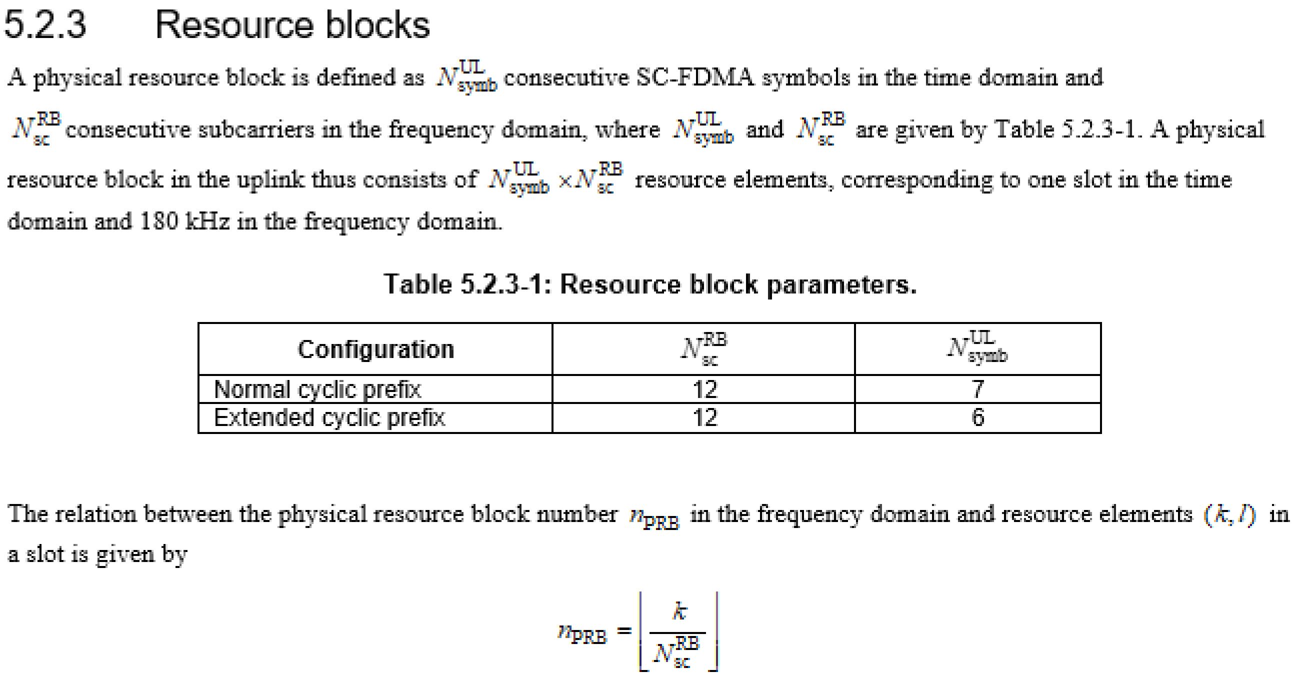
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

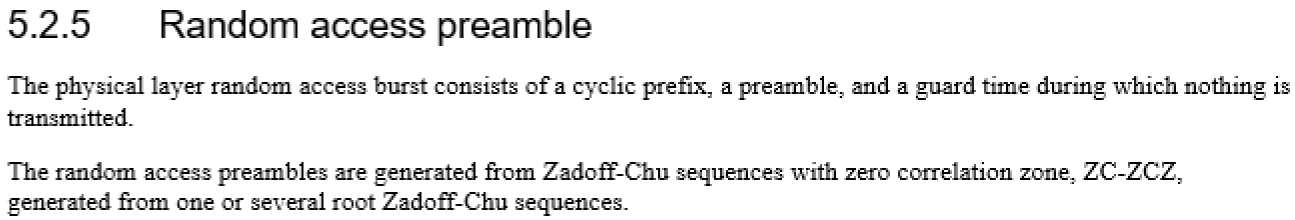
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

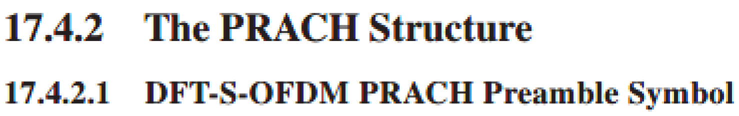


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

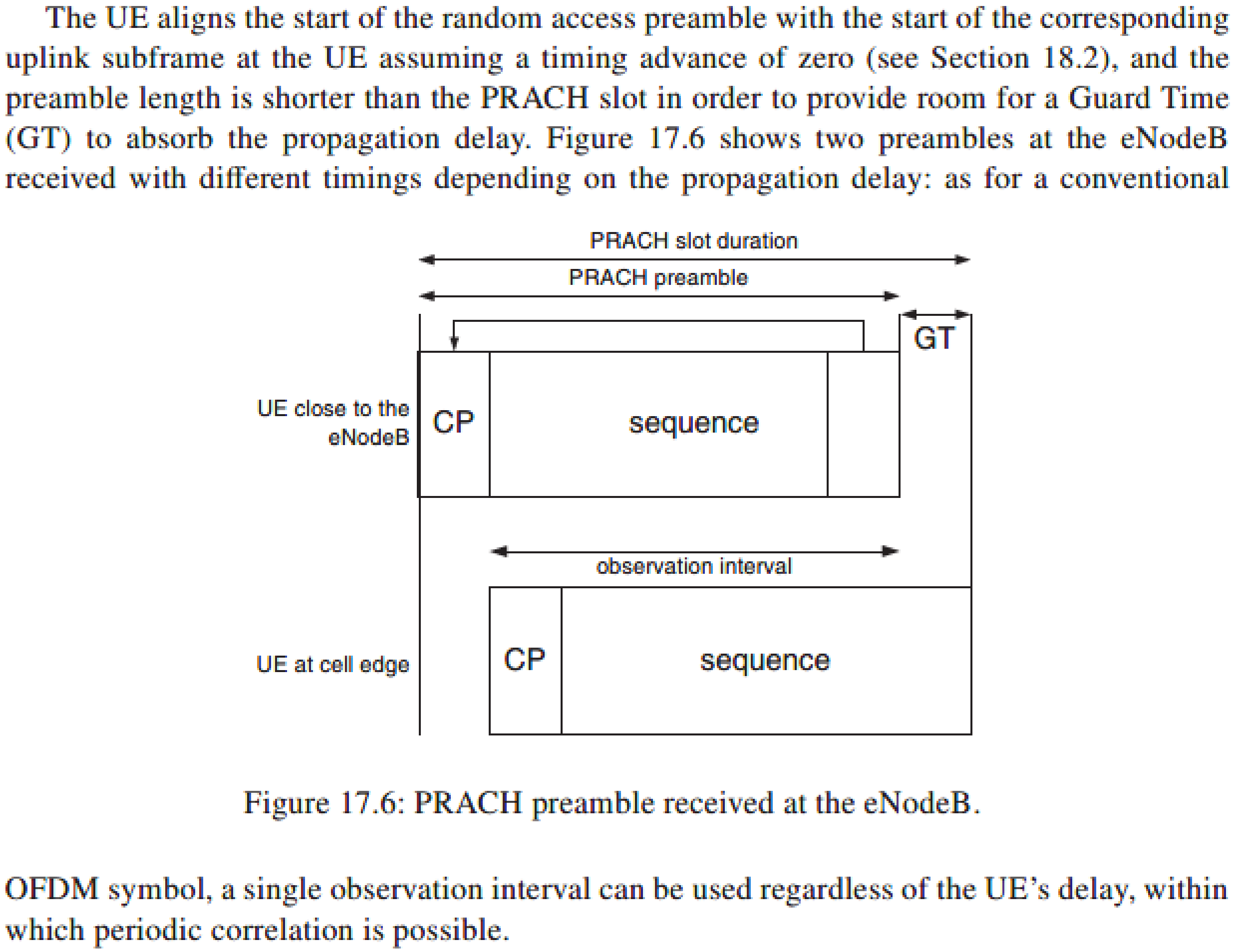


17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional

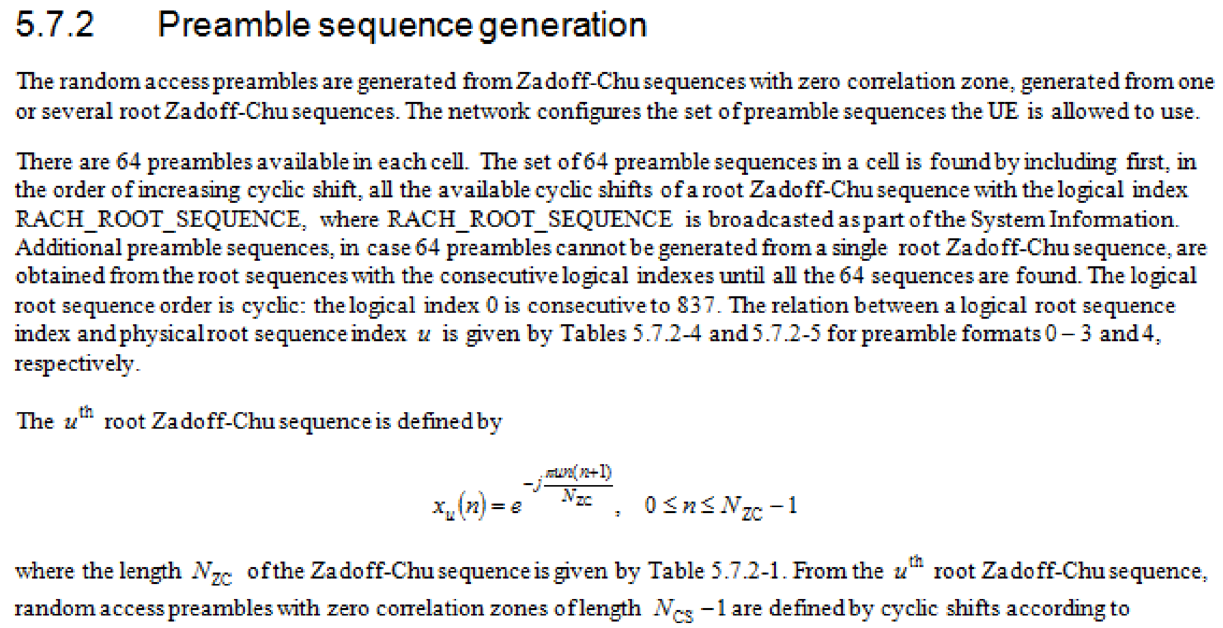
Figure 17.6: PRACH preamble received at the eNodeB.

OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378.

The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

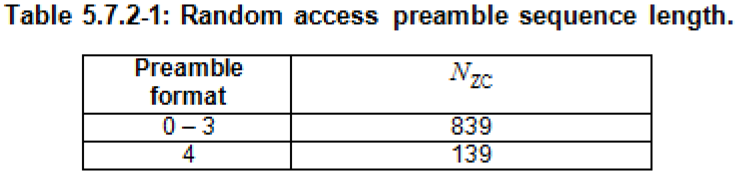
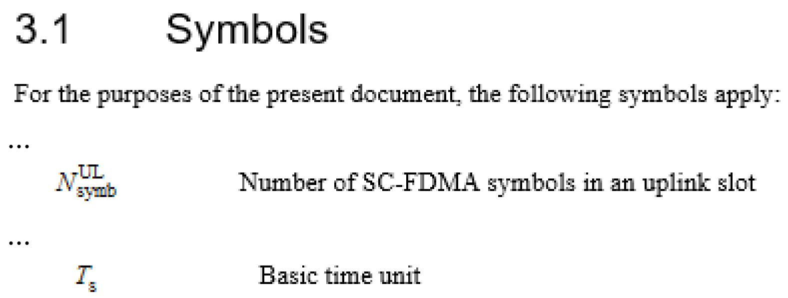
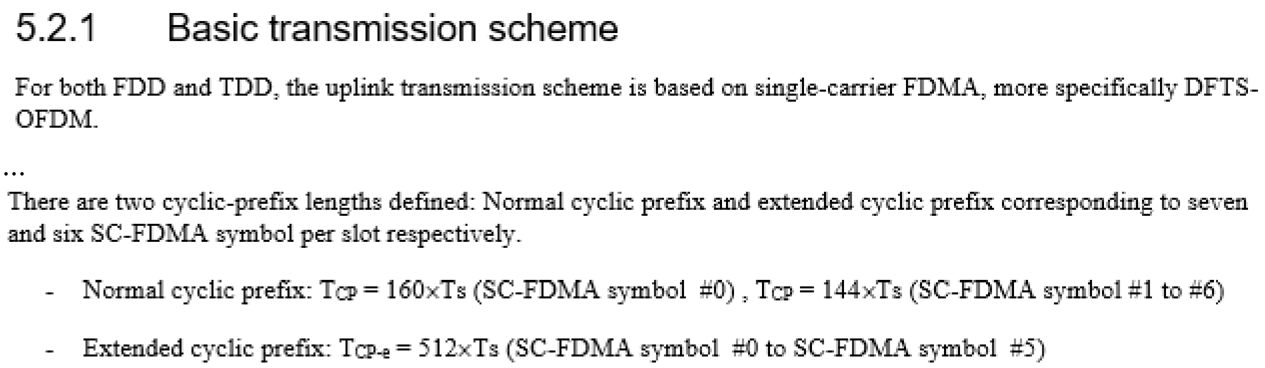


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Nissan's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs. 3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals. 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)

"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

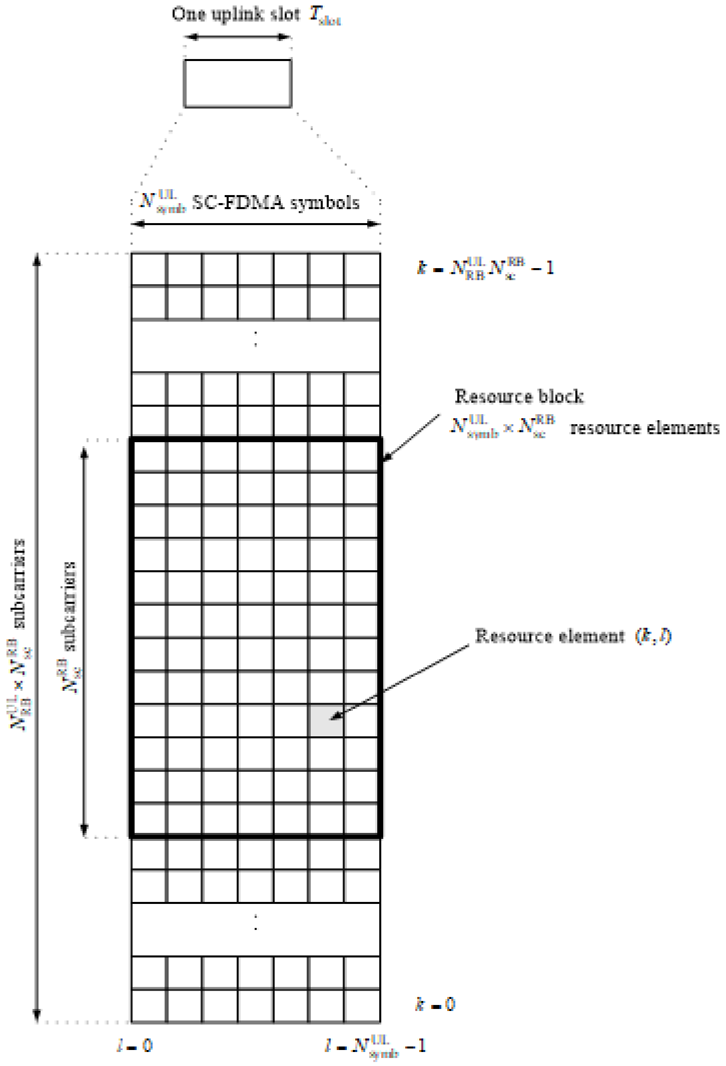
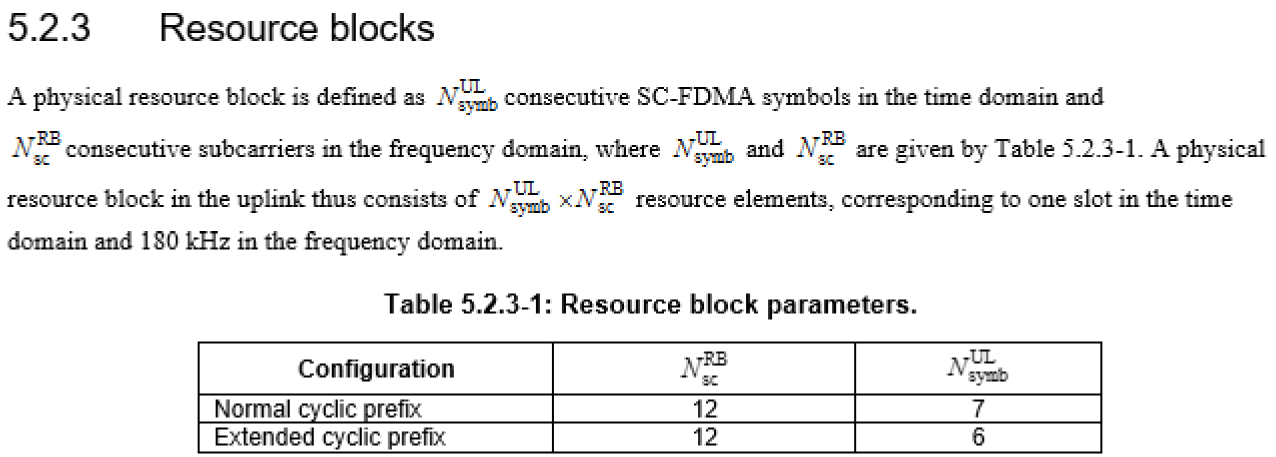


Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

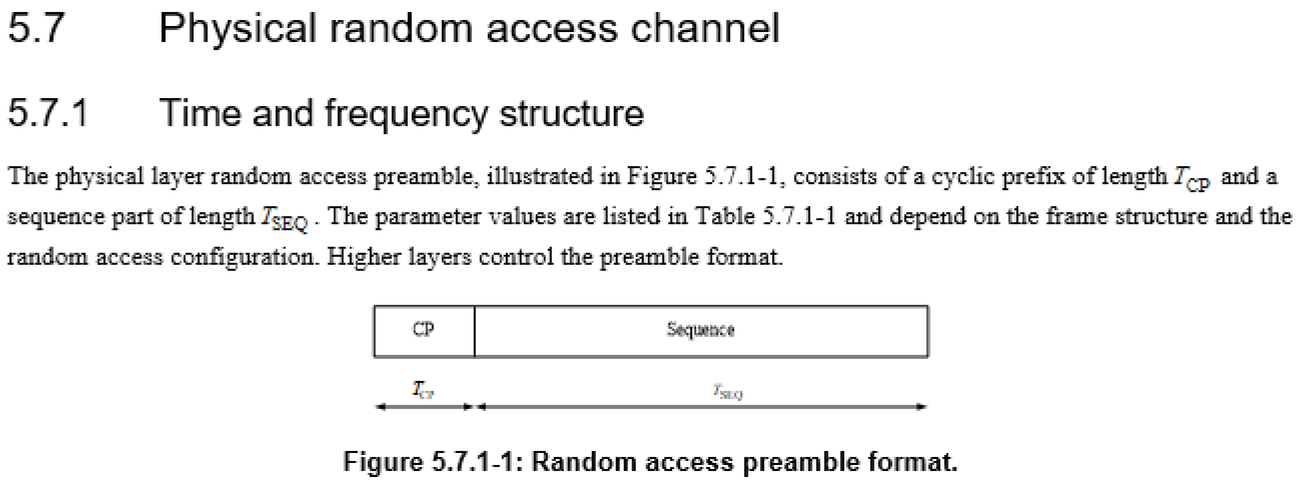
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

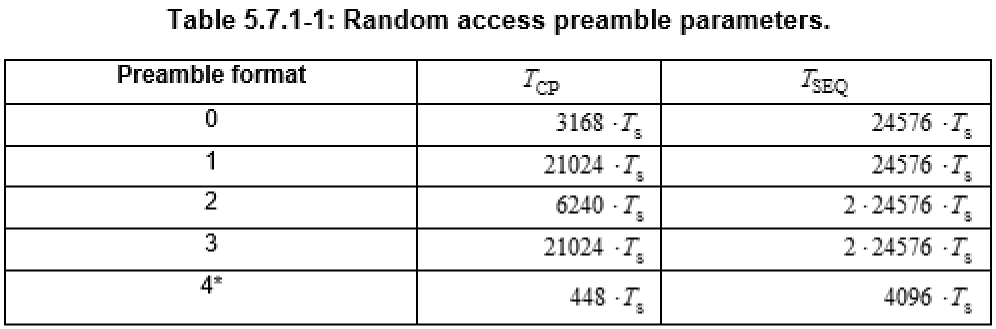
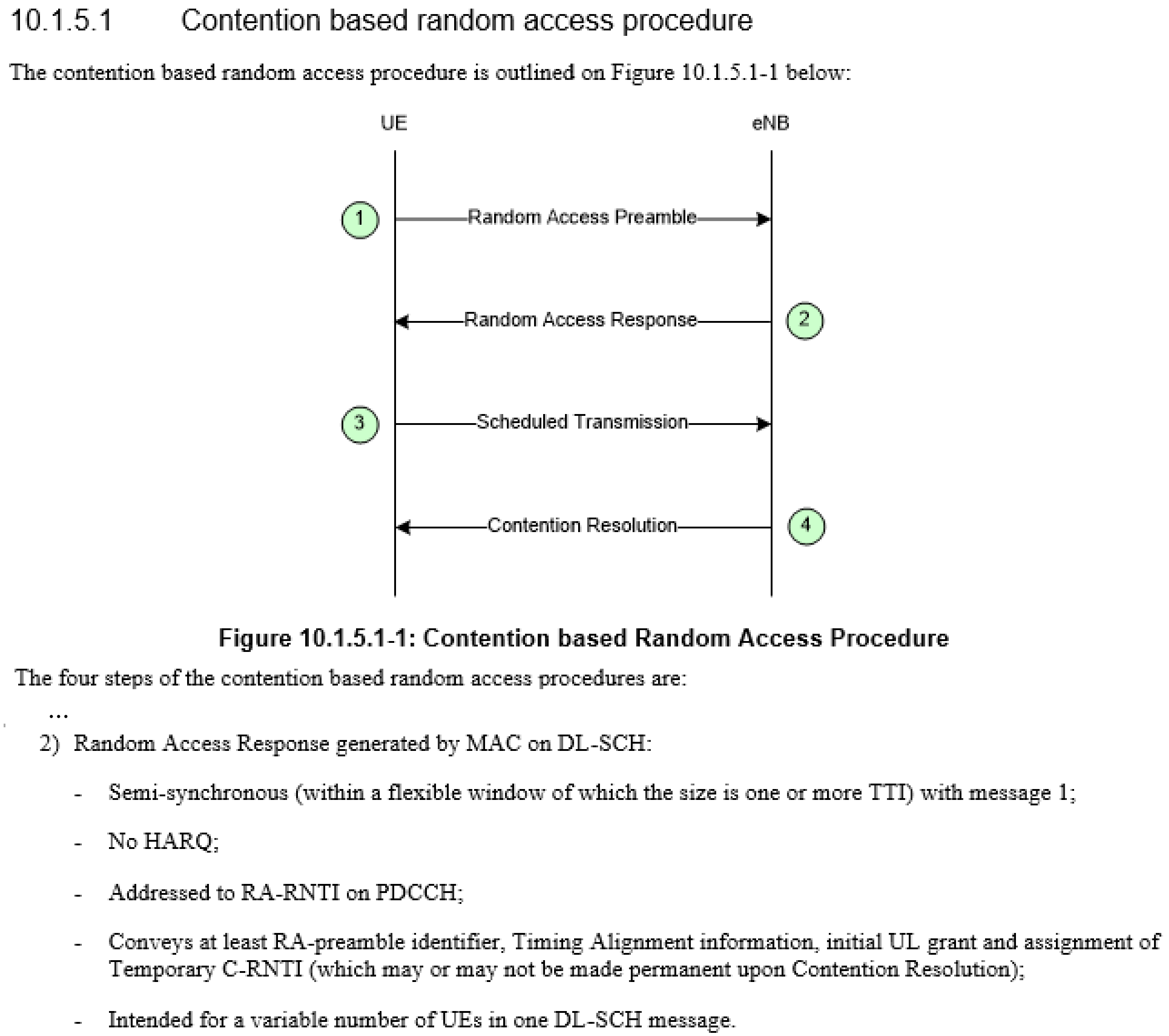


Table 5.7.1-1: Random access preamble parameters.

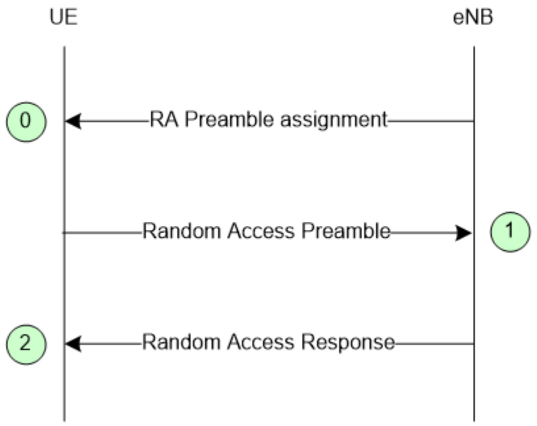
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

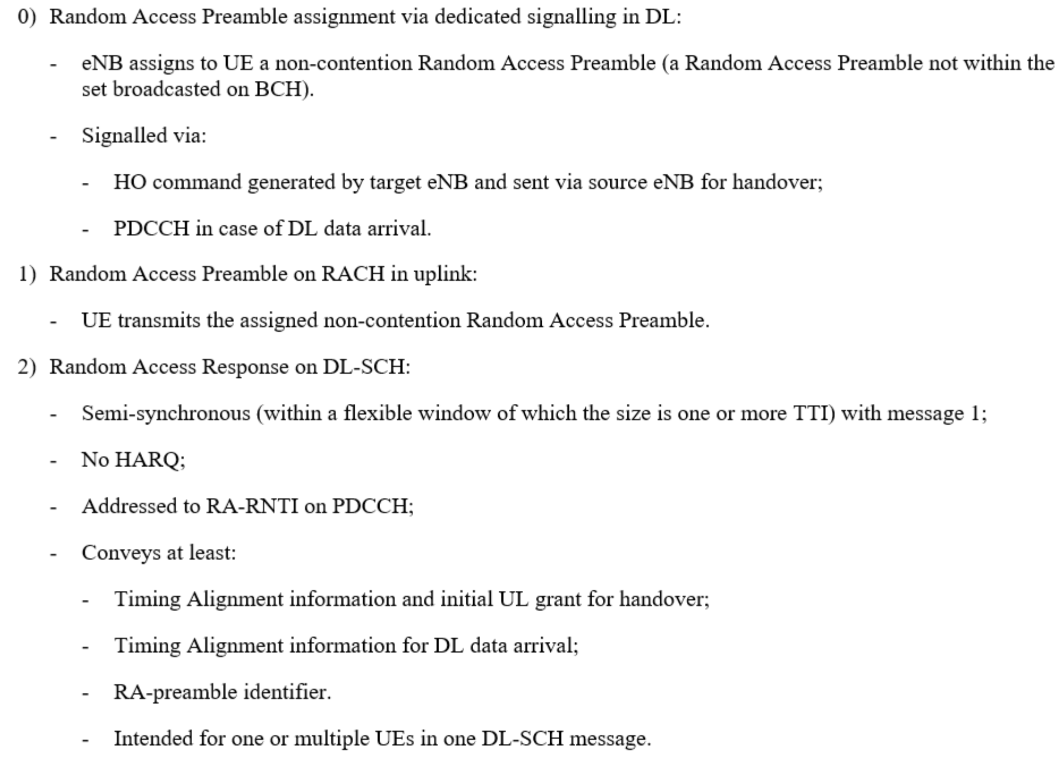
US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

receiving, from the base station, a response message. ;	Nissan’s Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53. 10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

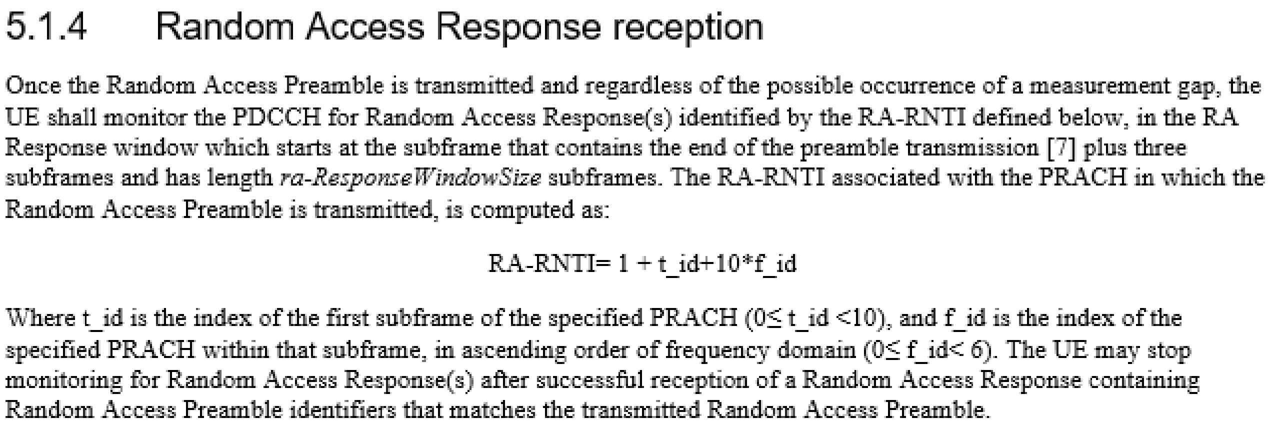


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
   - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



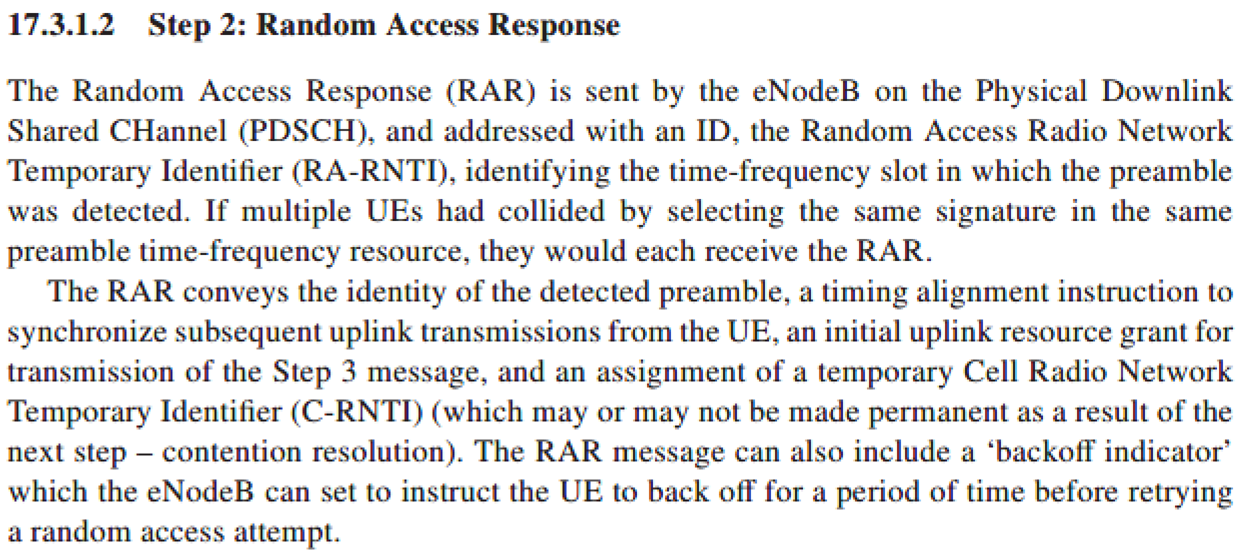
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

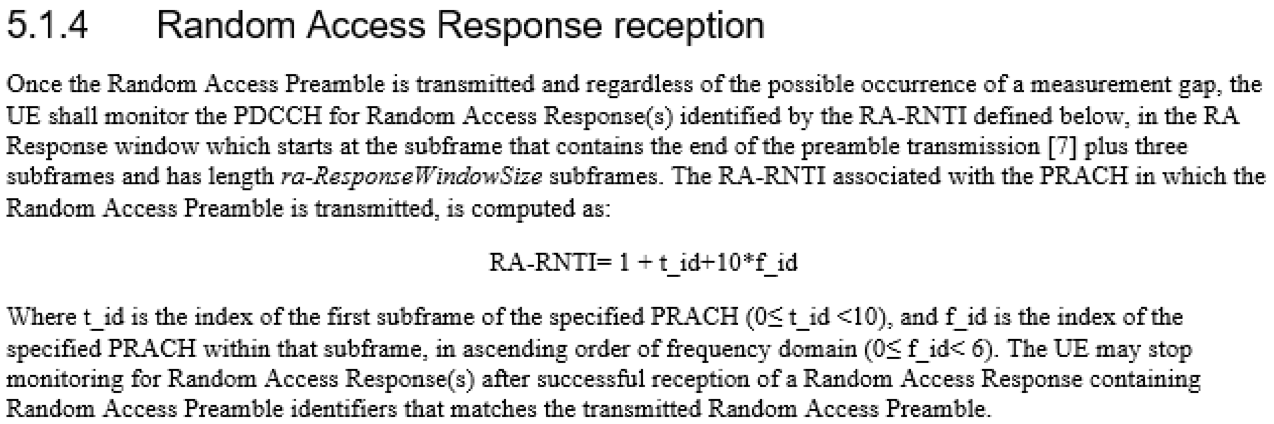
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

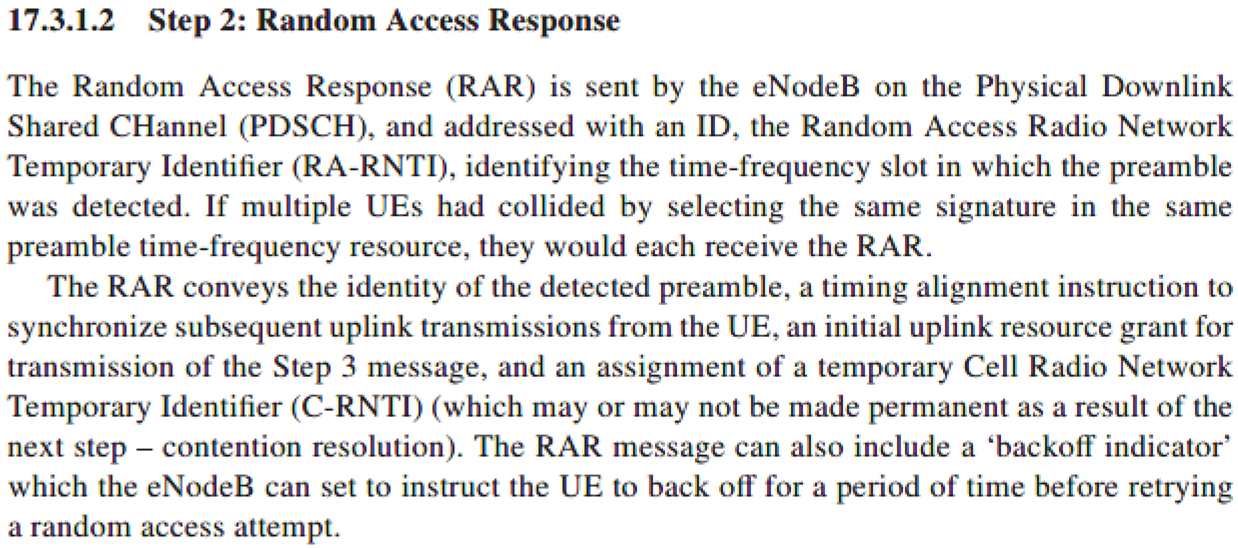
US Patent No. 10,833,908: Claim 12(a)
"The method claim 11, further comprising:"

12. The method claim 11, further comprising:	*See* Claim 11.

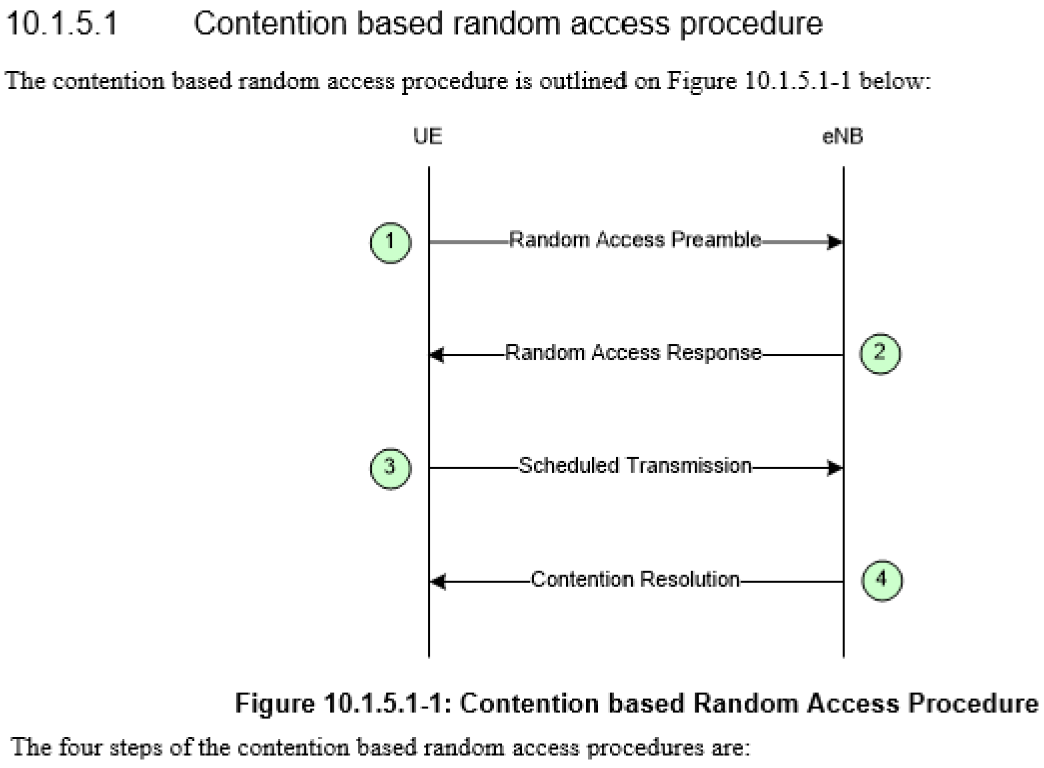
US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

determining if the response message identifies the sequence associated with the base station in the random access signal; and	Nissan’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

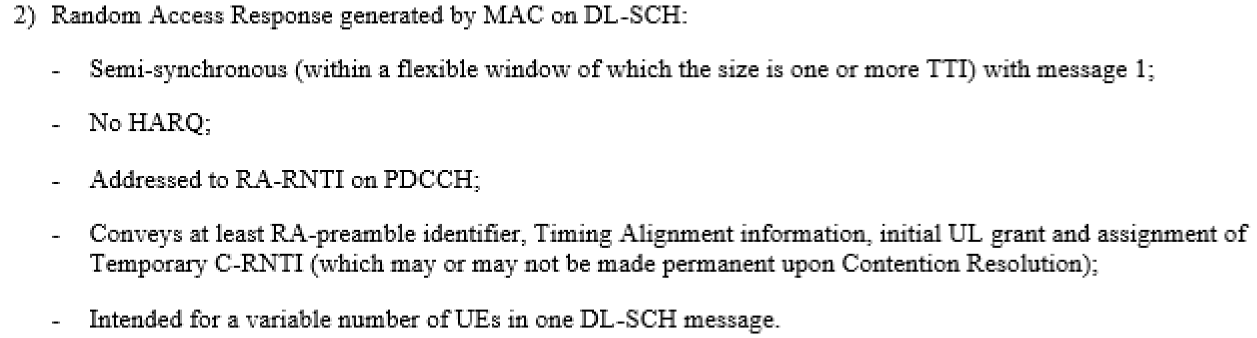
US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Nissan's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

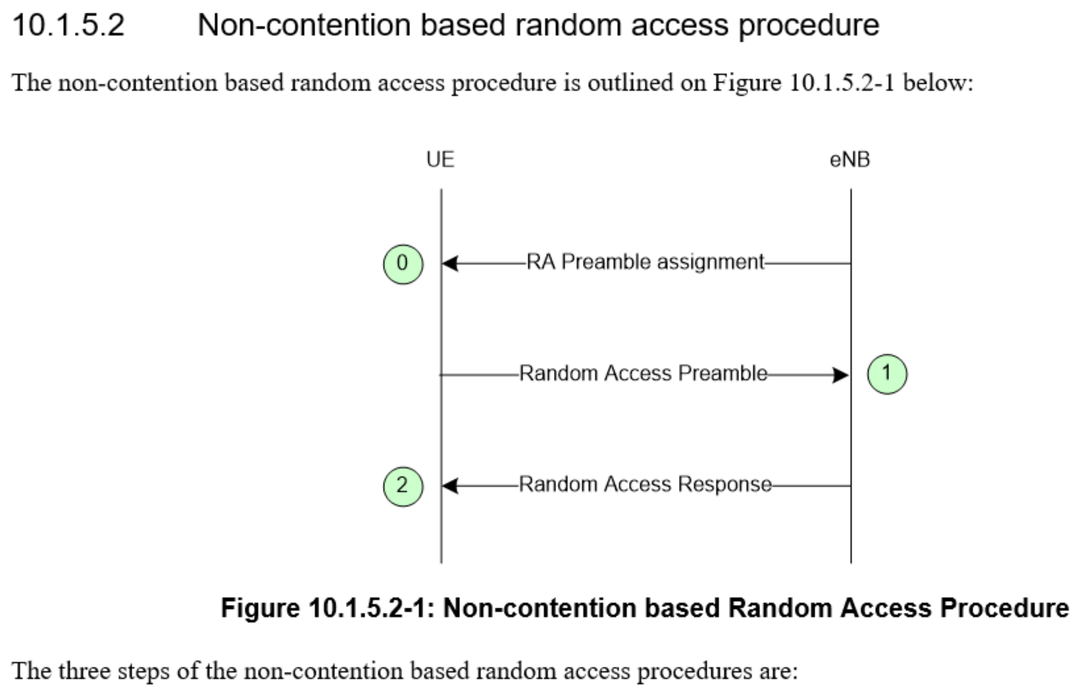
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

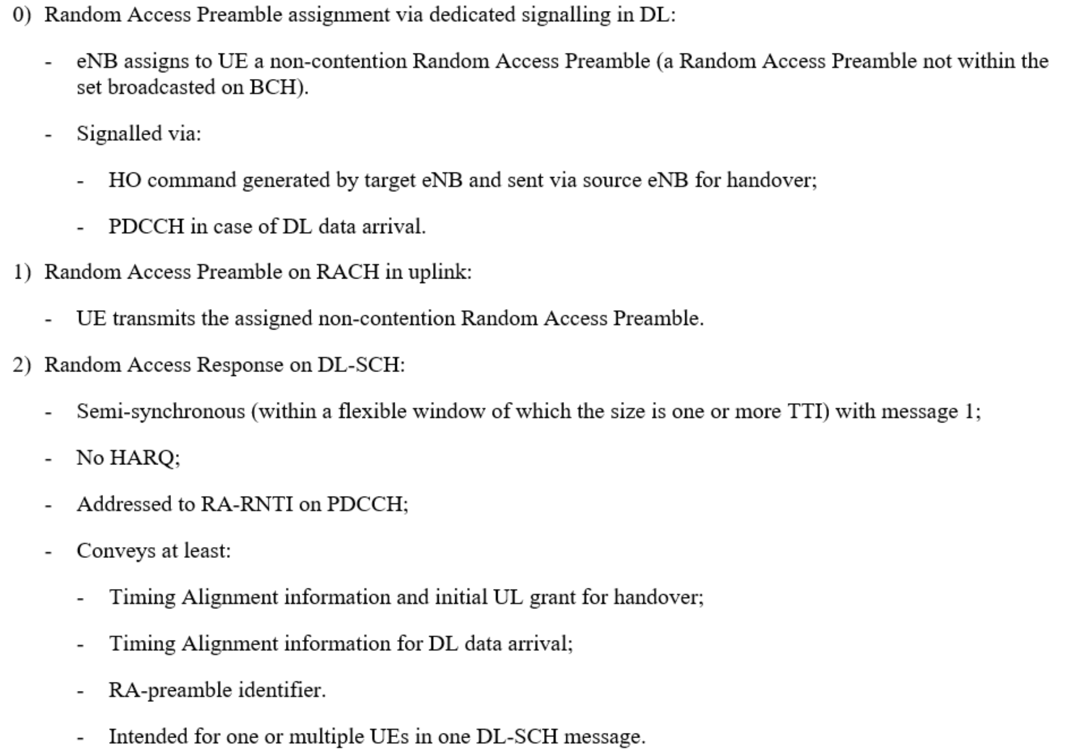


10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

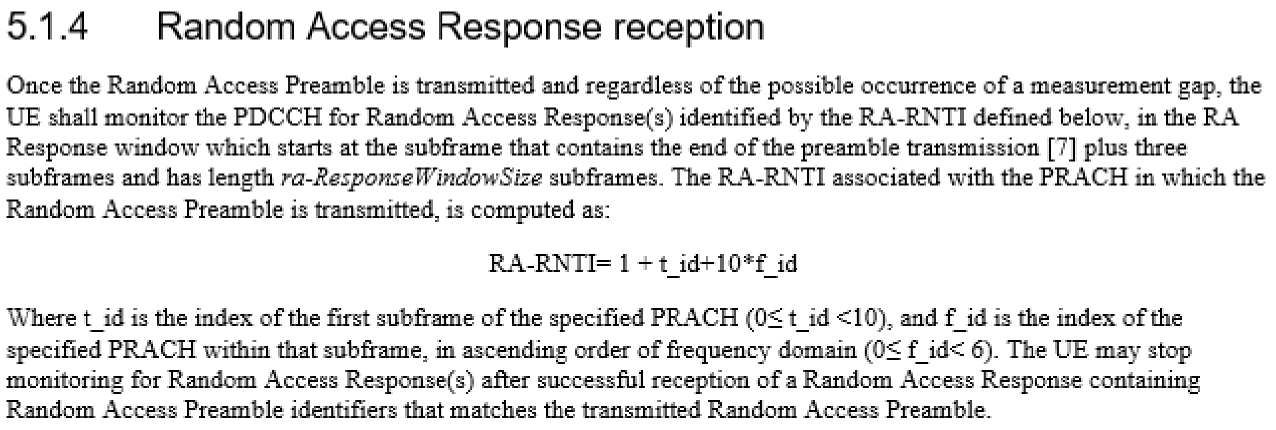
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

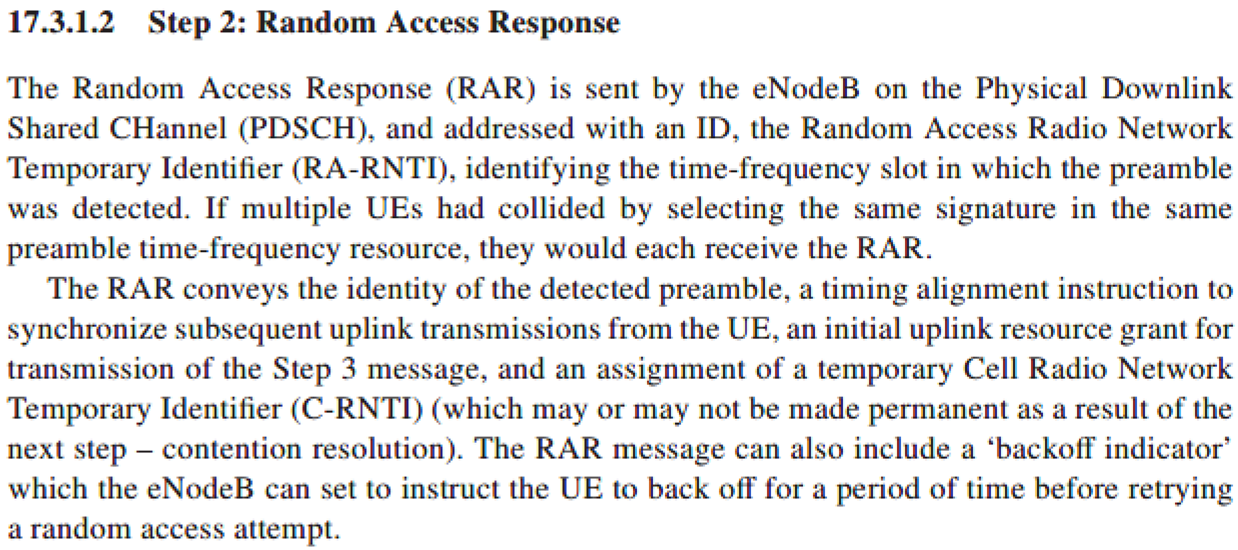
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI= 1 + t_id+10*f_id

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



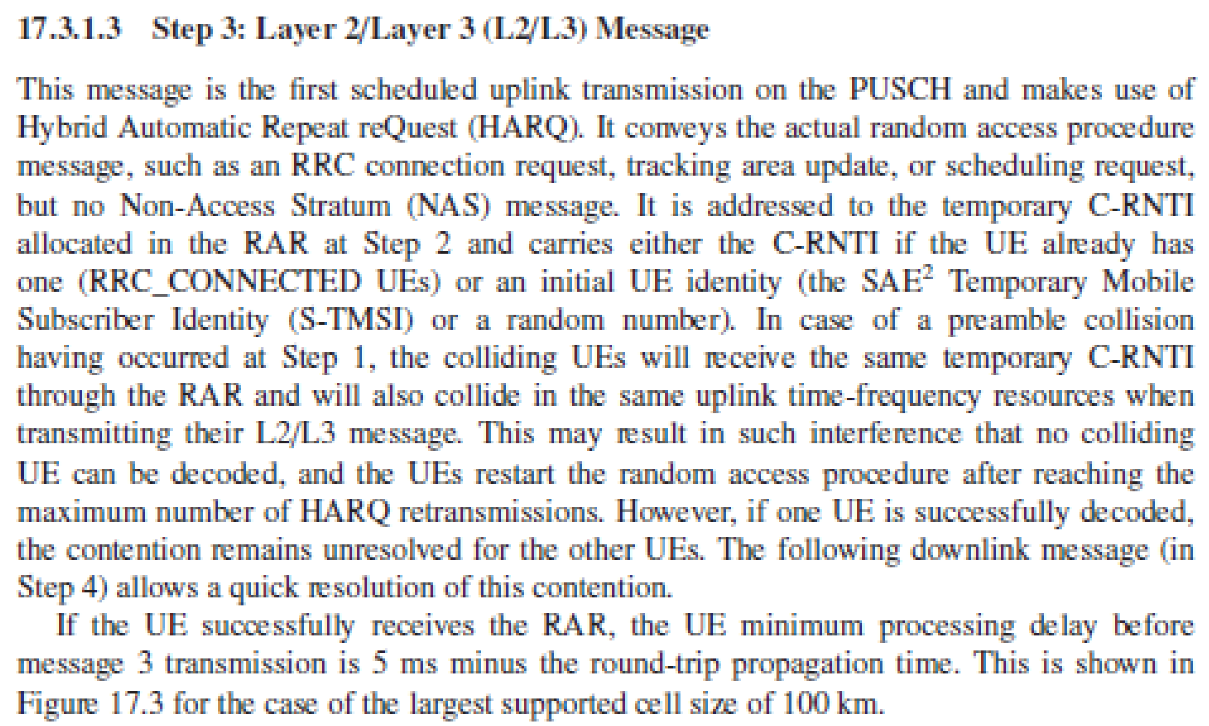
17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

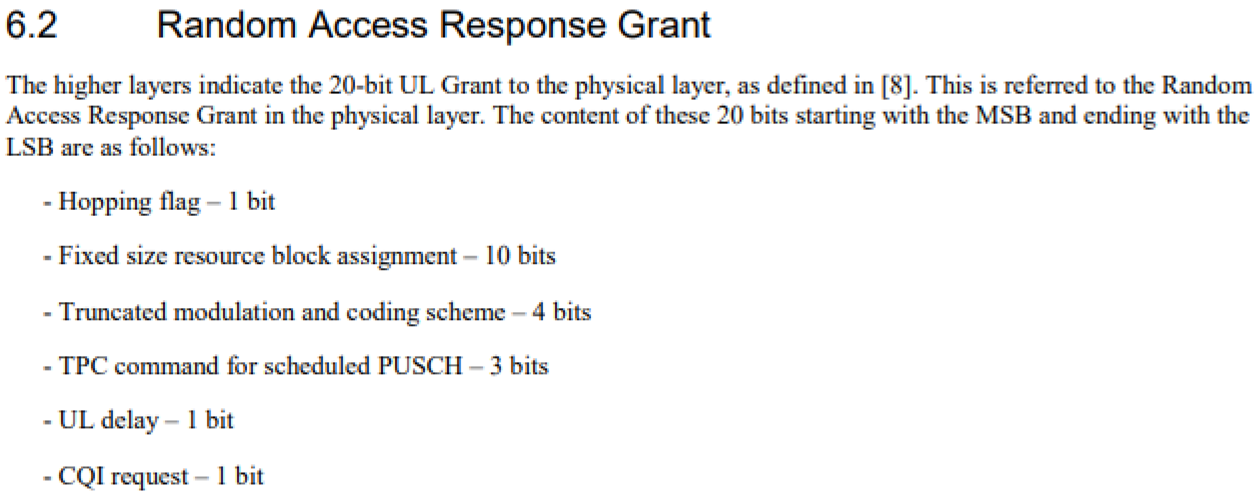
The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

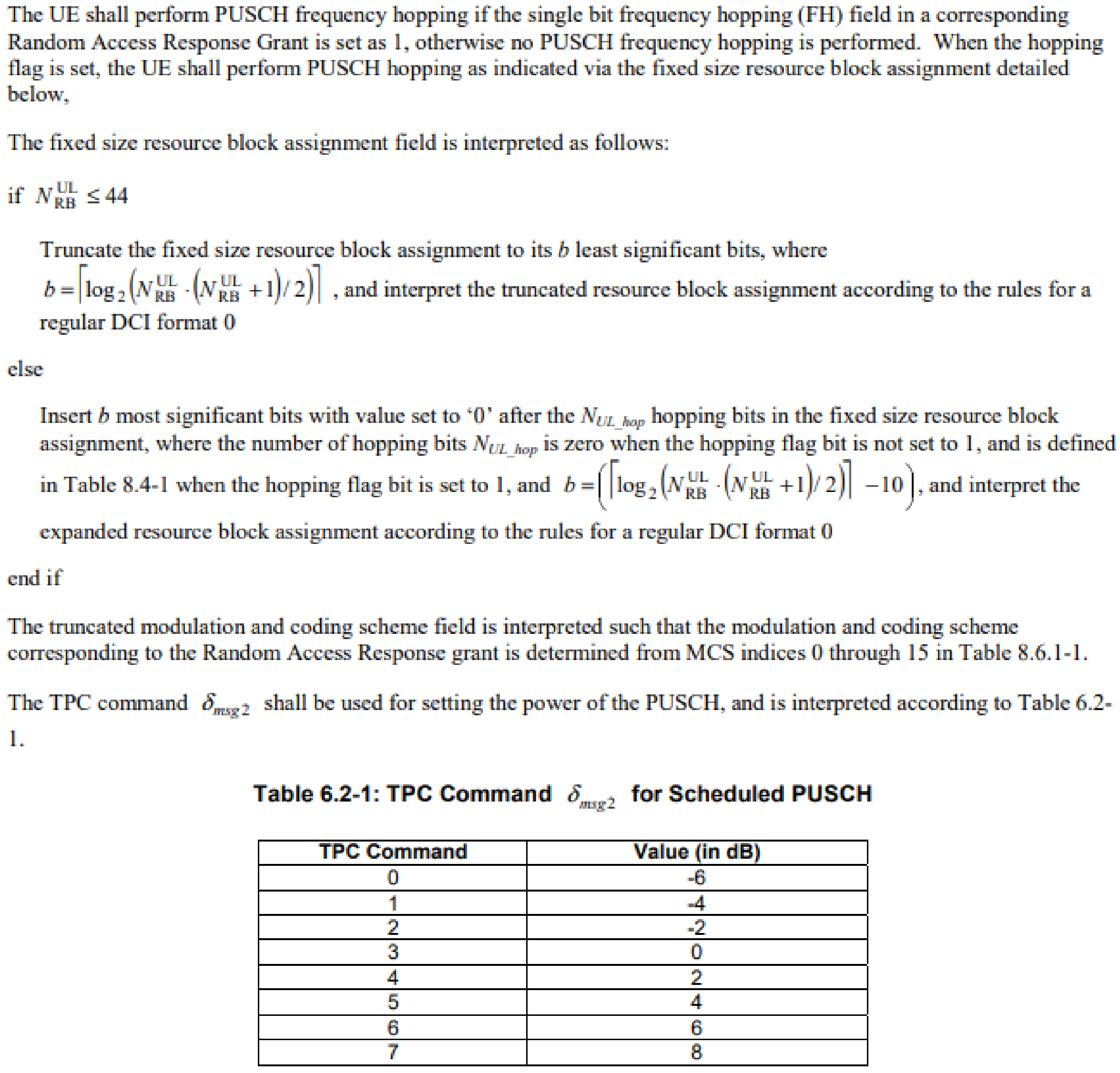
	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 13(a)
“The method of claim 12, wherein the response message includes power adjustment information and”

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by Nissan’s Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)

"The method of claim 12, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

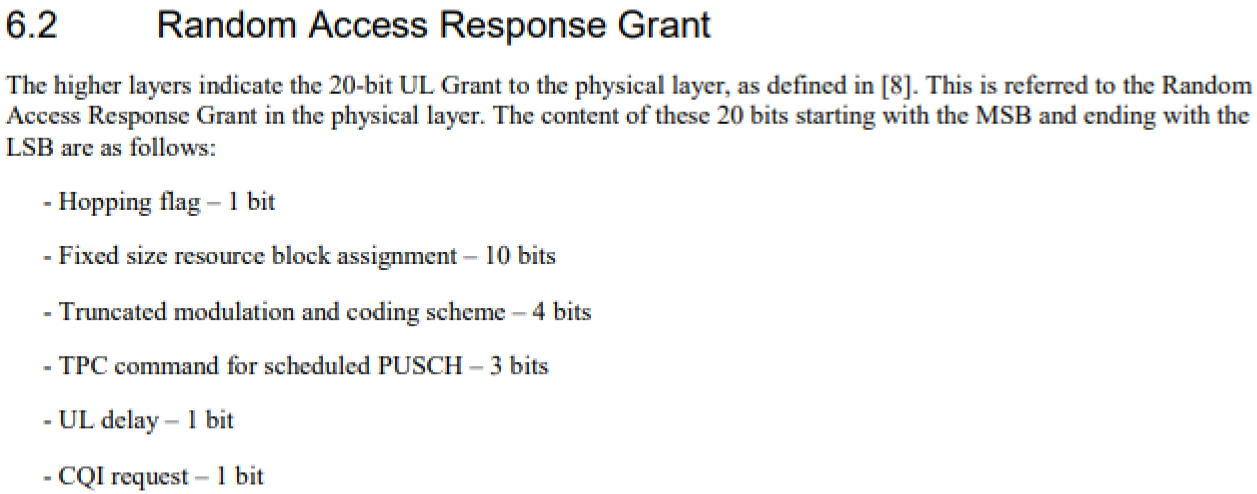
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

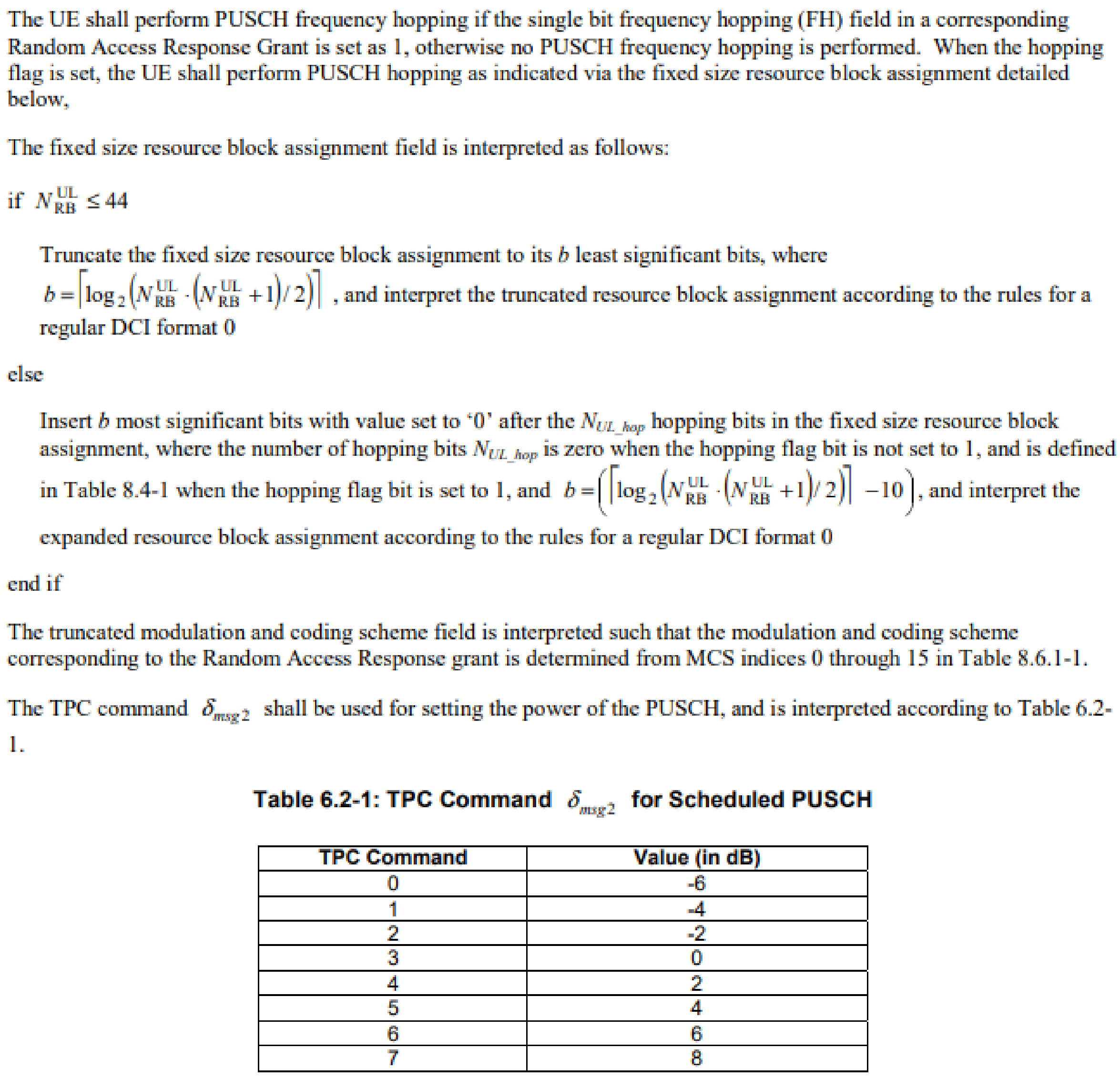
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the second uplink signal is transmitted according to the power adjustment information.	Nissan's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

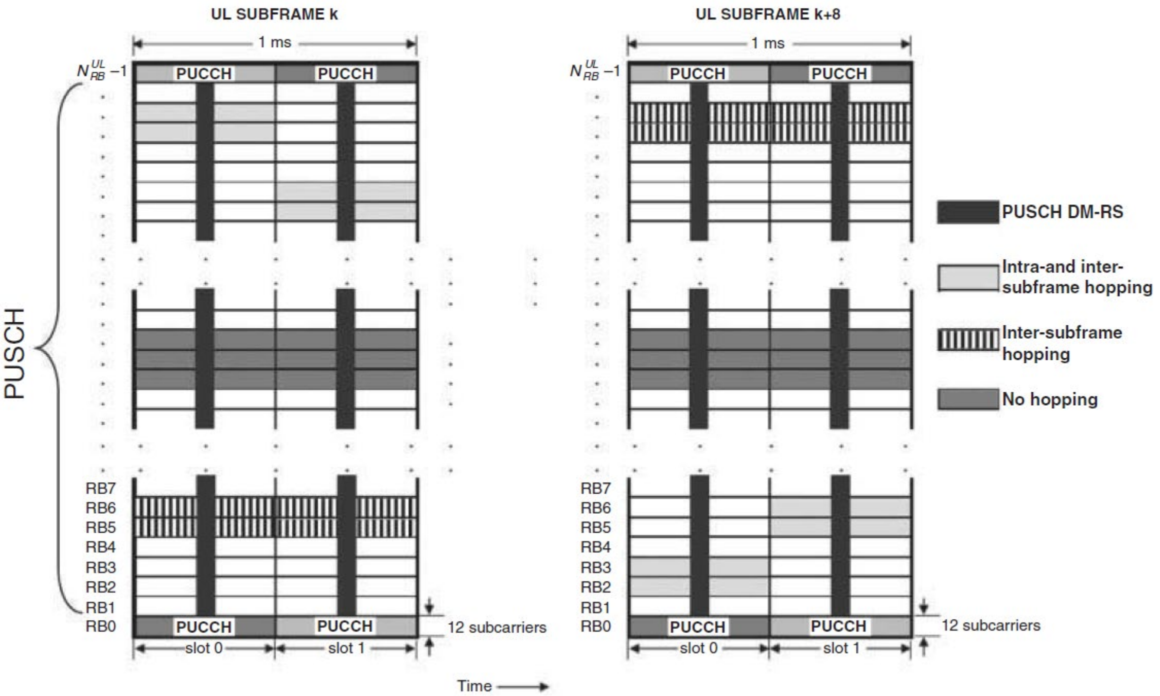
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 14

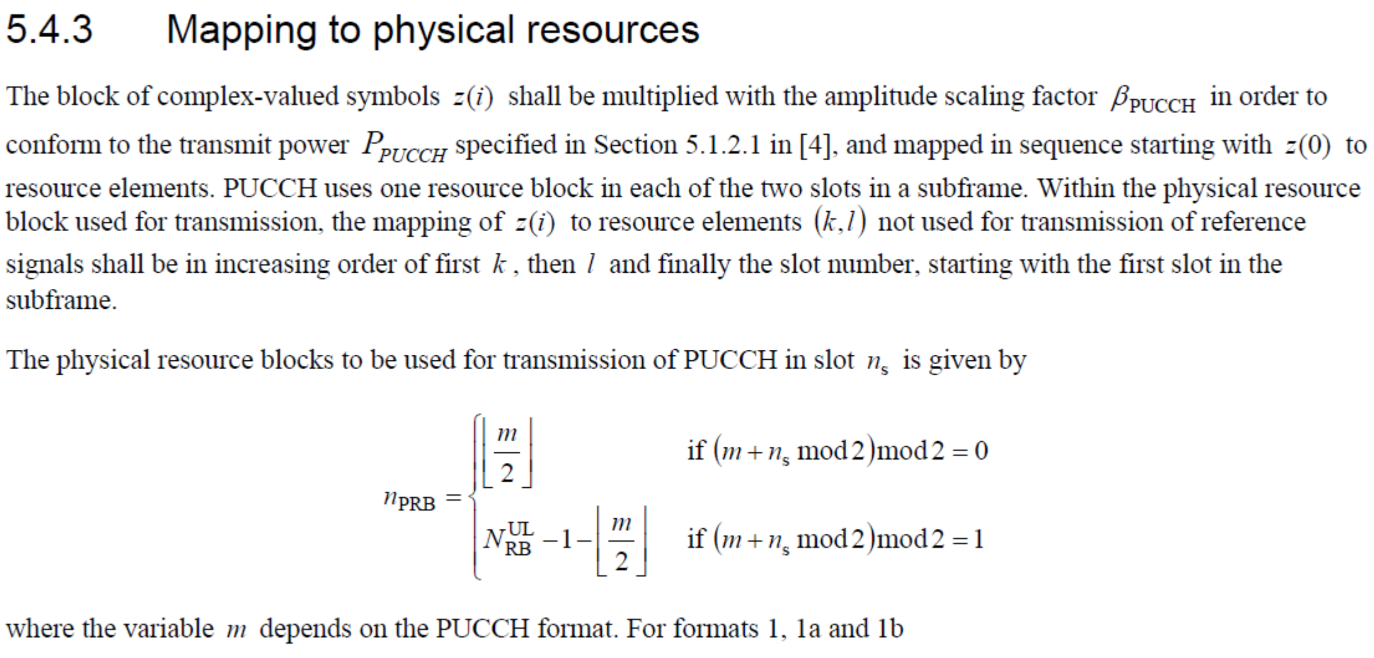
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Nissan's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 11. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

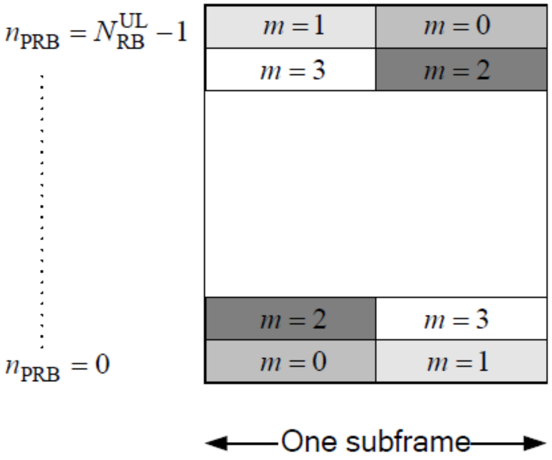


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

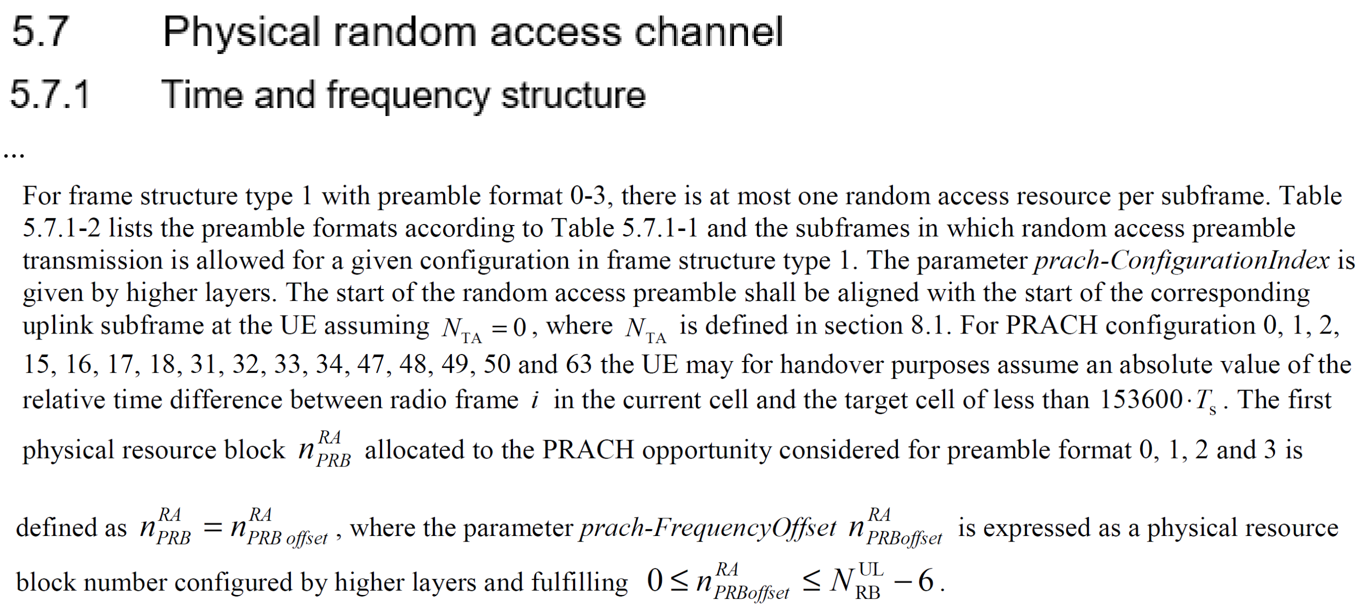
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\mathrm{RA}}_{\mathrm{PRBoffset}}$. For FDD, the parameter directly determines

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

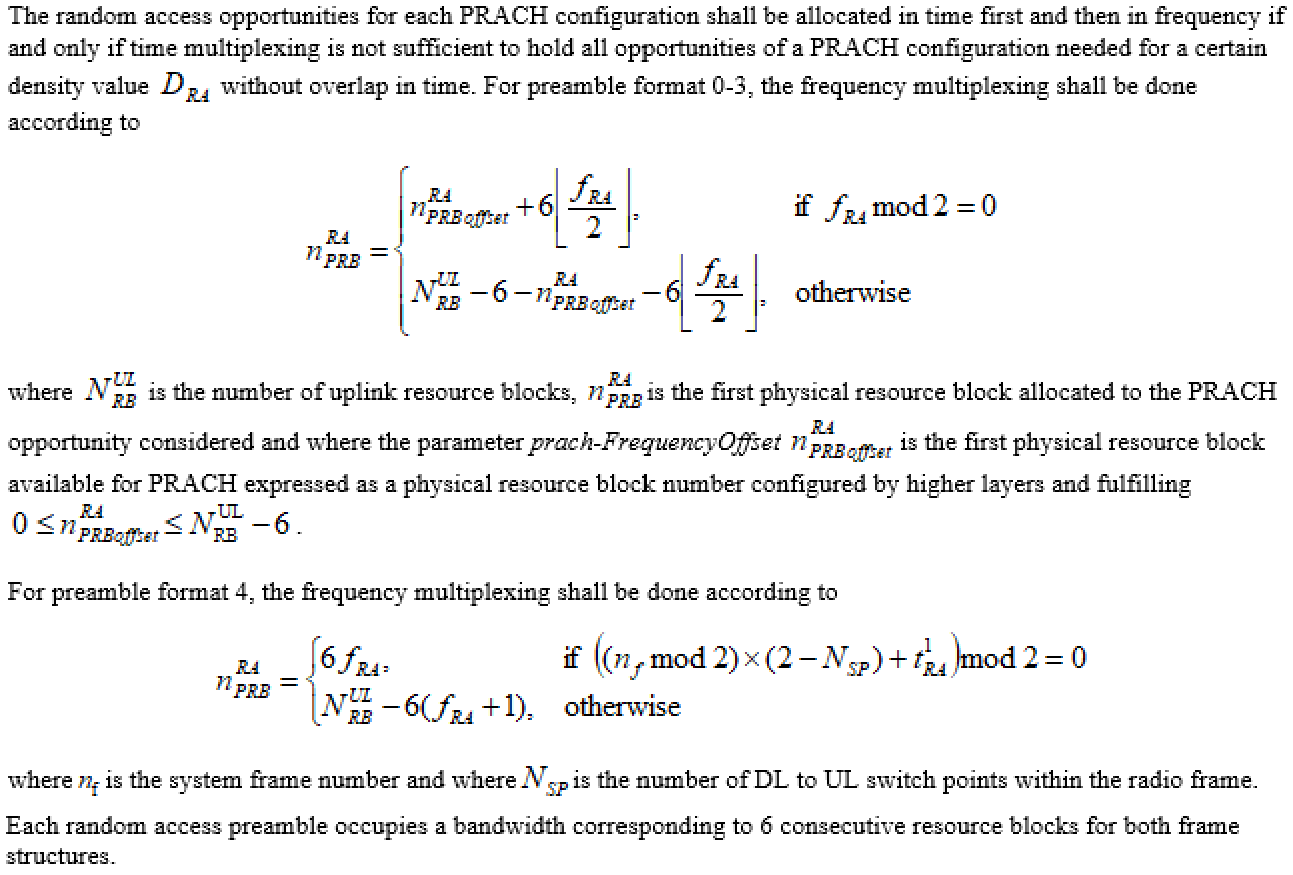
…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

…

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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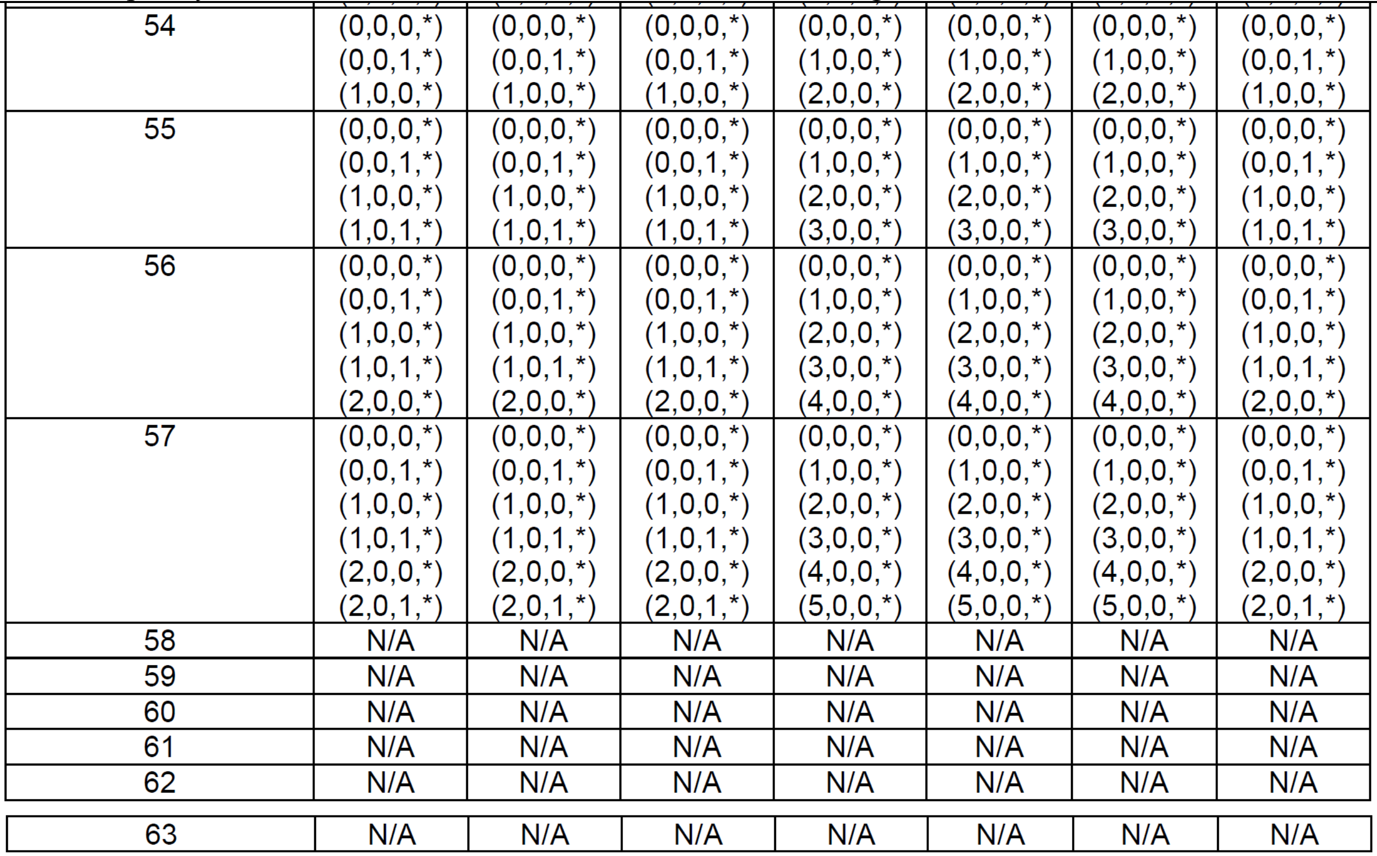
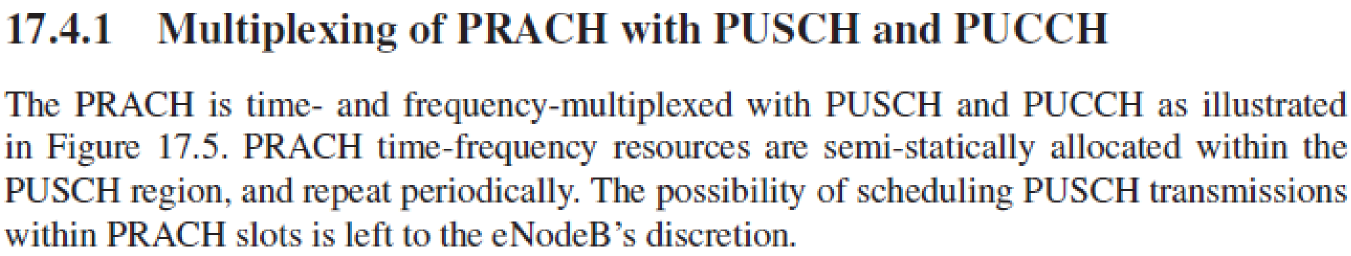
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

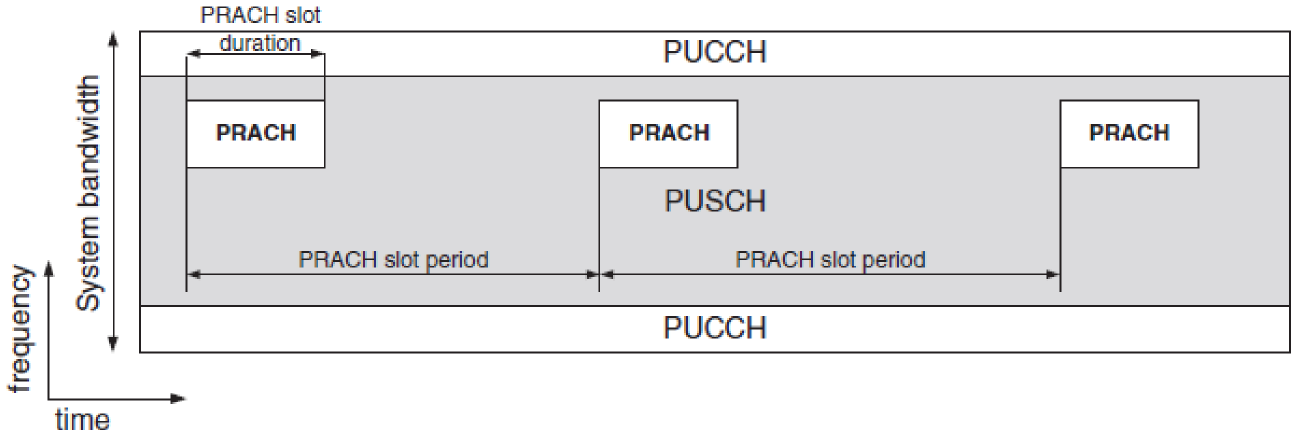
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



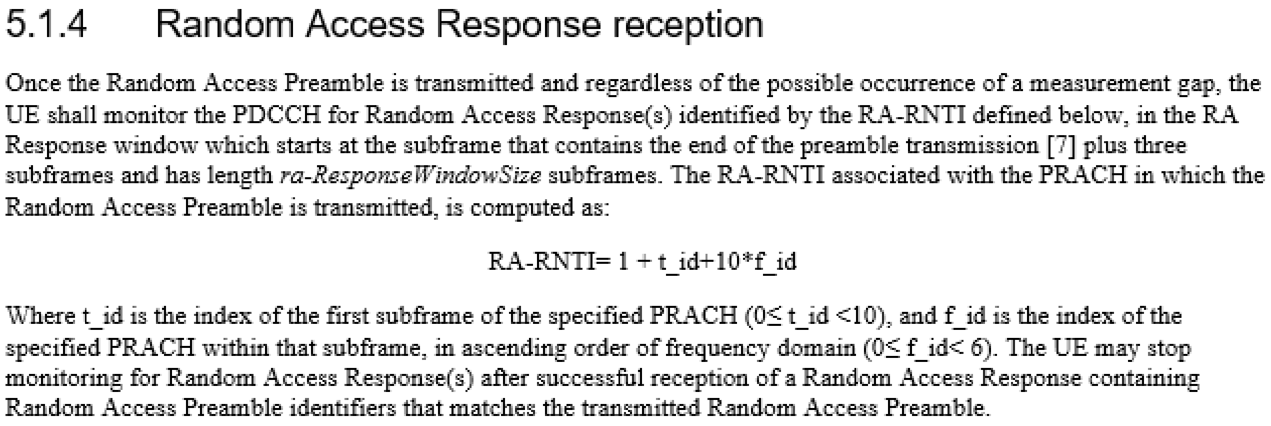
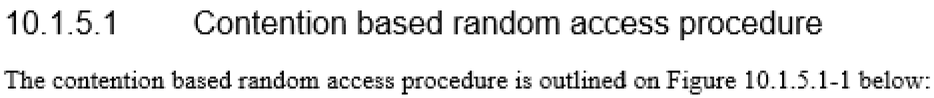
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 15
"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Nissan's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15
"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

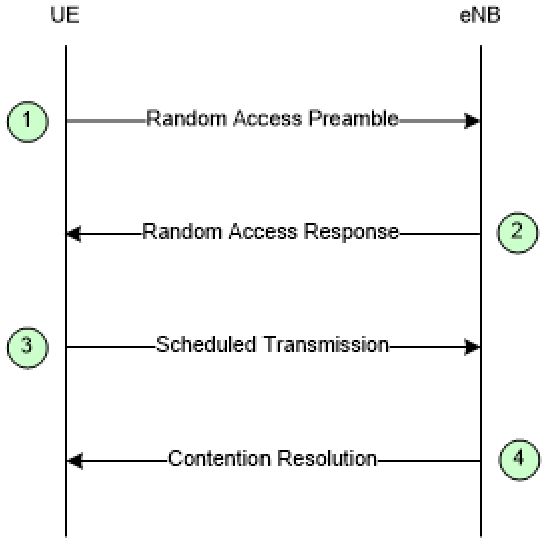
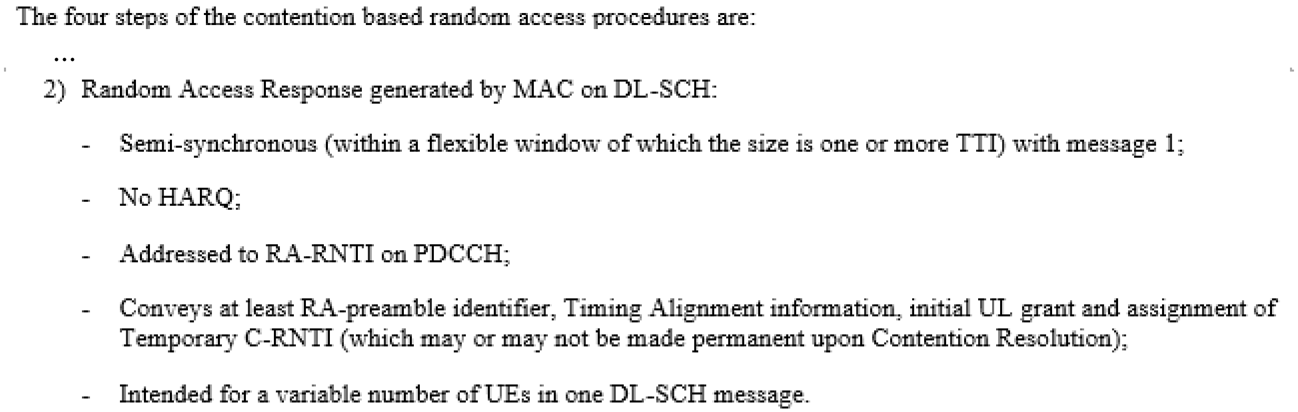


Figure 10.1.5.1-1: Contention based Random Access Procedure


The four steps of the contention based random access procedures are:

…

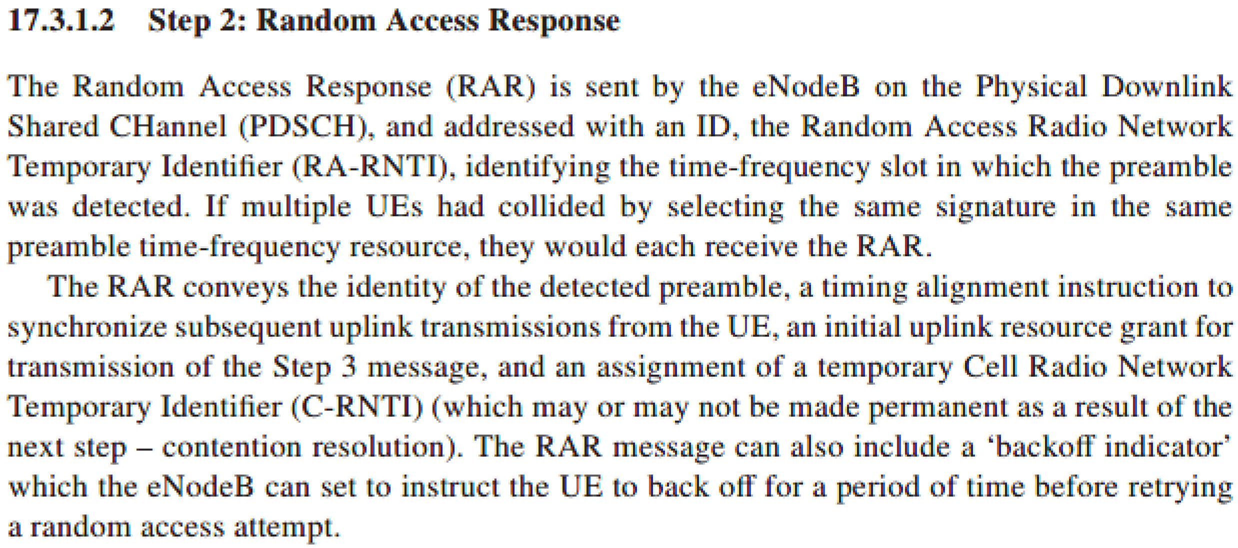
2) Random Access Response generated by MAC on DL-SCH:

  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
  - Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

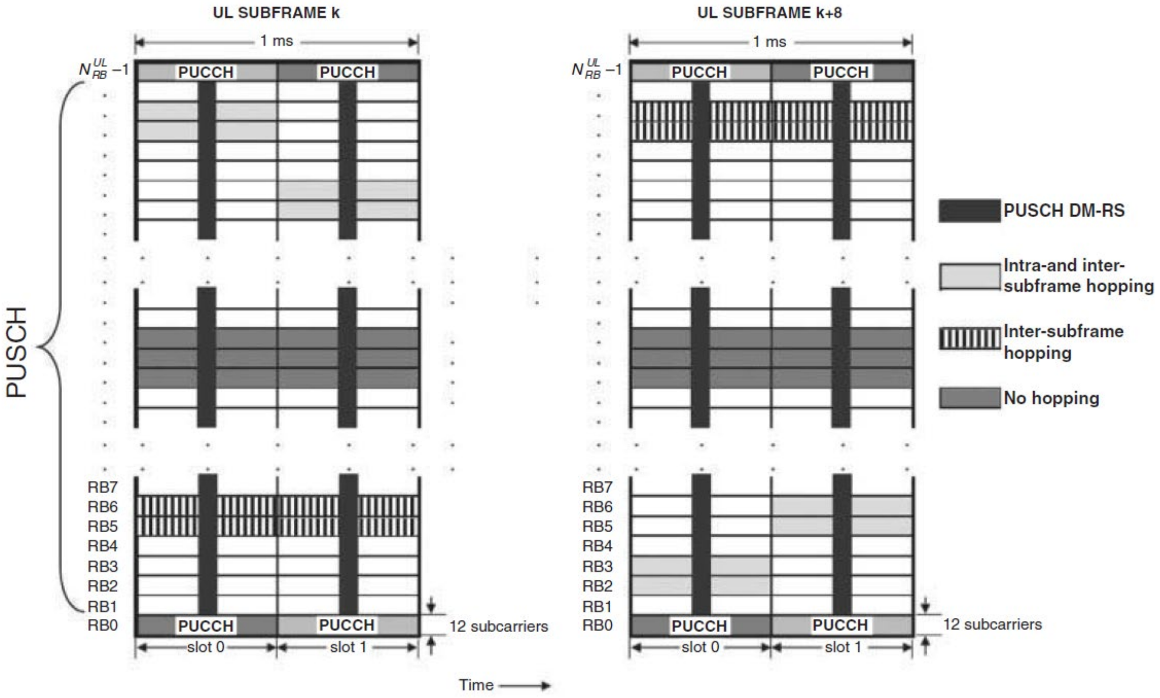
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 16
"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Nissan's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 17

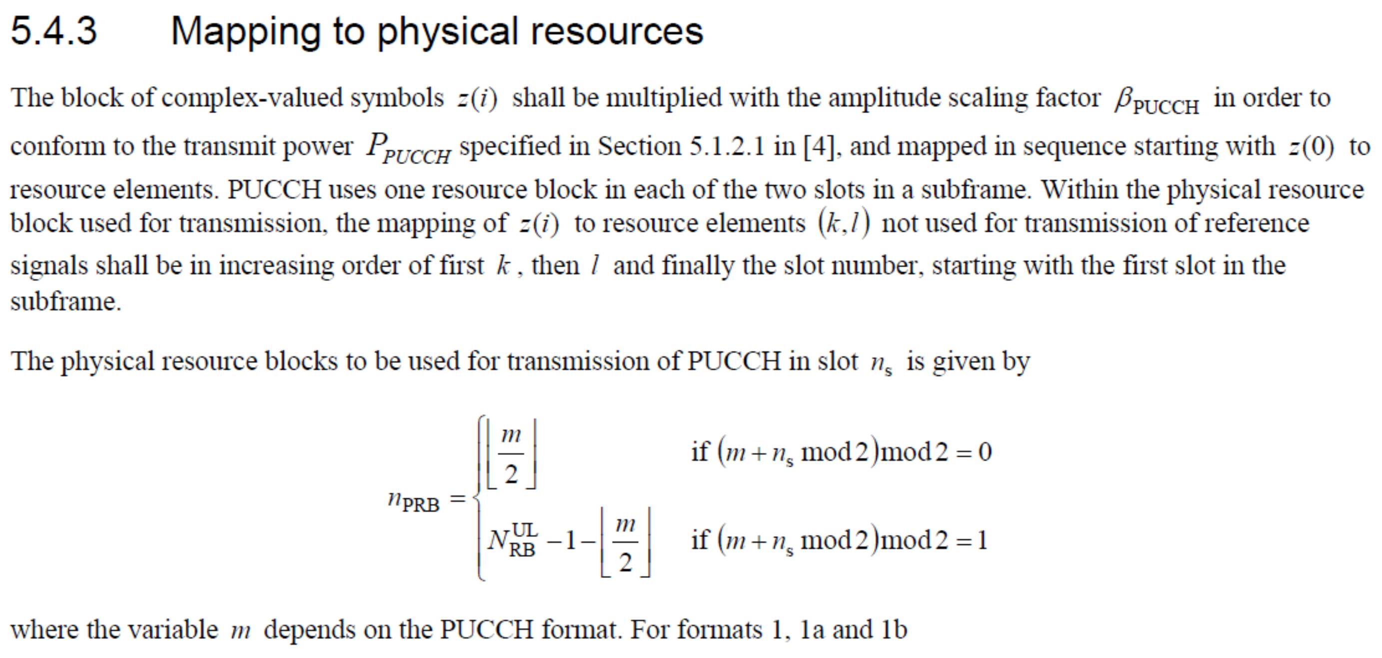
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Nissan's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

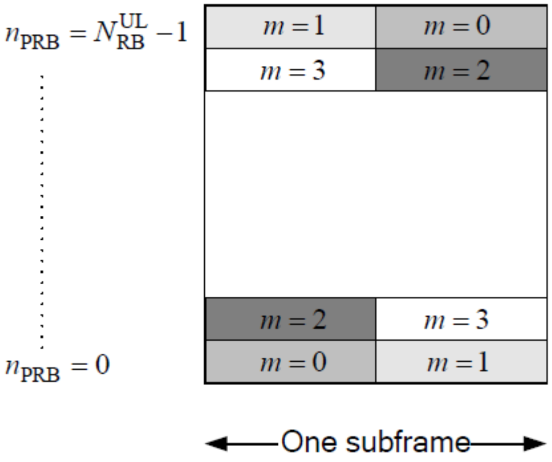
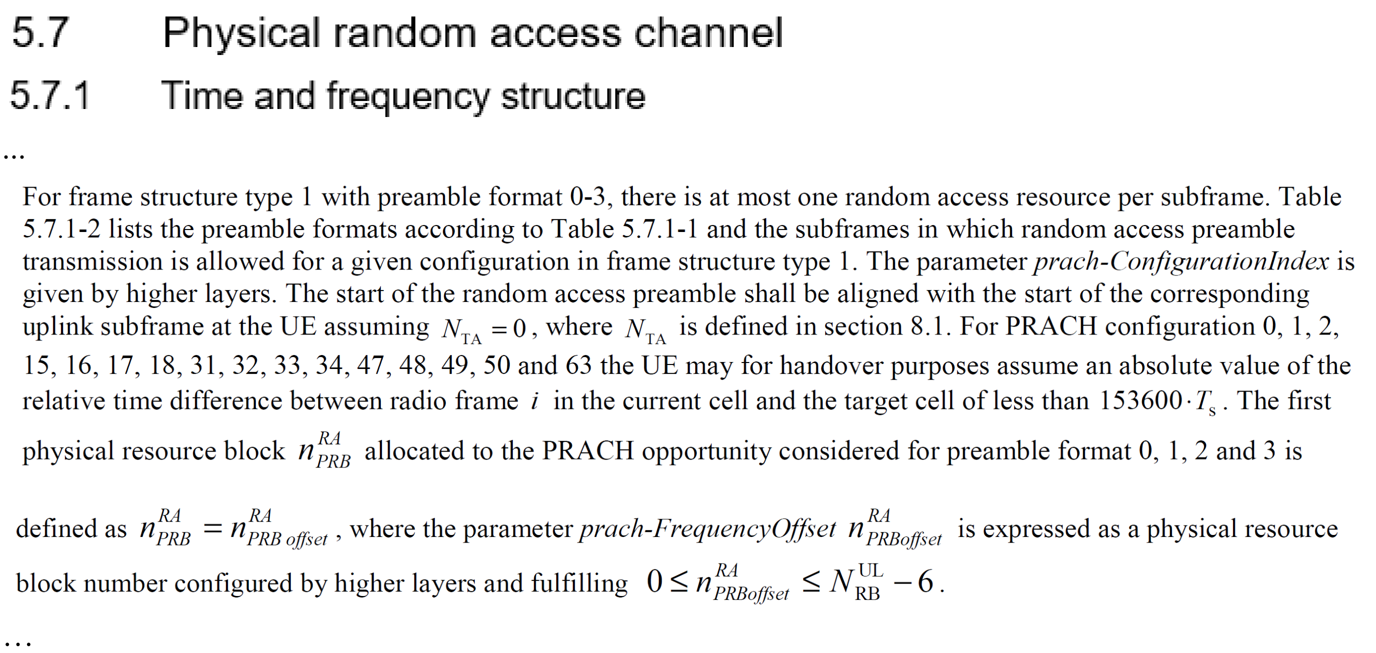


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

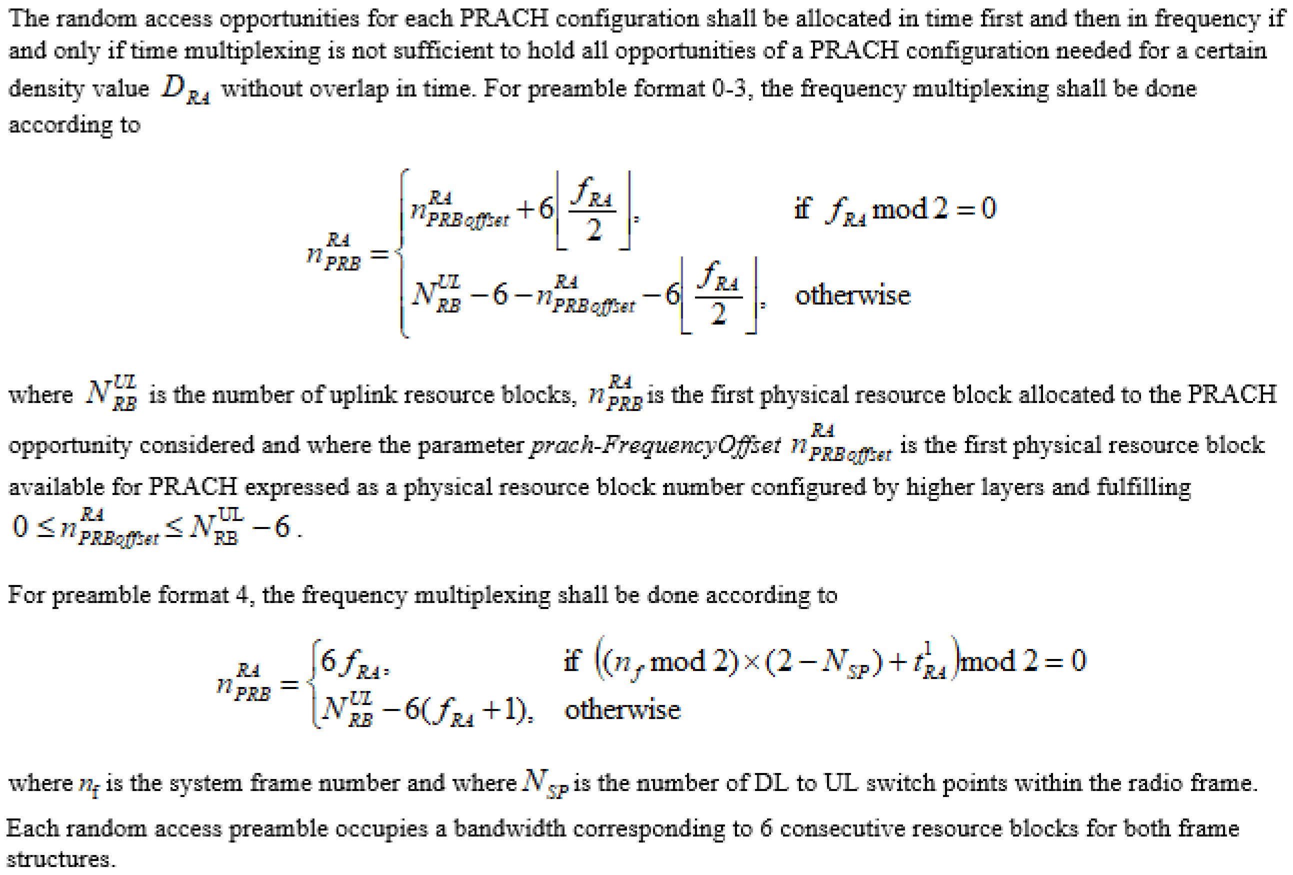
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 17
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. …

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \leq n_{PRBoffset}^{RA} \leq N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.
.
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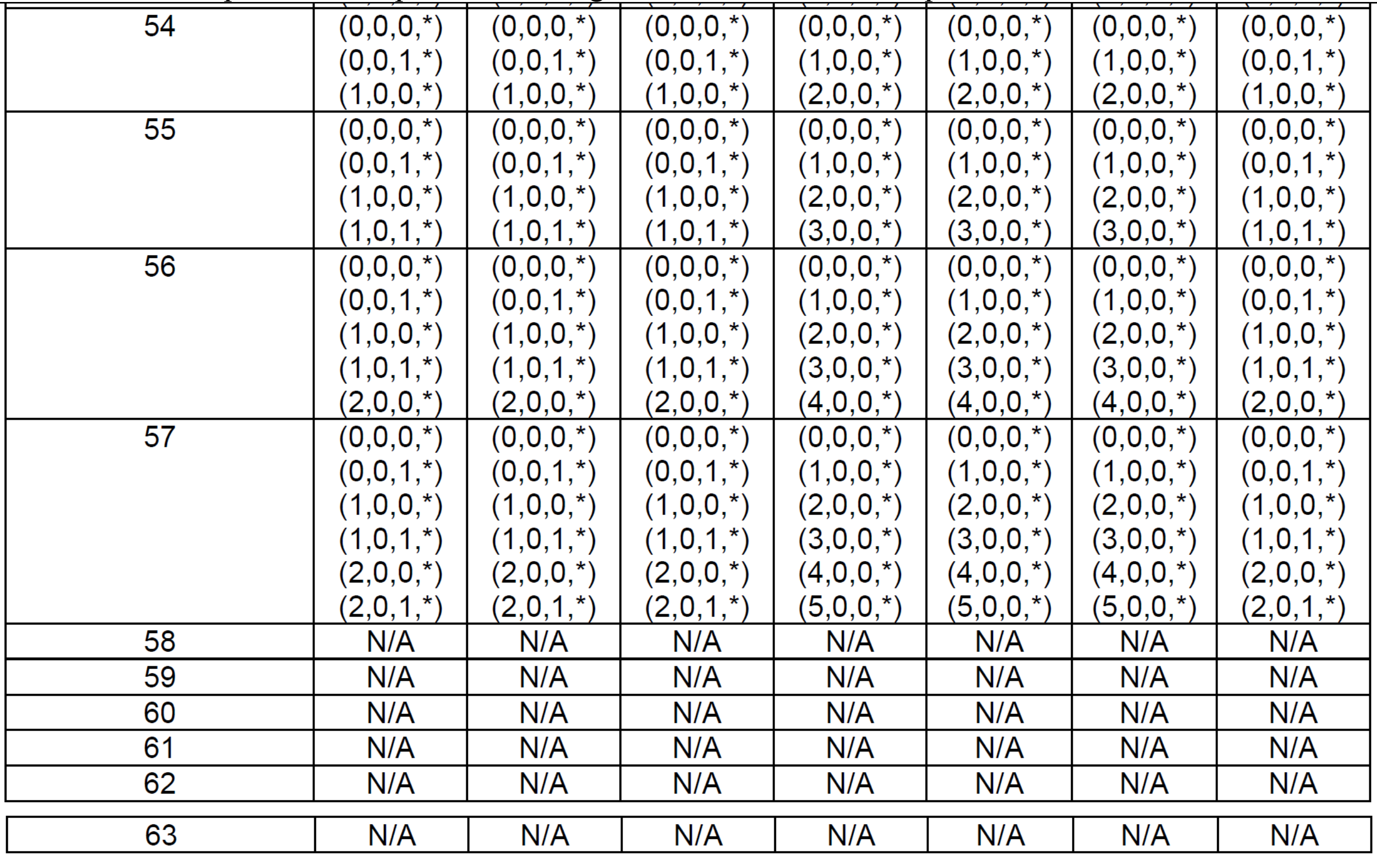
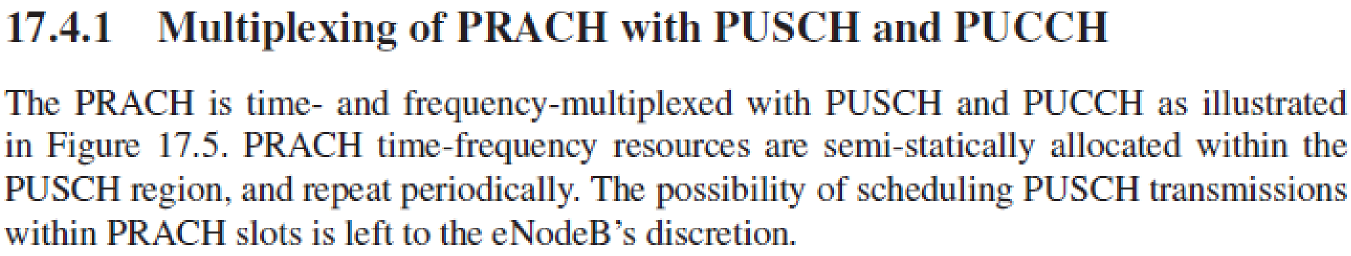


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

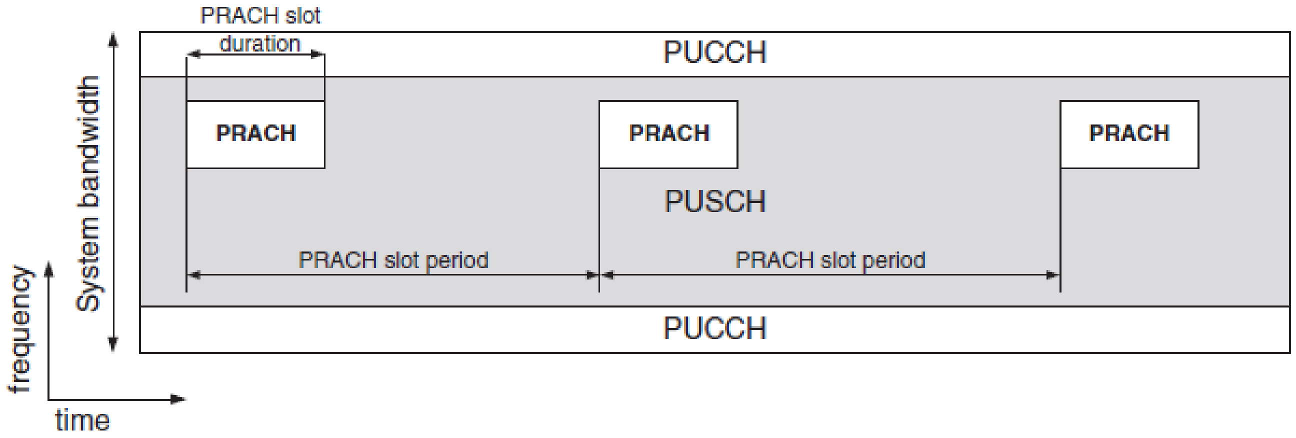


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

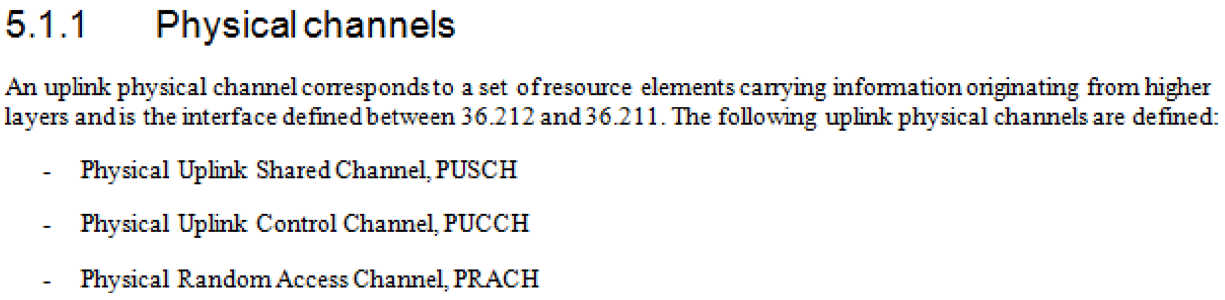
US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

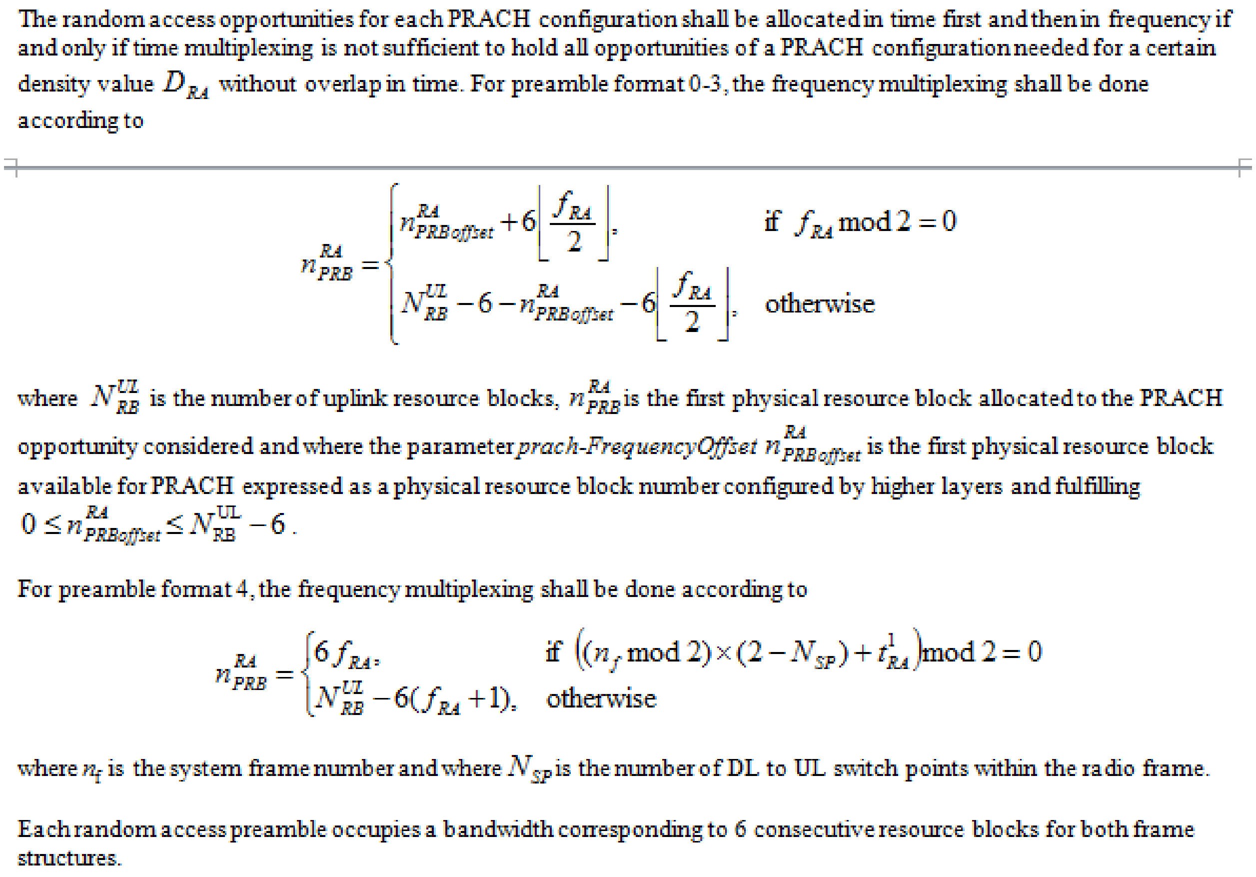
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

US Patent No. 10,833,908: Claim 18

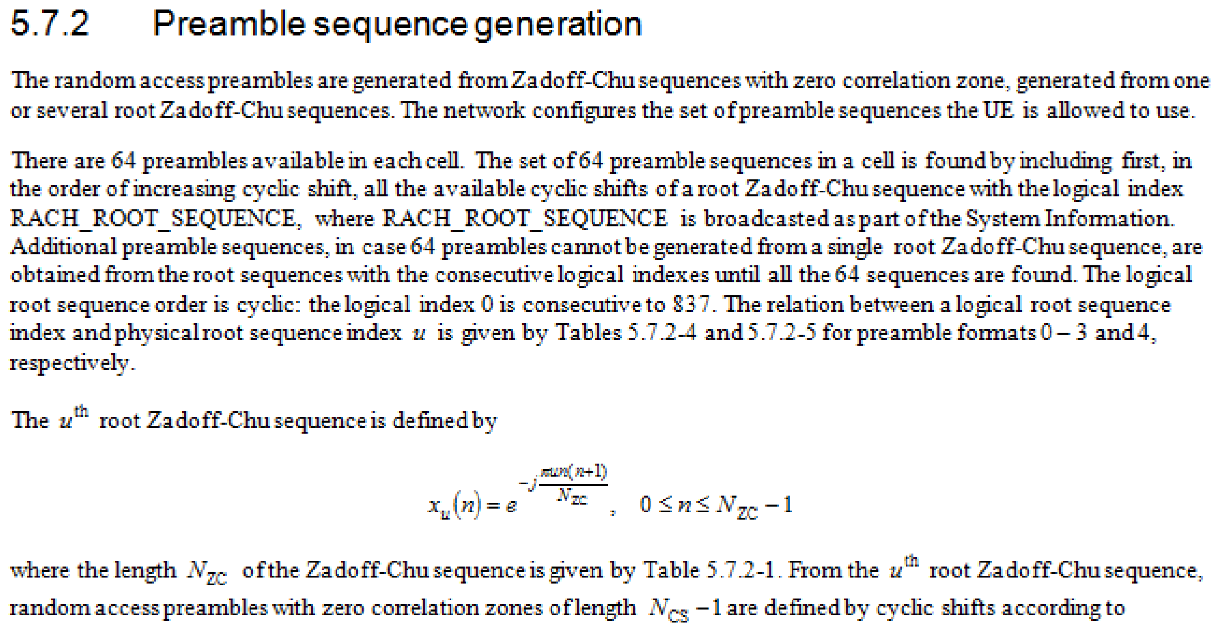
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Nissan's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

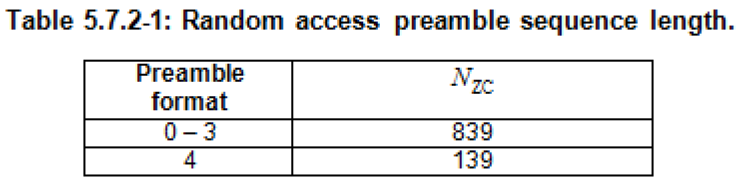
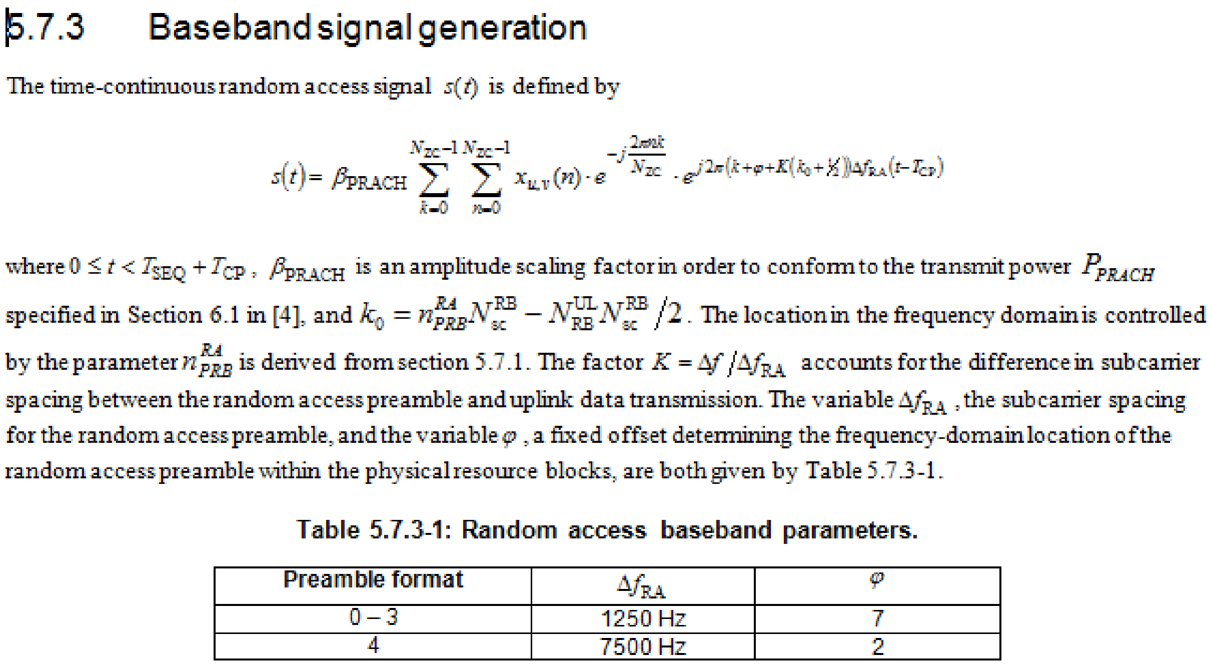


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)= \beta_{\mathrm{PRACH}} \sum_{k=0}^{N_{\mathrm{ZC}}-1} \sum_{n=0}^{N_{\mathrm{ZC}}-1} x_{u,v}(n) \cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}} \cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

where $0 \le t < T_{\mathrm{SEQ}} + T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\mathrm{sc}}^{\mathrm{RB}} - N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}} / 2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

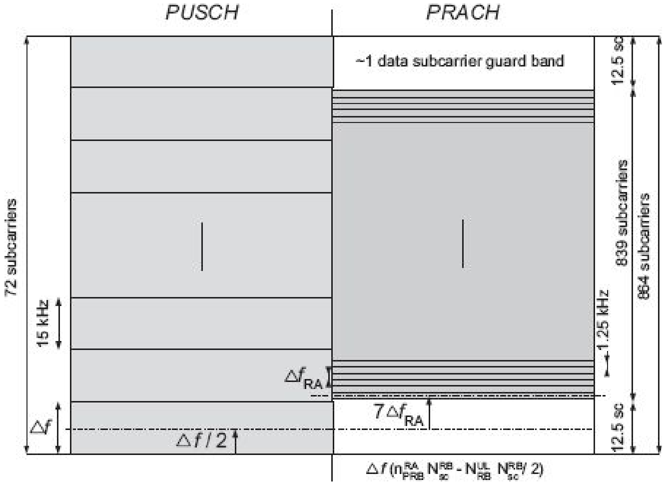
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

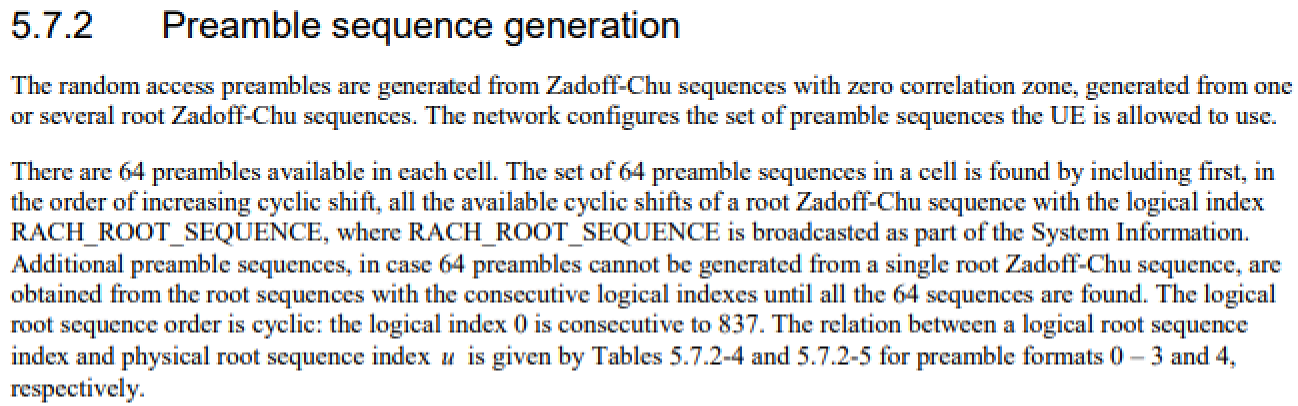
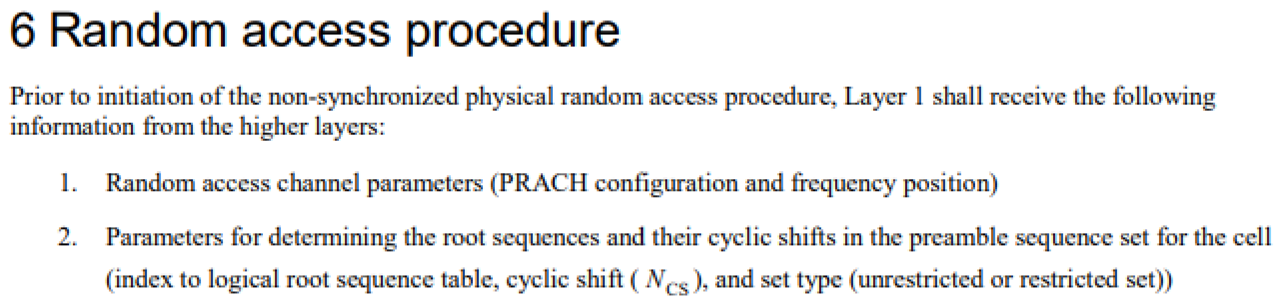
Figure 17.14: PRACH preamble mapping onto allocated subcarriers.



See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Nissan's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

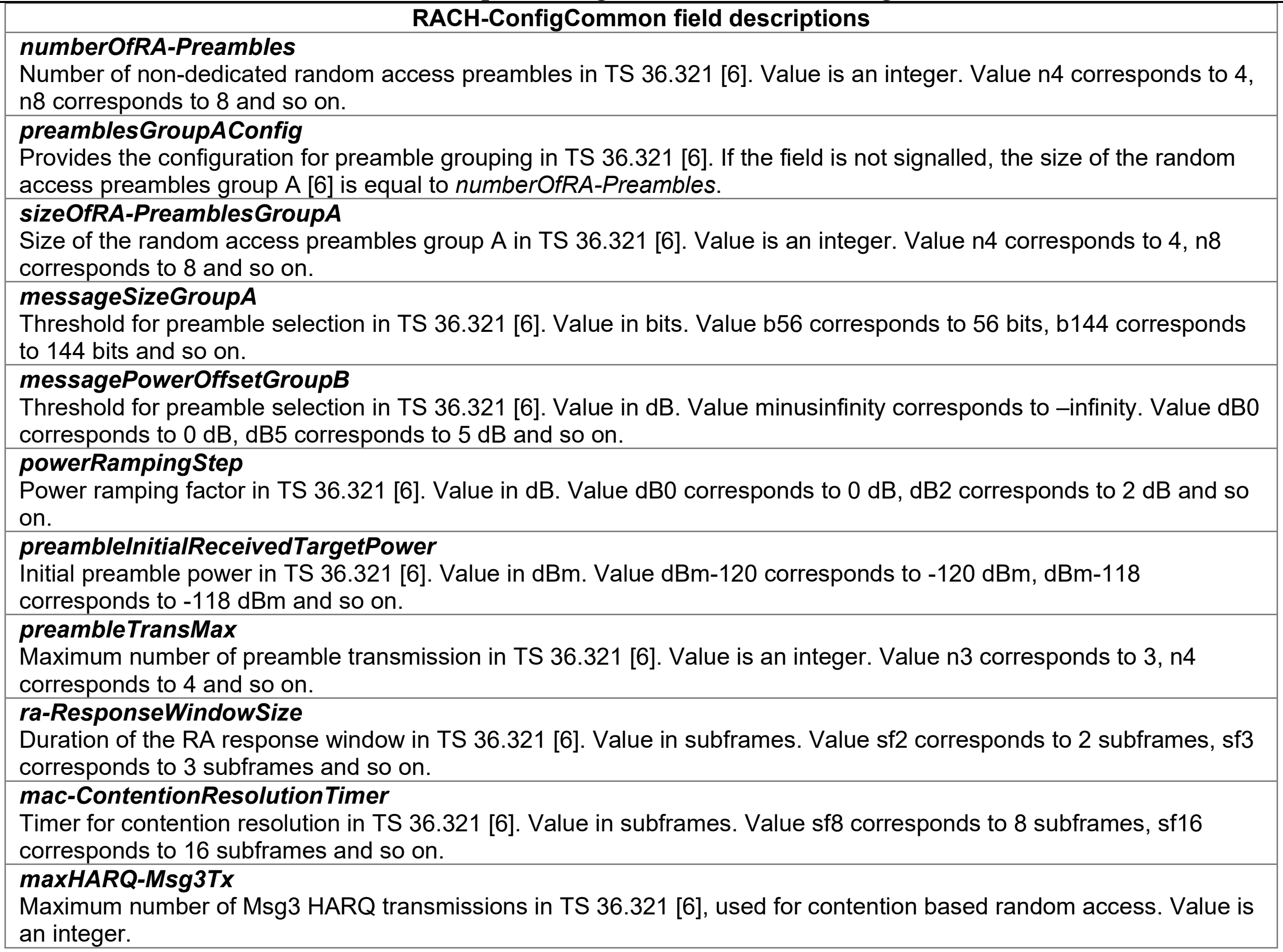
```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

“The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

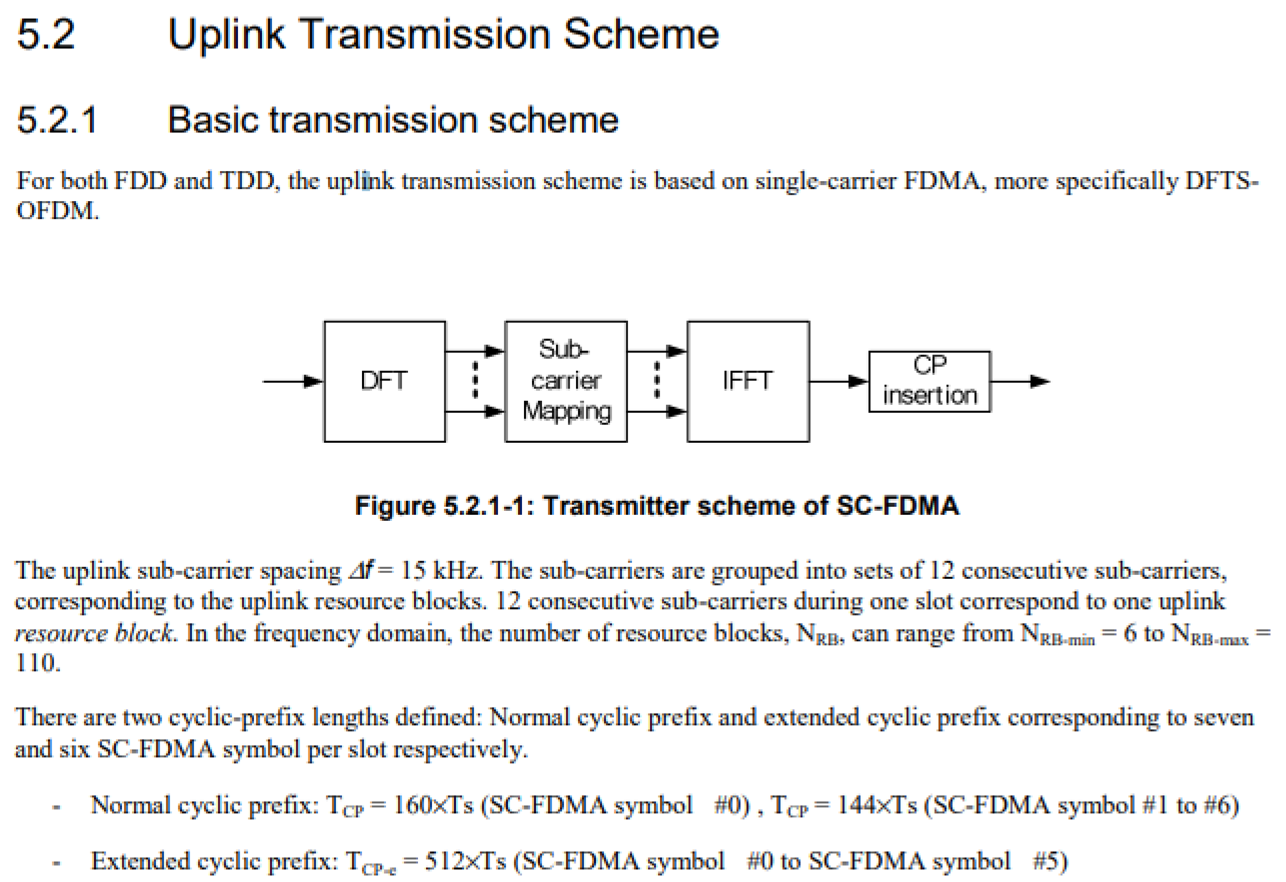


RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

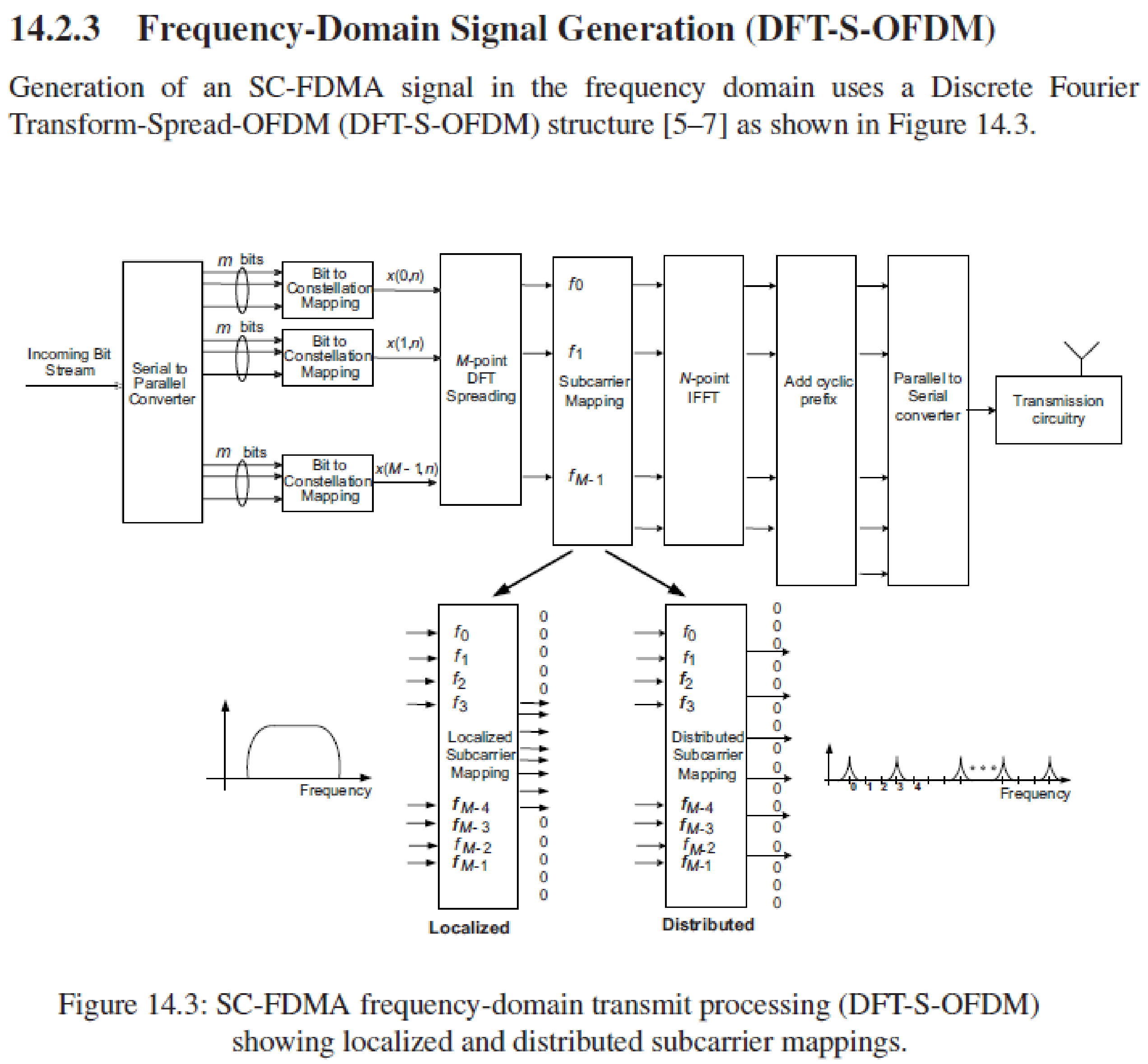
See also Claim 9.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. Nissan's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,* Nissan's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

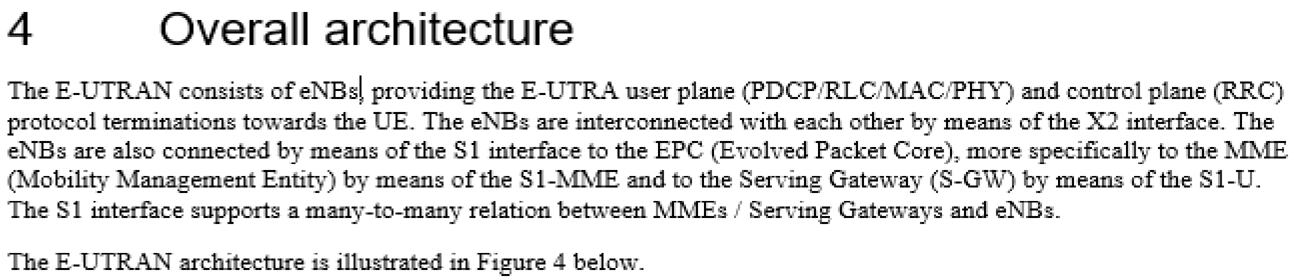
Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20
“The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.”

	See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:”

21. A mobile station comprising:	To the extent the preamble is considered a limitation, Nissan’s Accused Instrumentalities meet the preamble of claim 21 of the ’908 patent. *E.g.,* Nissan’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Nissan offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff’s Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

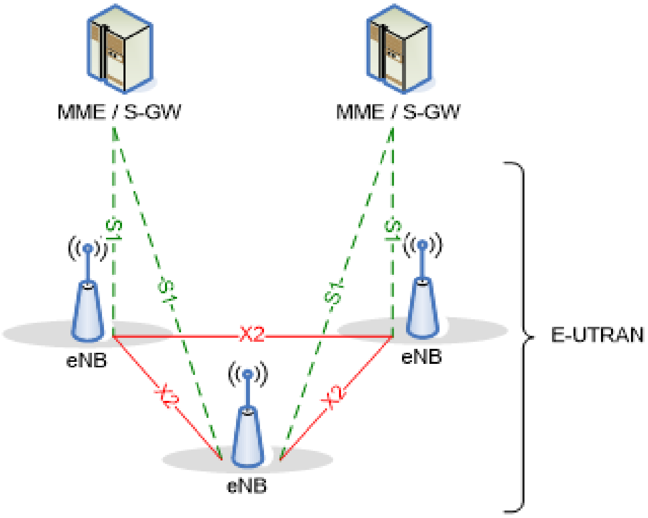


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

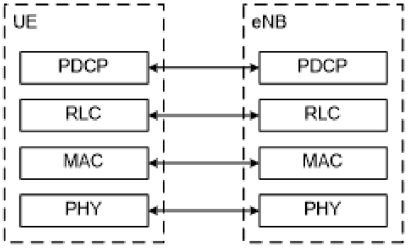


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	Nissan's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The Nissan Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

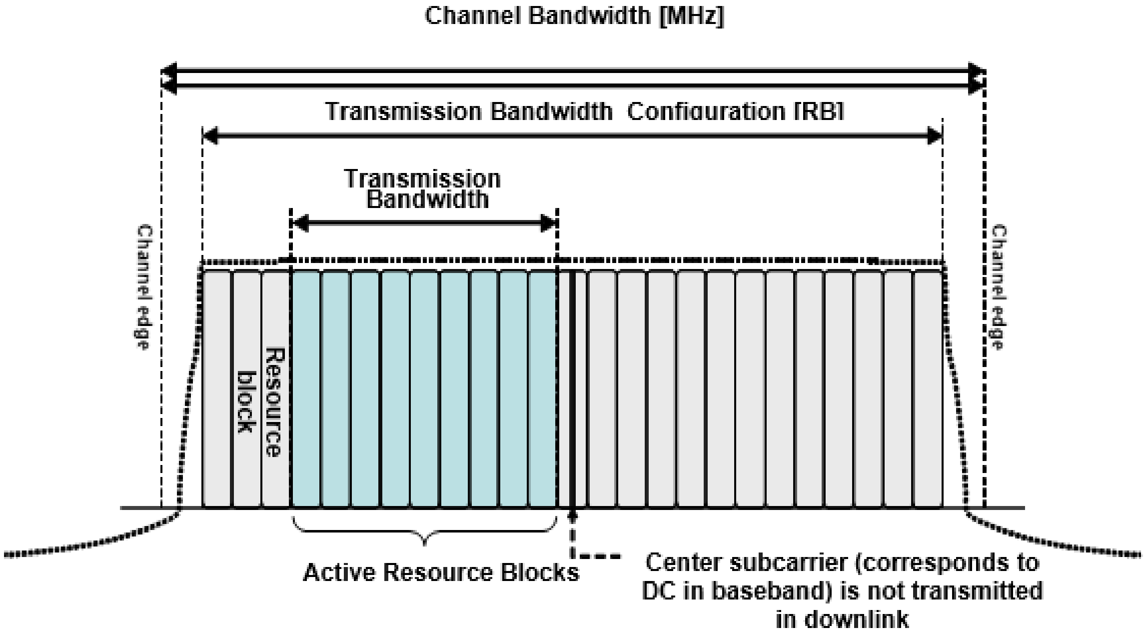
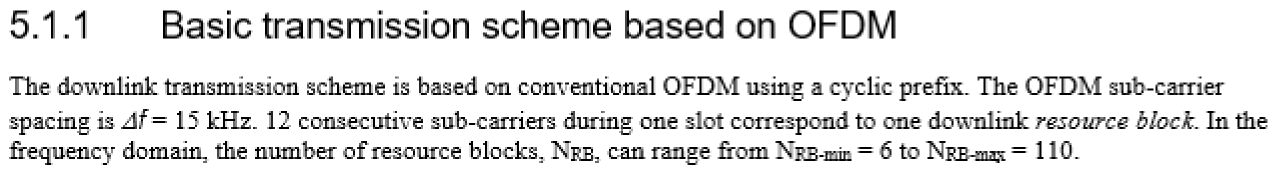


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

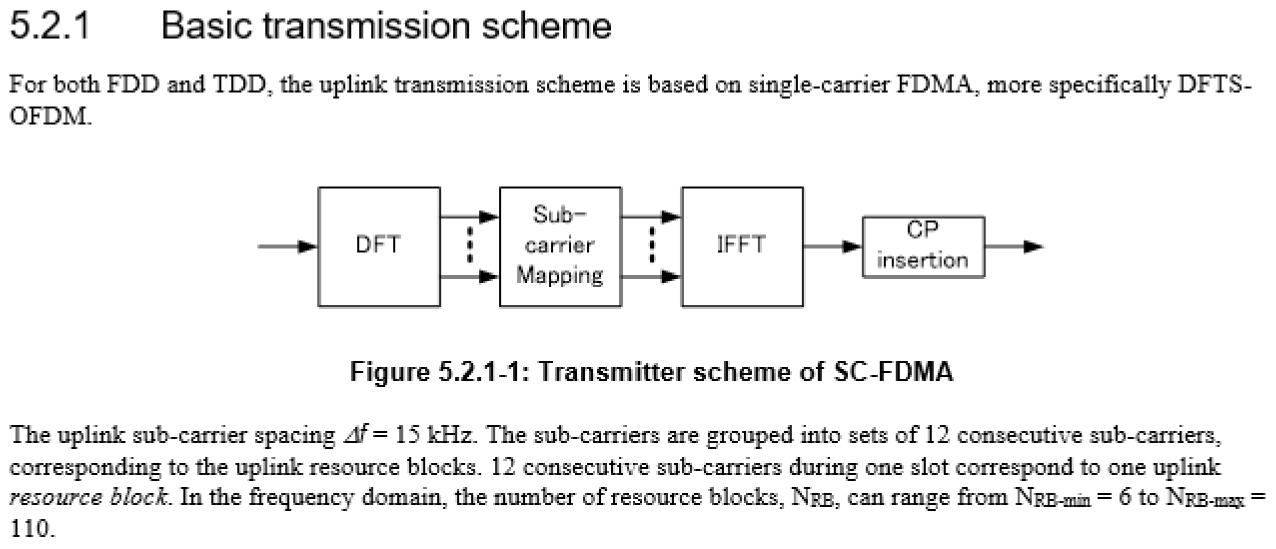
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

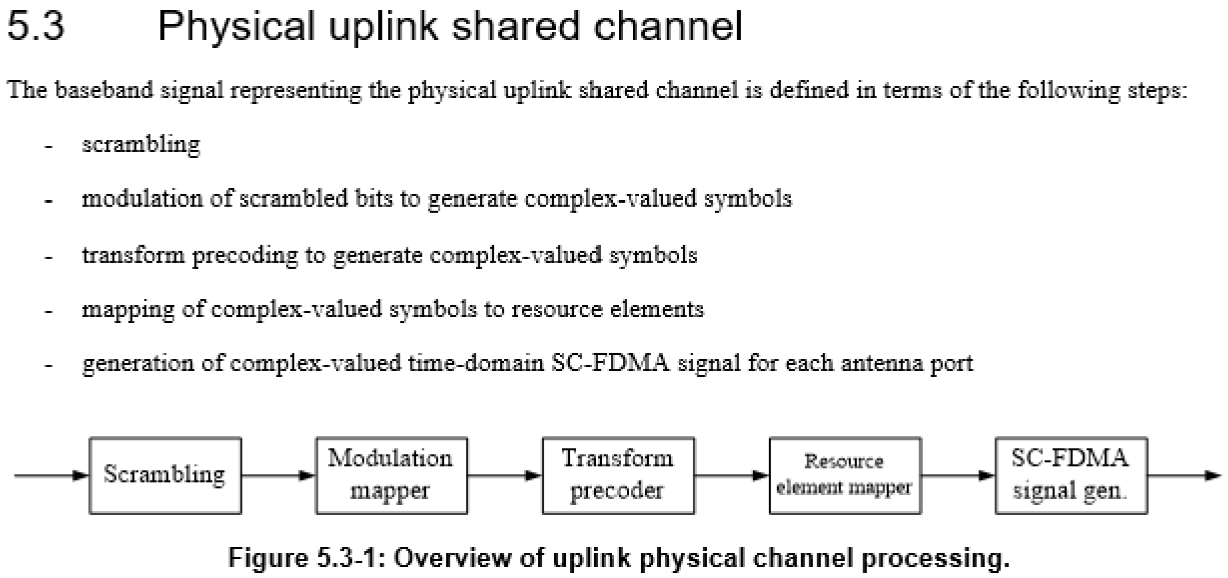
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

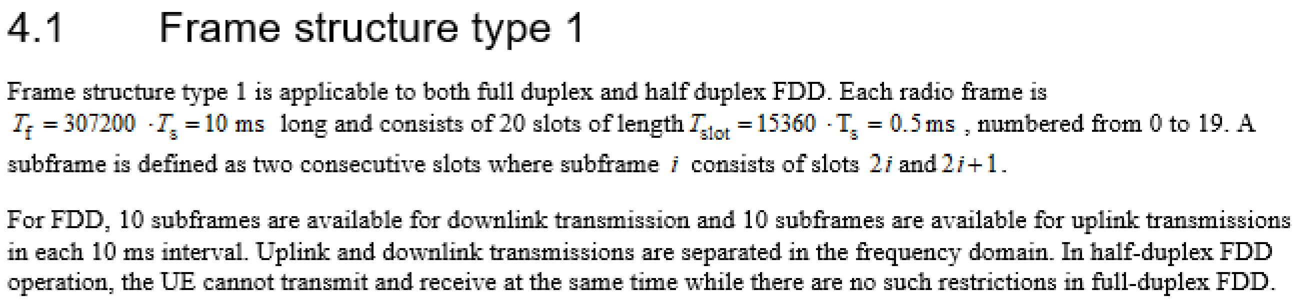
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\text{ ms}$ long and consists of 20 slots of length $T_{\text{slot}} = 15360 \cdot T_s = 0.5\text{ ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

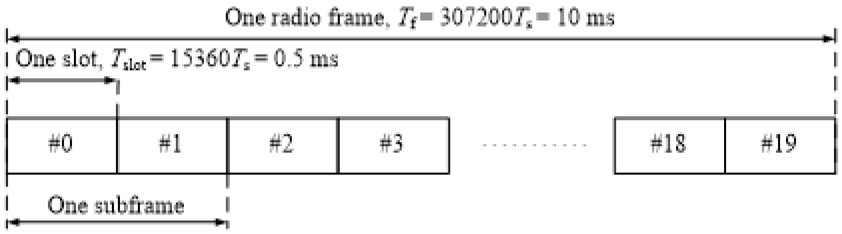
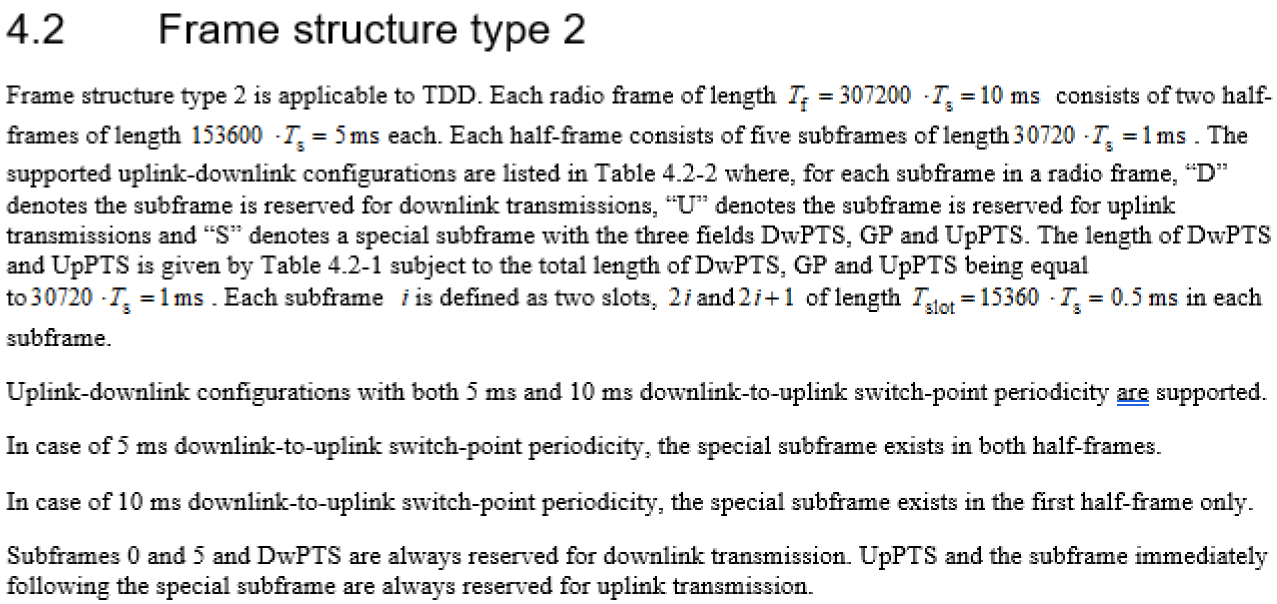


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

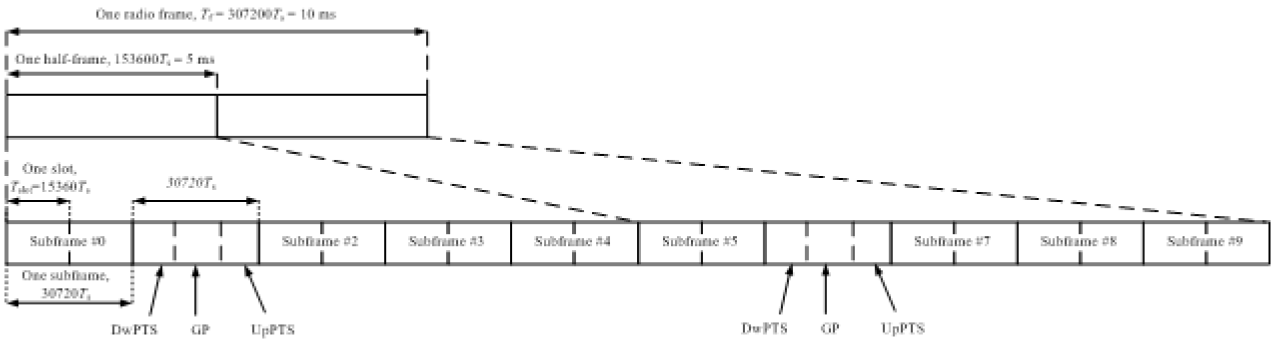
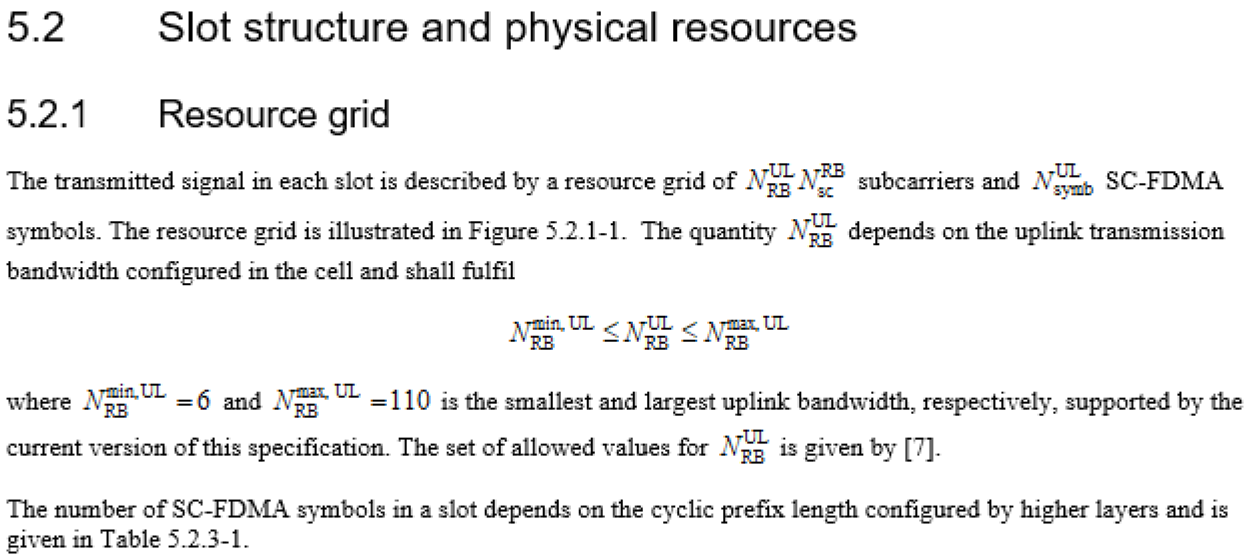


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

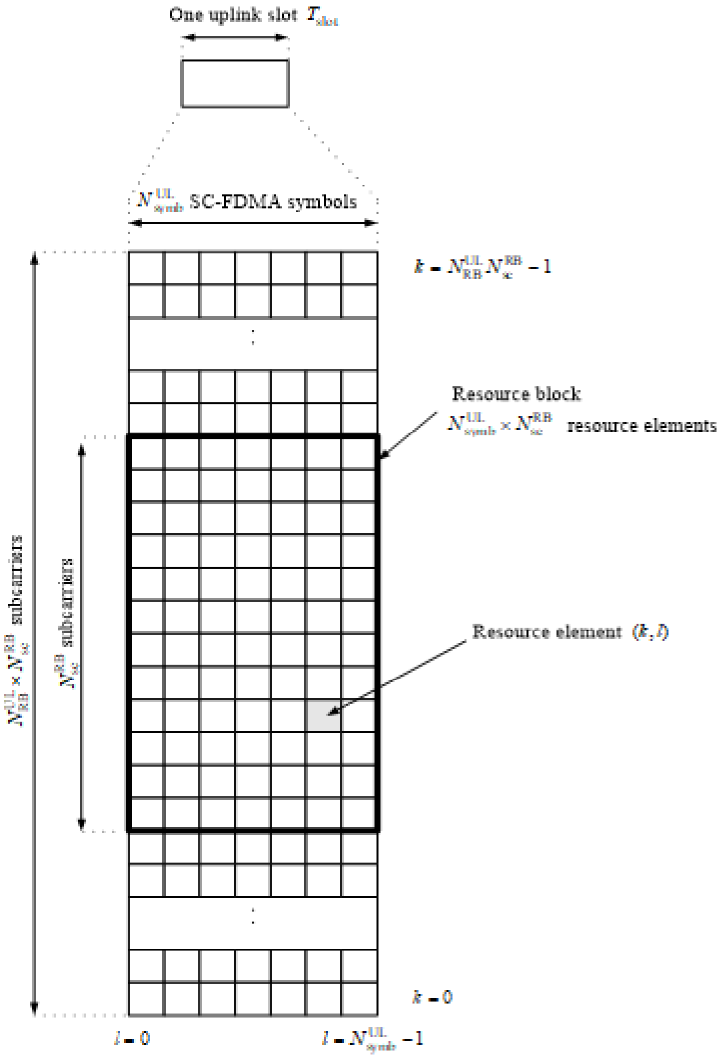
The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

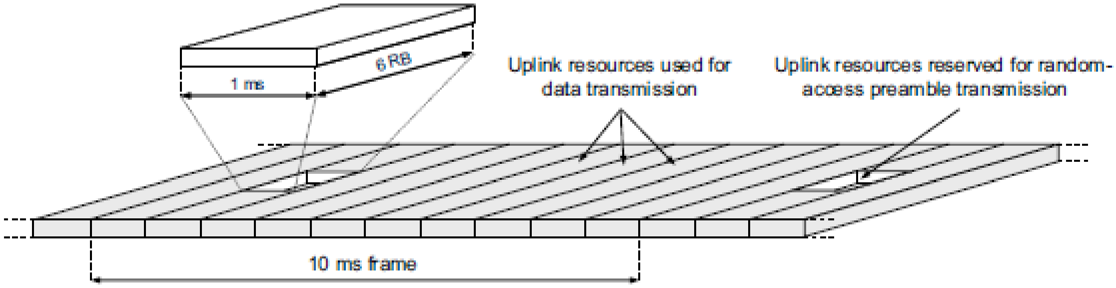
where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

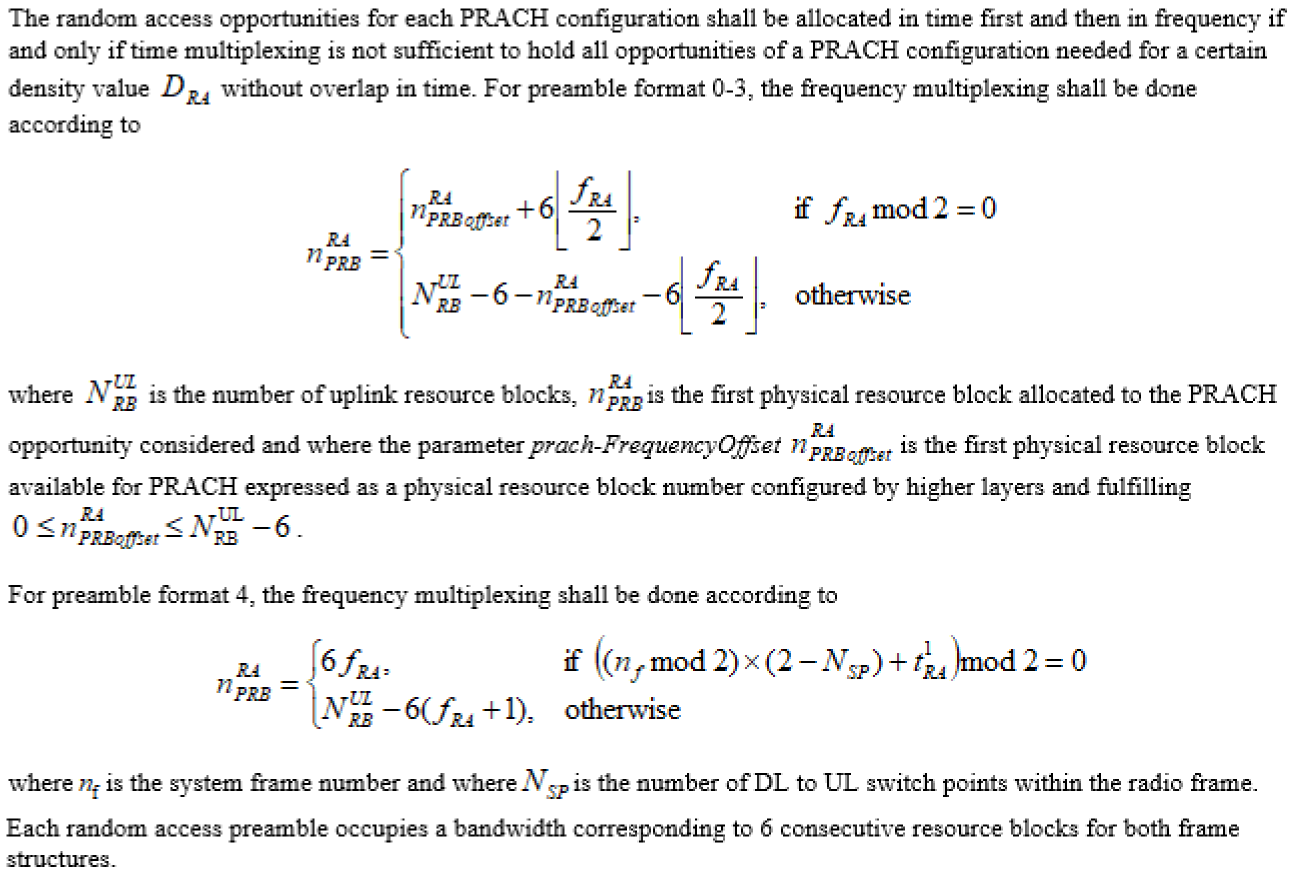
US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	Nissan's Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

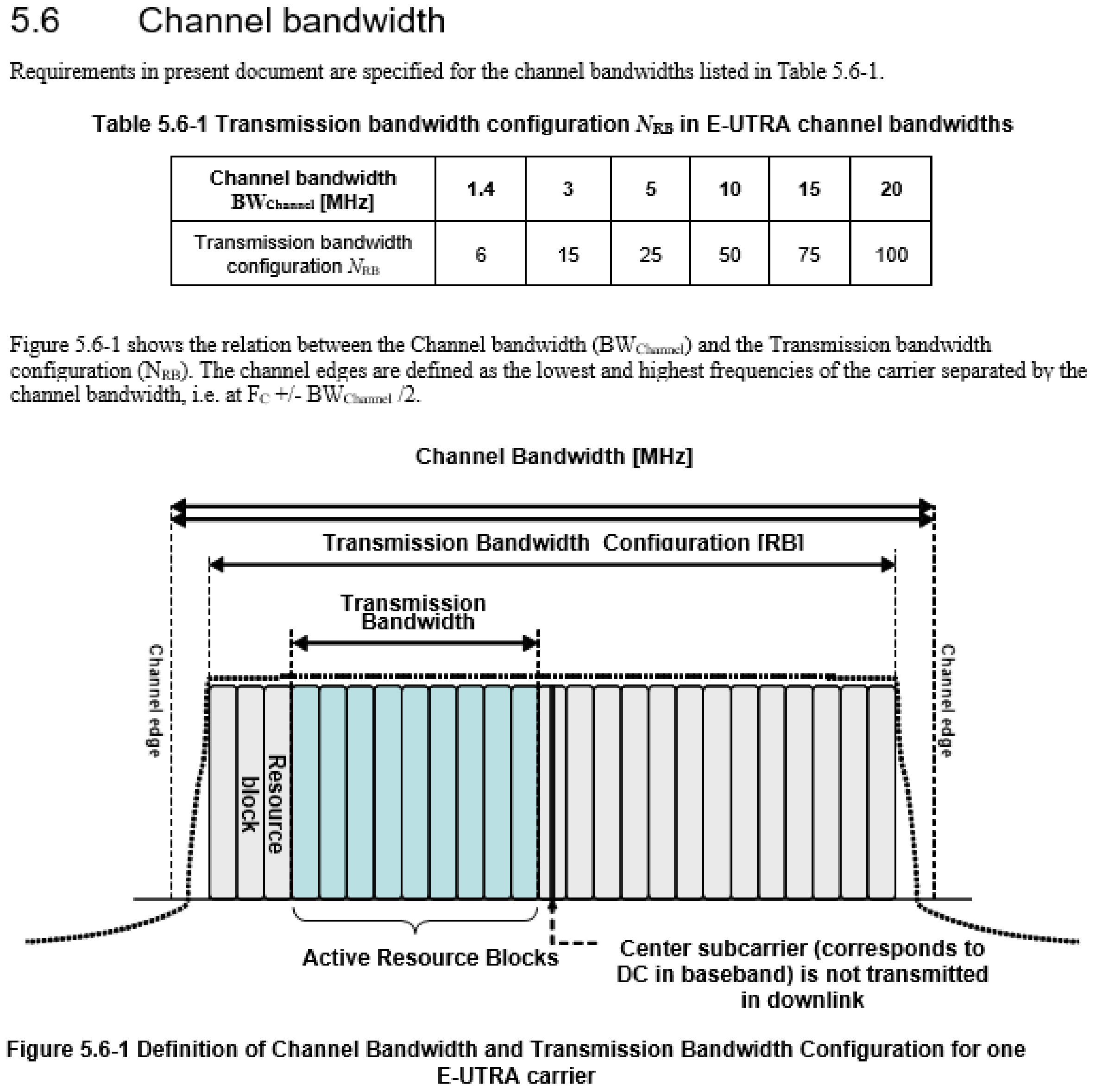
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

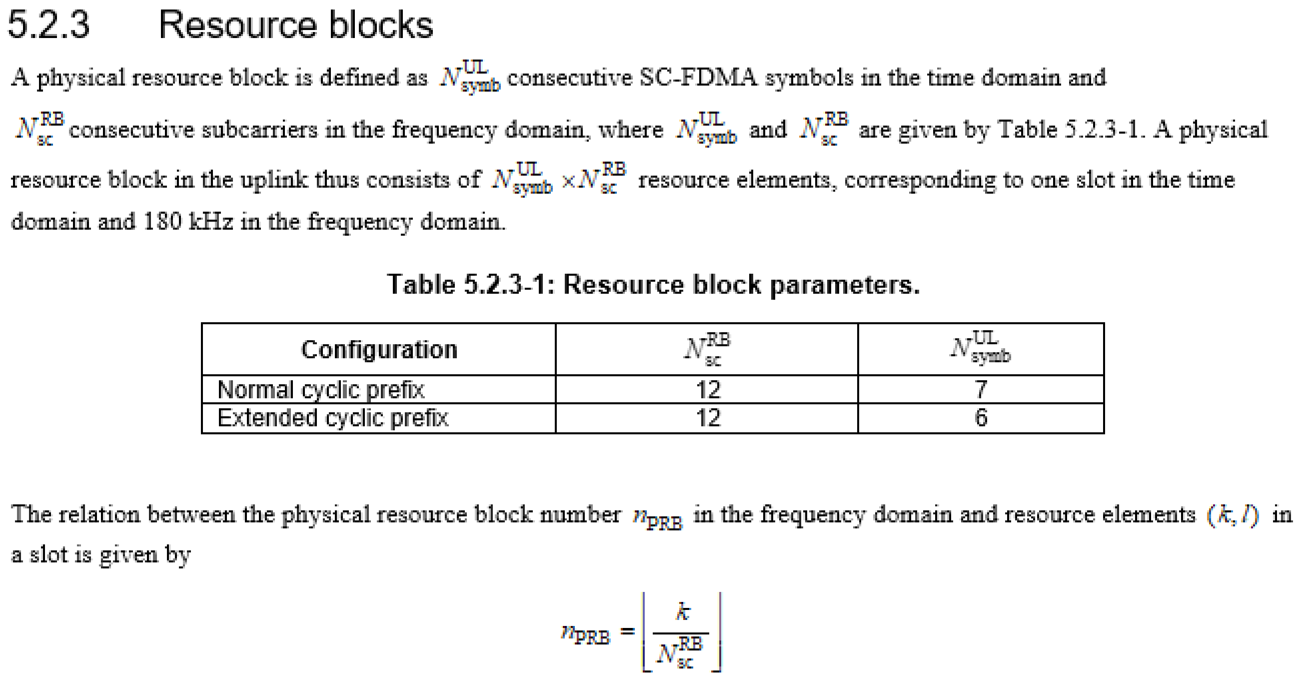
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)

“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

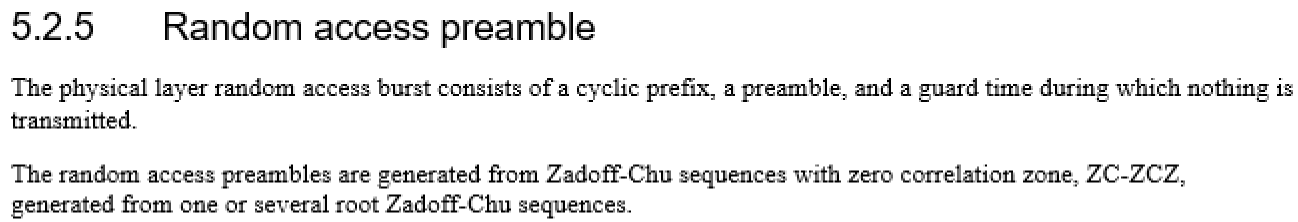
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

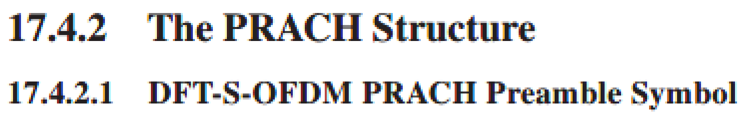


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.



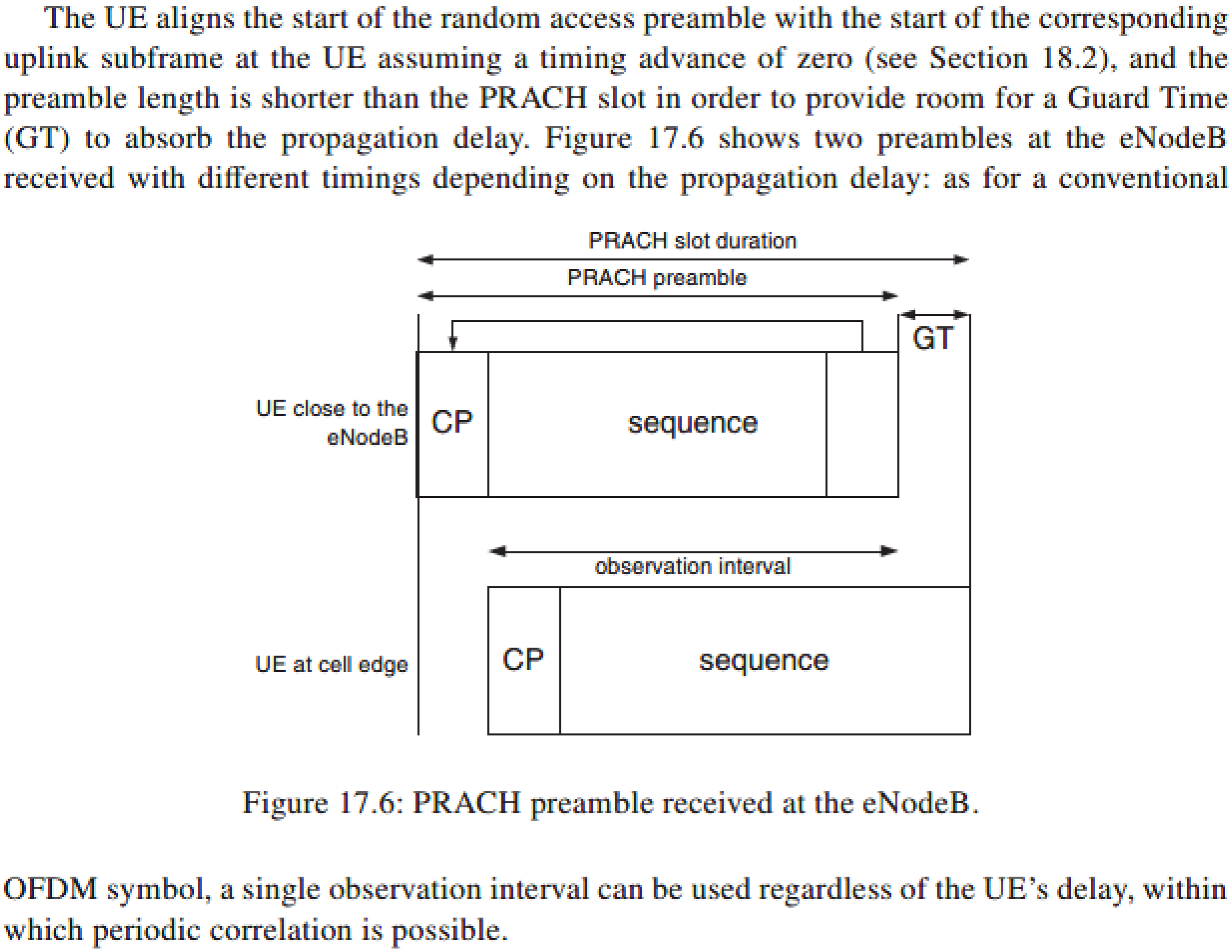
17.4.2 The PRACH Structure

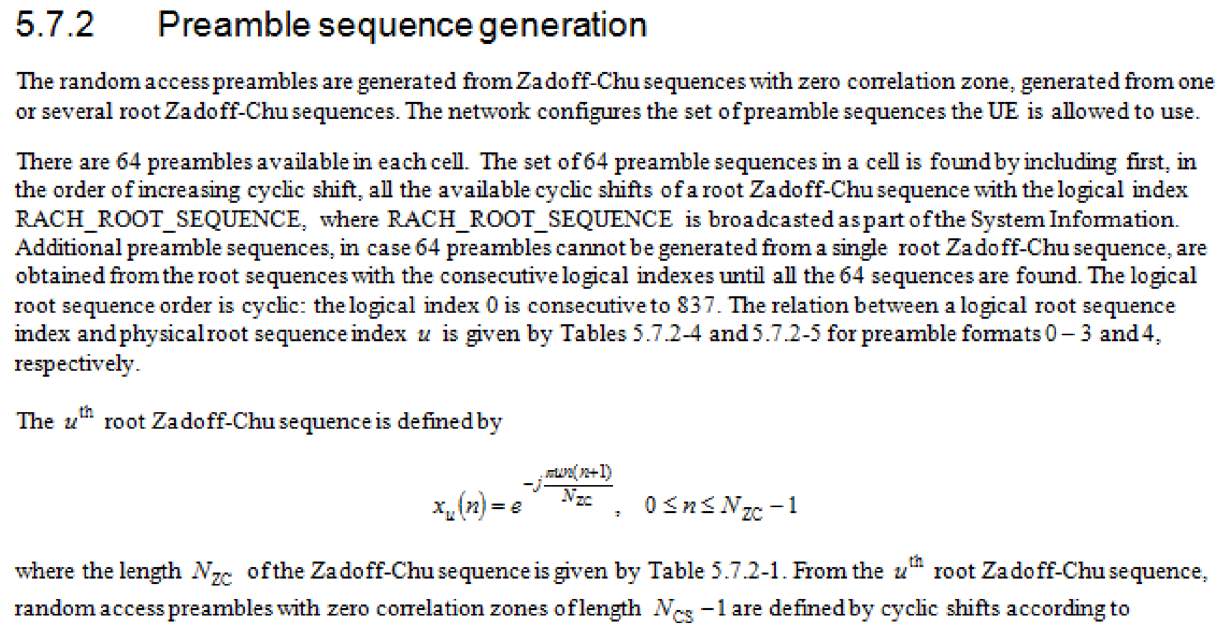
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE's delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

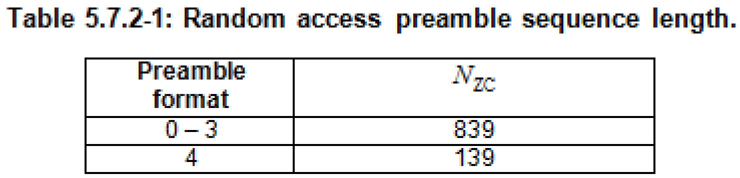
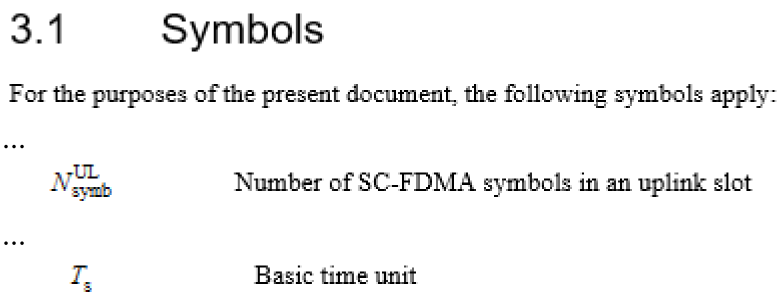
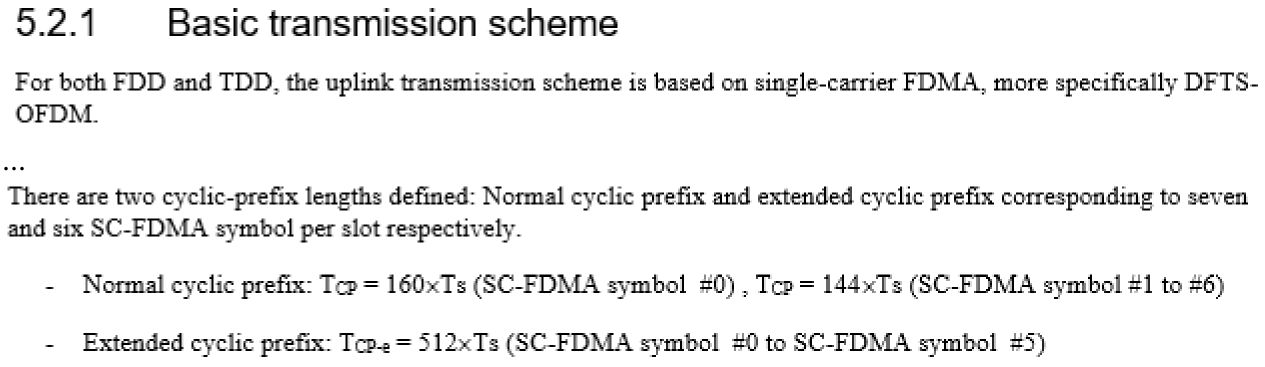


Table 5.7.2-1: Random access preamble sequence length.

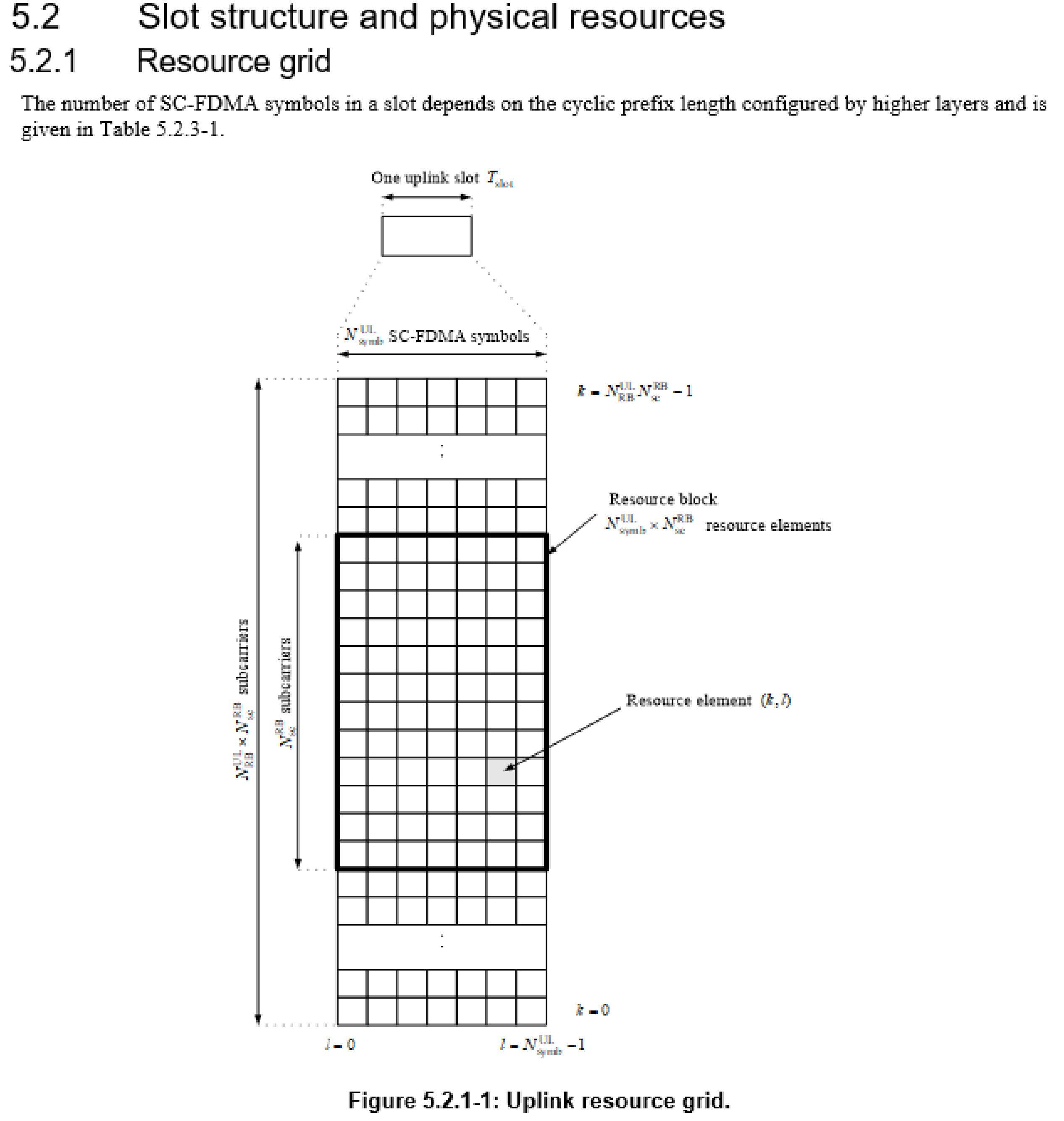
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Nissan's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs. 3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals. 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



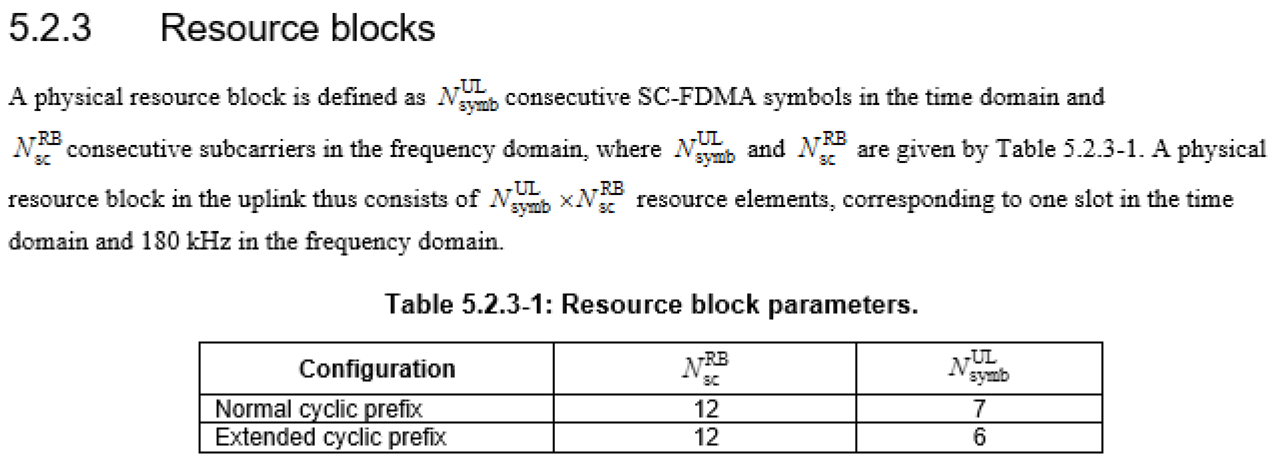
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

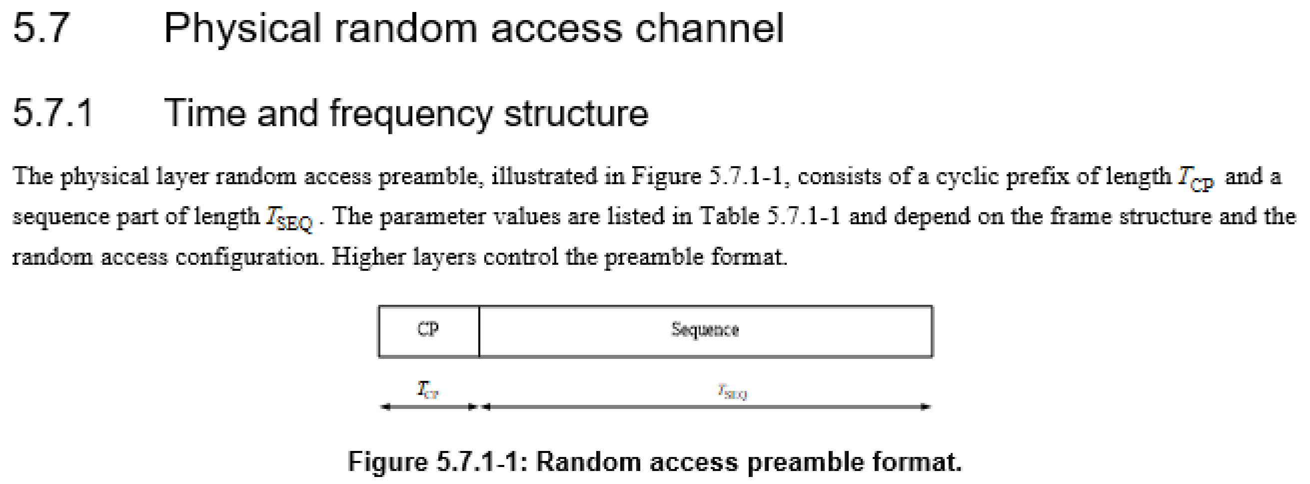
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

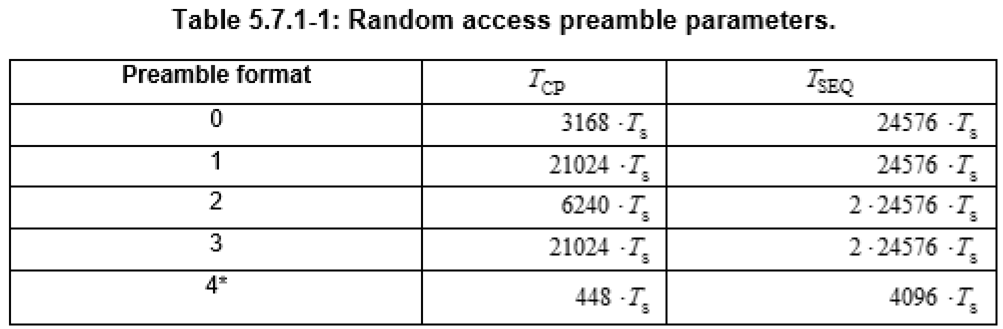
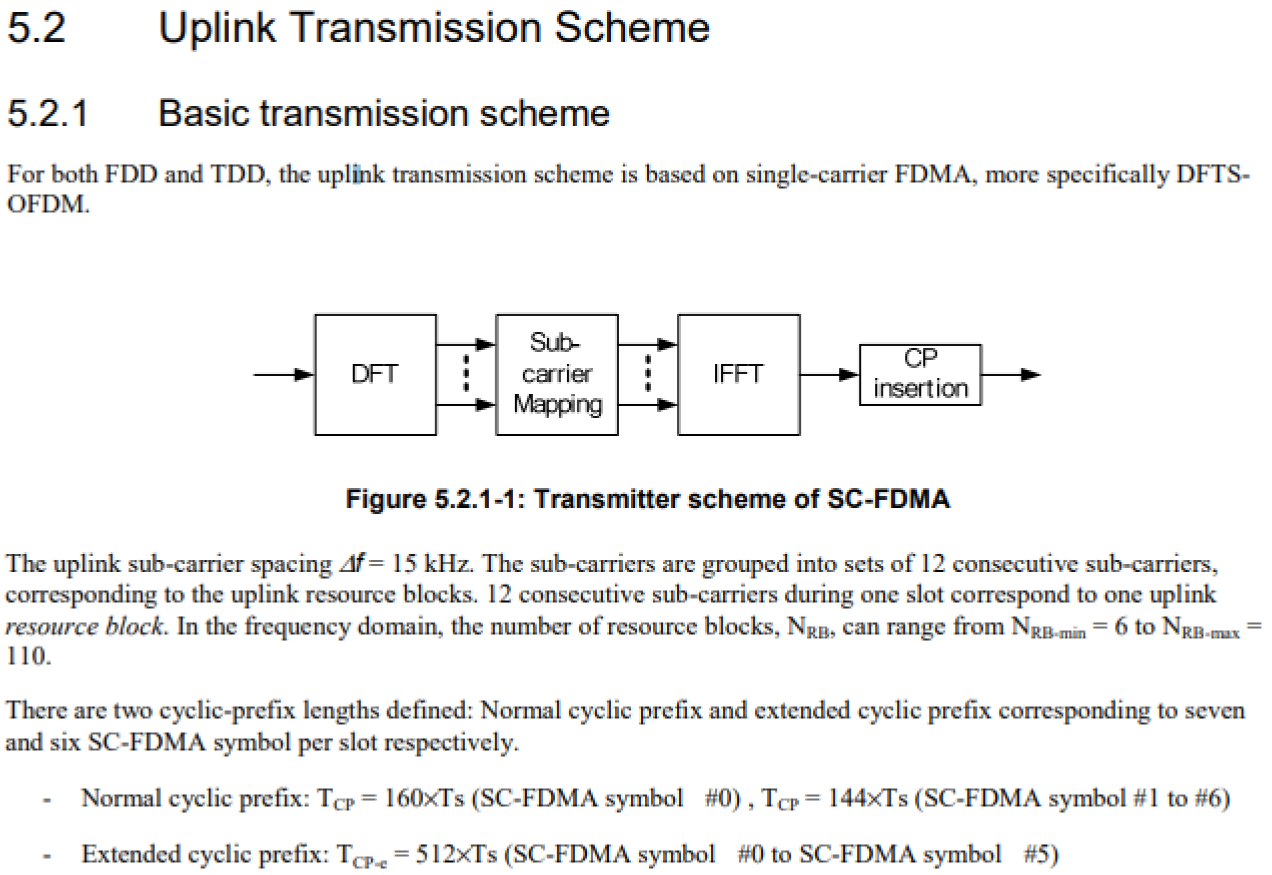


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)
"a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;"

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	Nissan's Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, Nissan's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

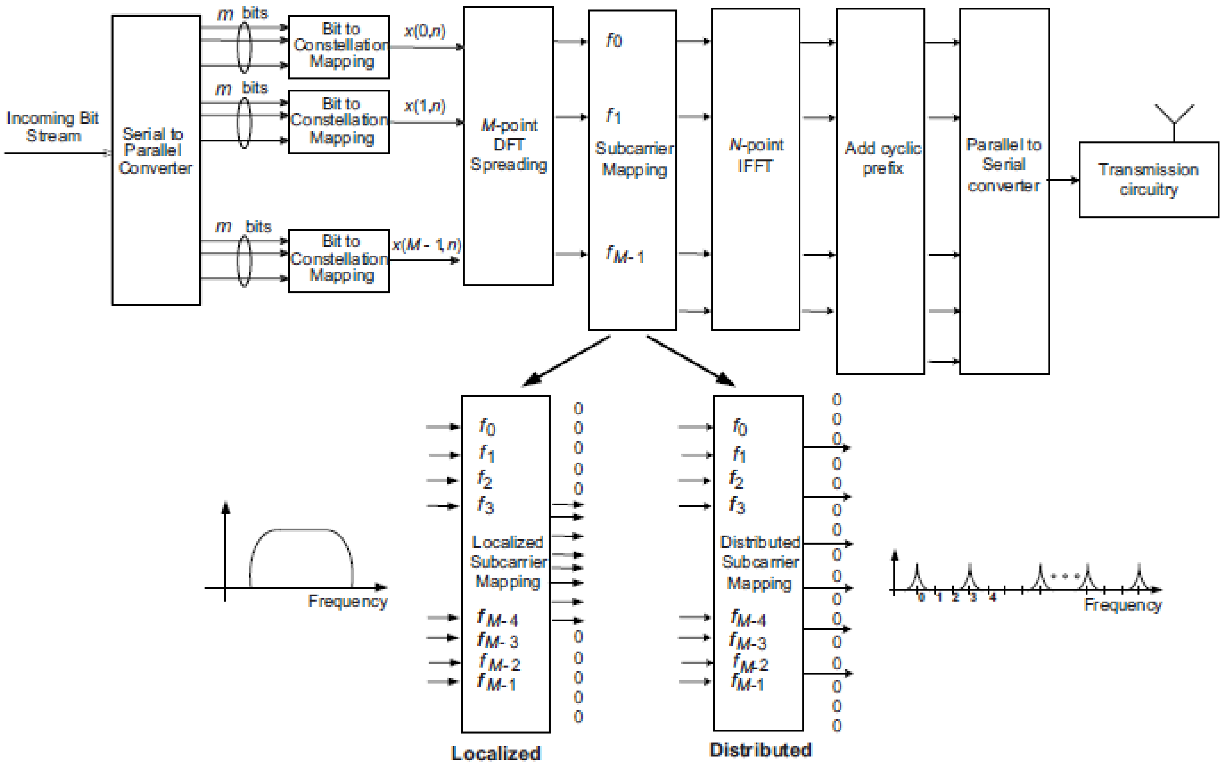


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

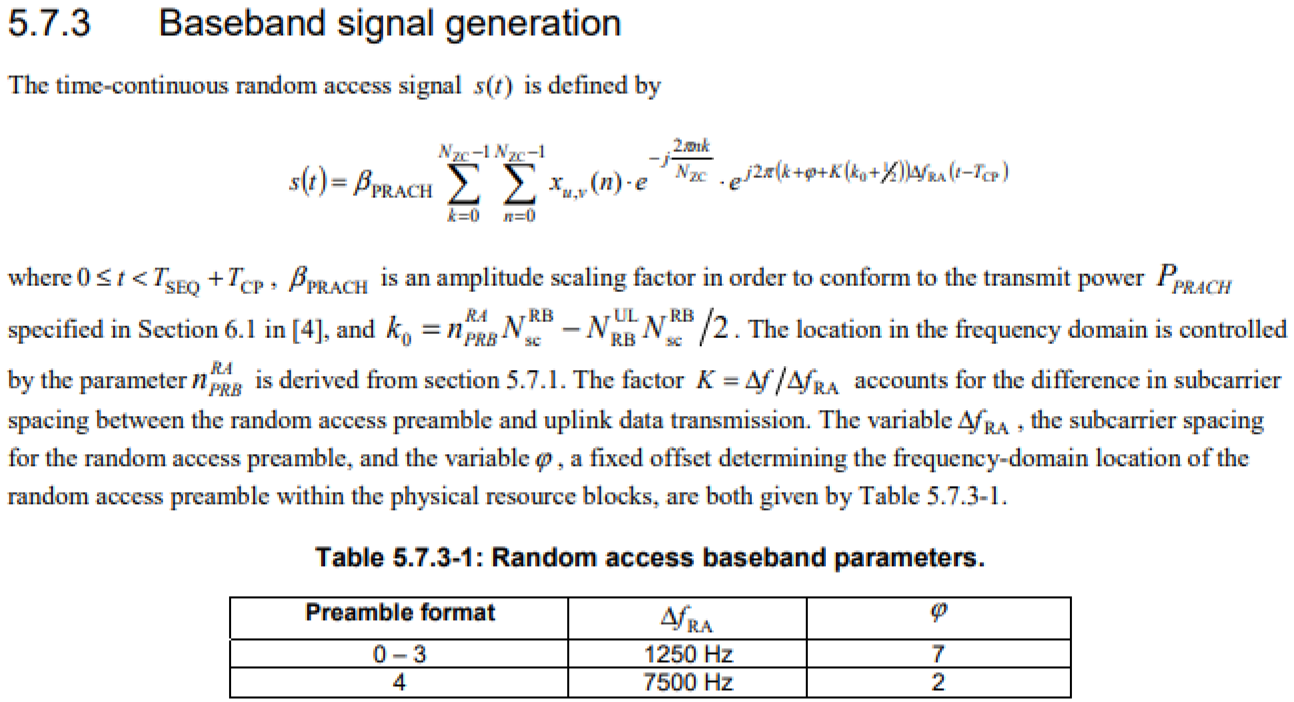
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

US Patent No. 10,833,908: Claim 21(f)
"wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band"

wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;

Nissan's Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

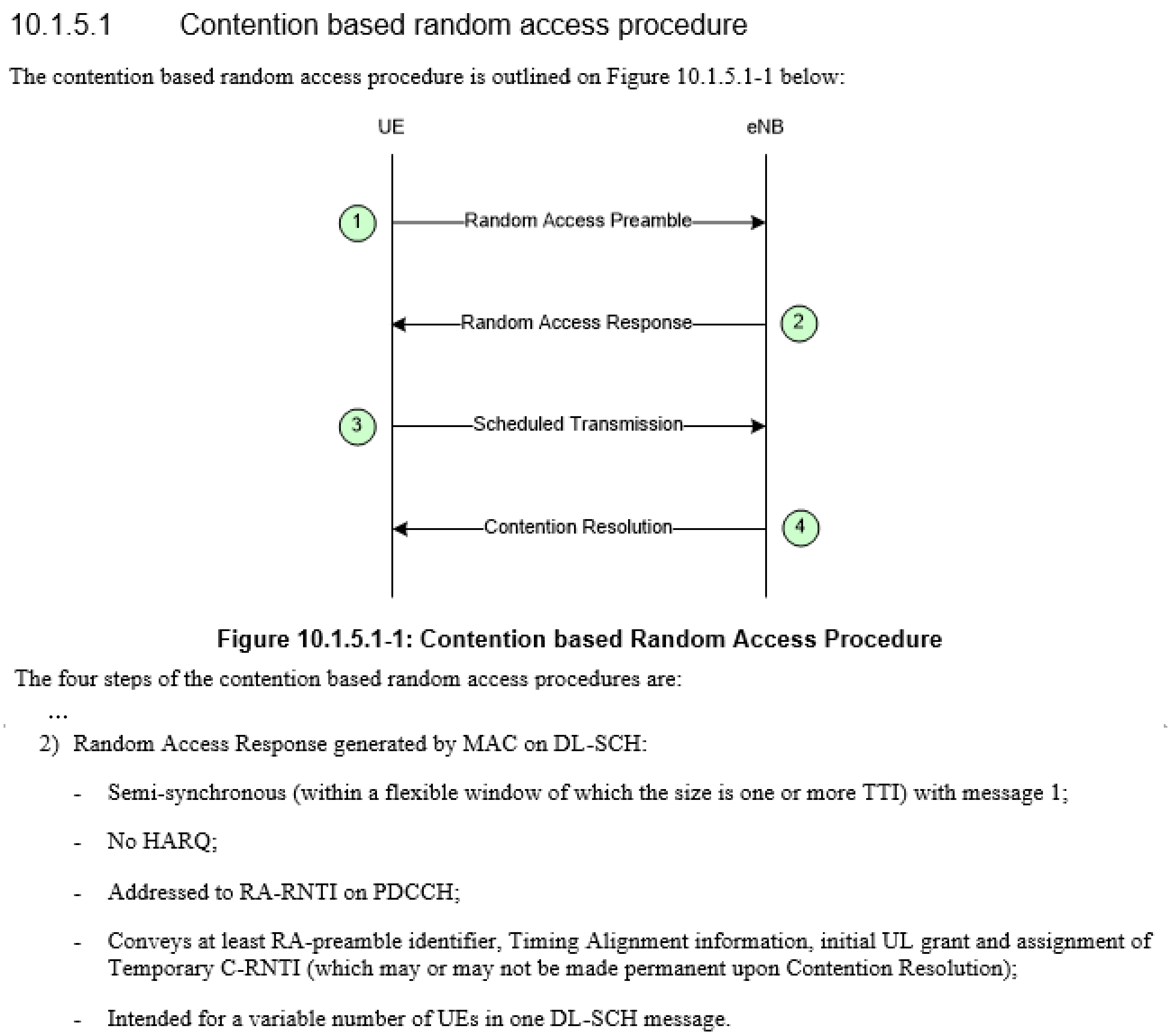
$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

where $0\leq t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

wherein the mobile station is further configured to receive, from the base station, a second analog signal	Nissan's Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

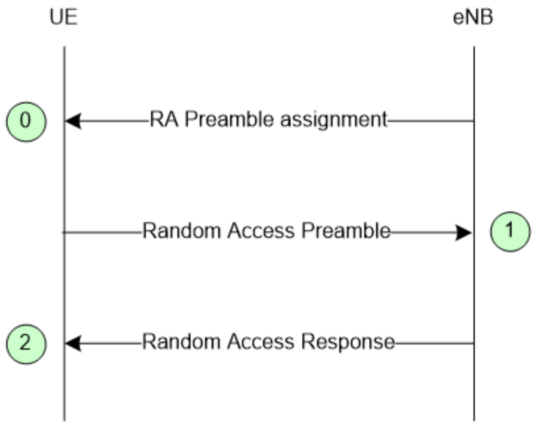
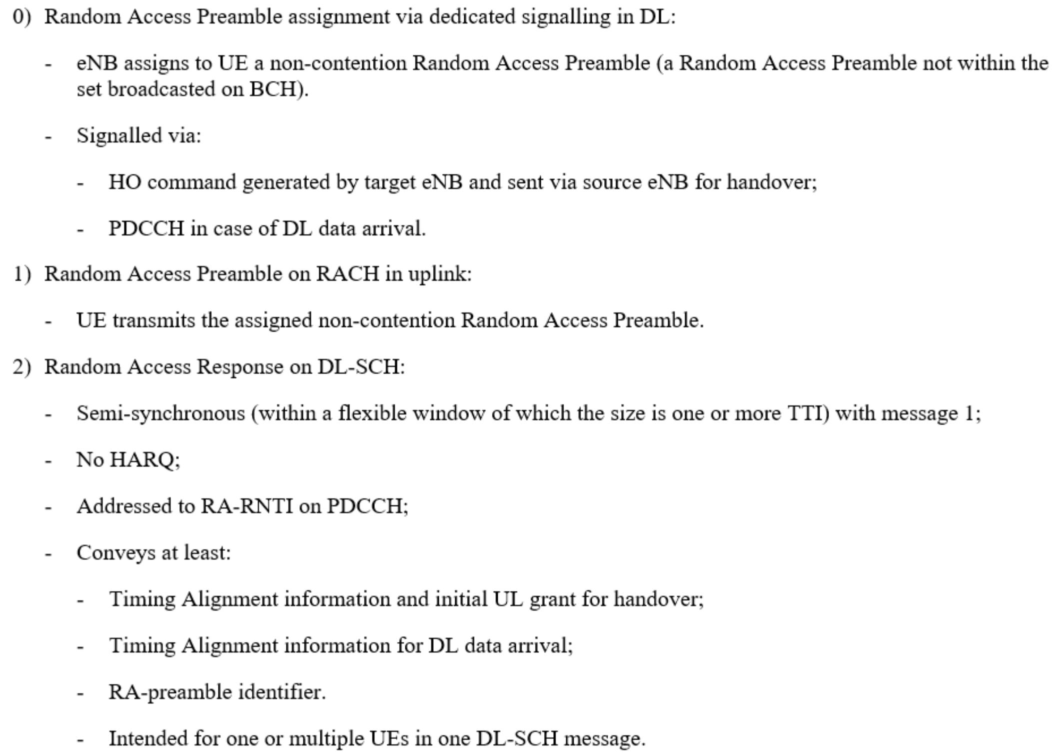


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

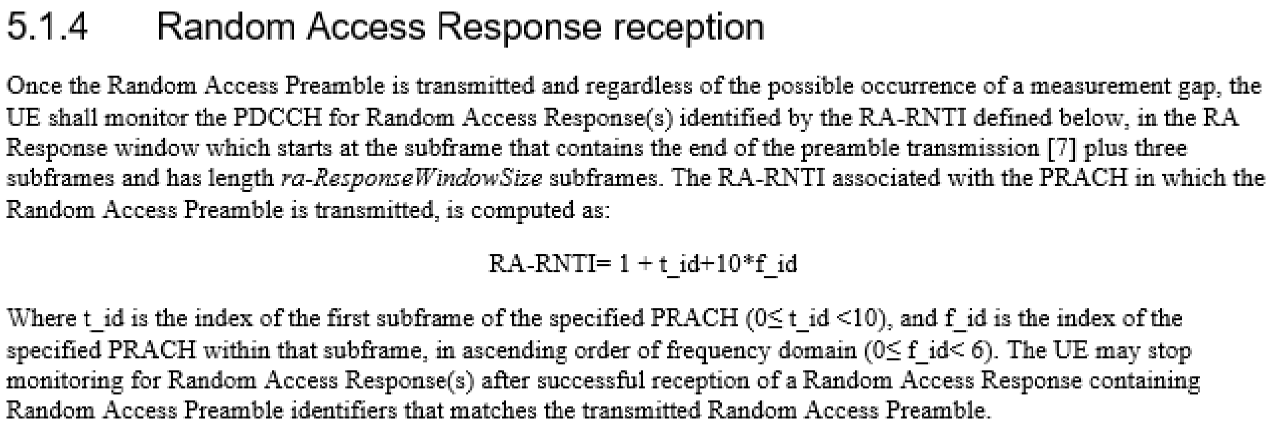
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



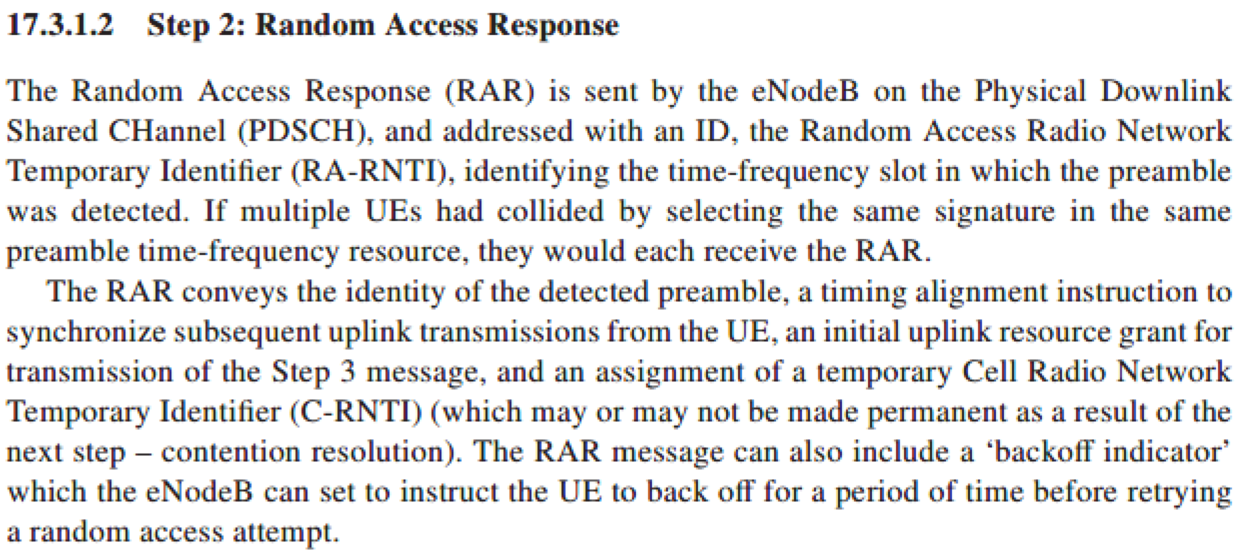
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.



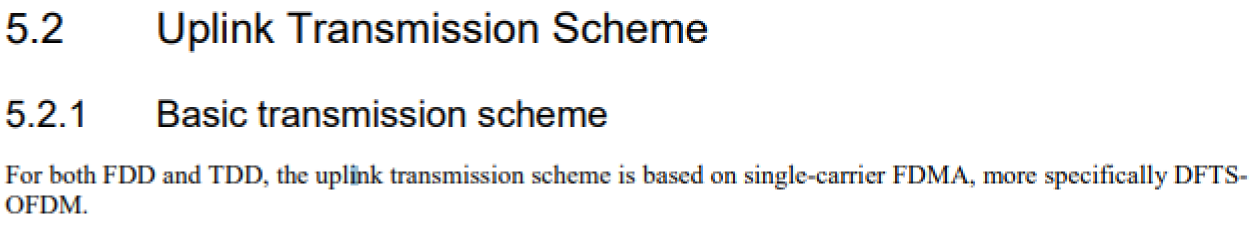
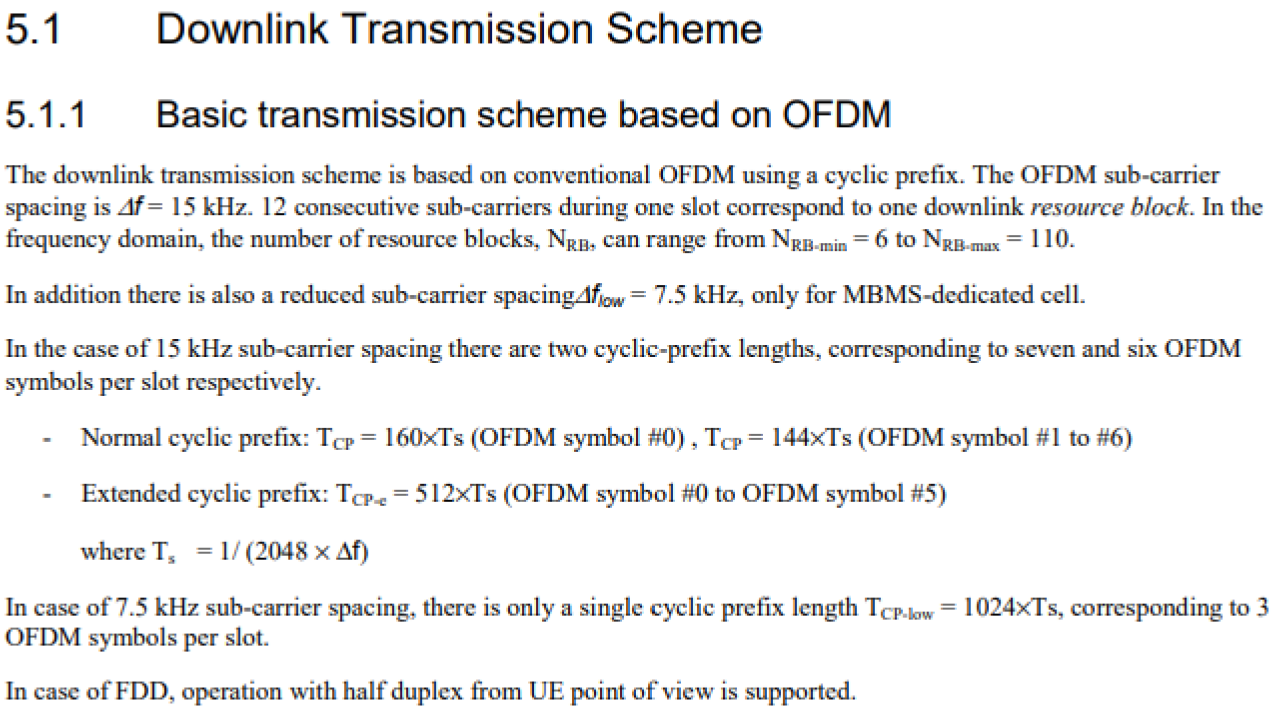
17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 21(h)
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	Nissan's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, Nissan's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.  5.1 Downlink Transmission Scheme 5.1.1 Basic transmission scheme based on OFDM The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

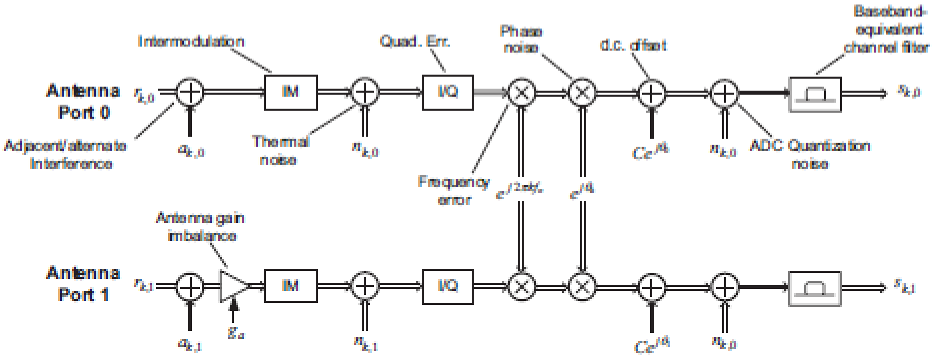


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.

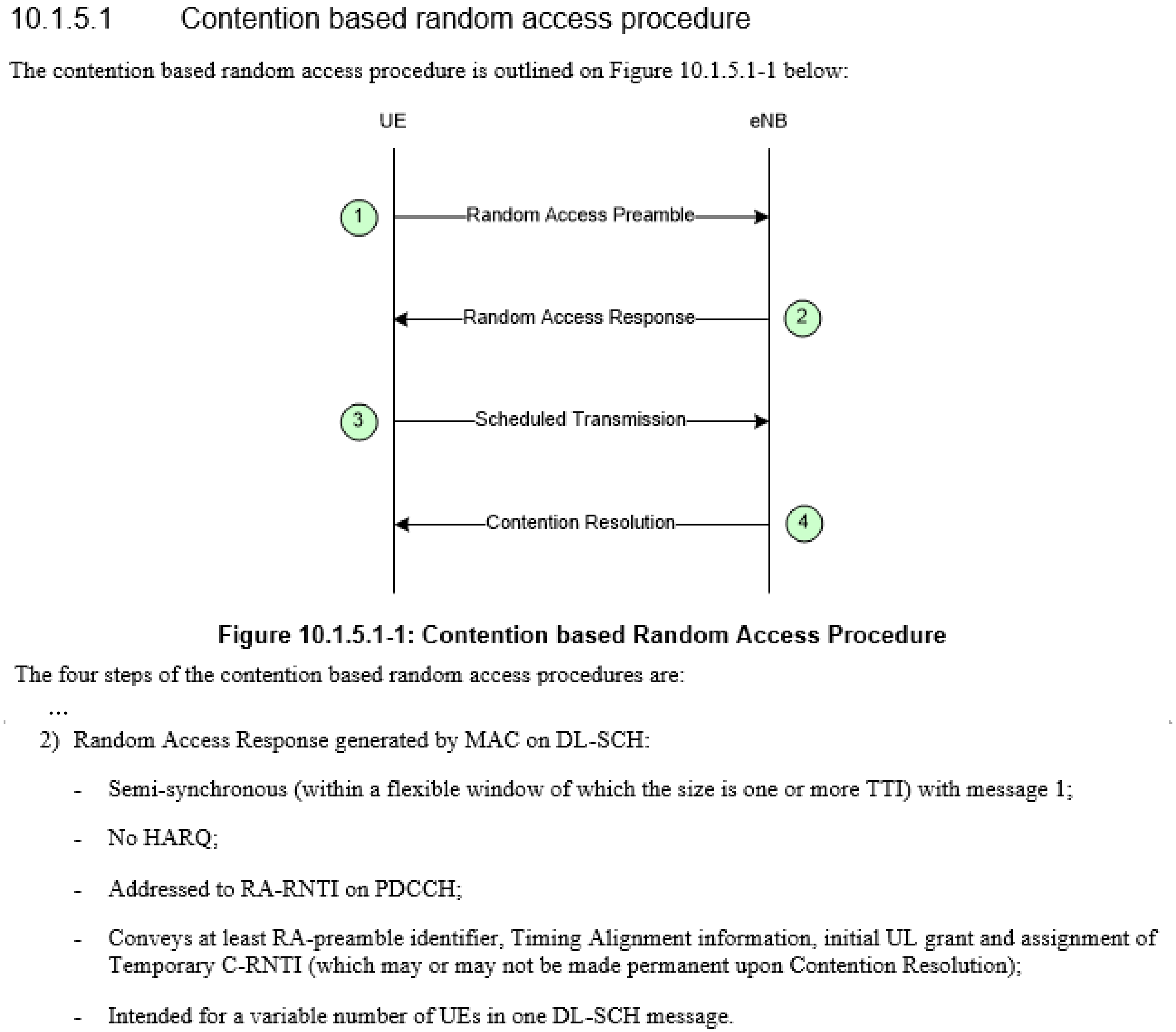
- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

...

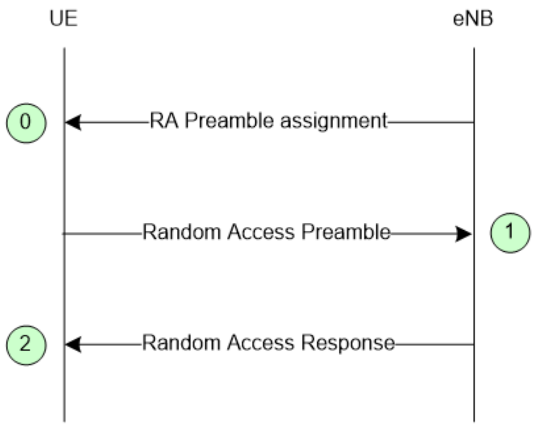
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

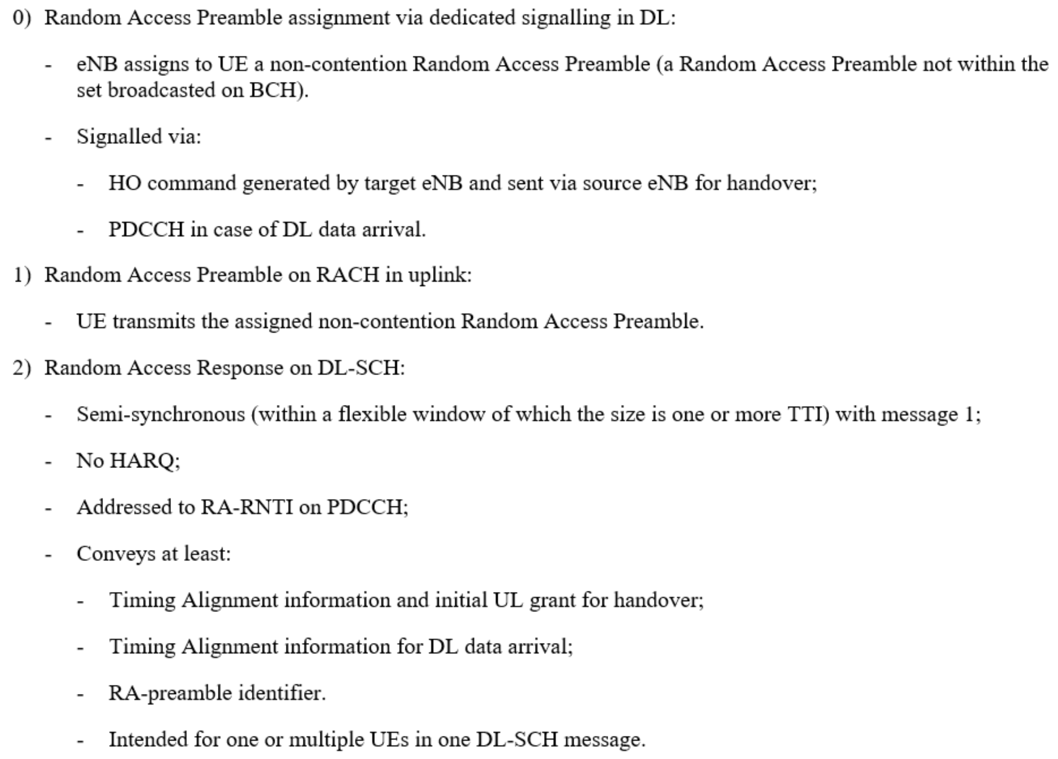
US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

	10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

“wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message..”

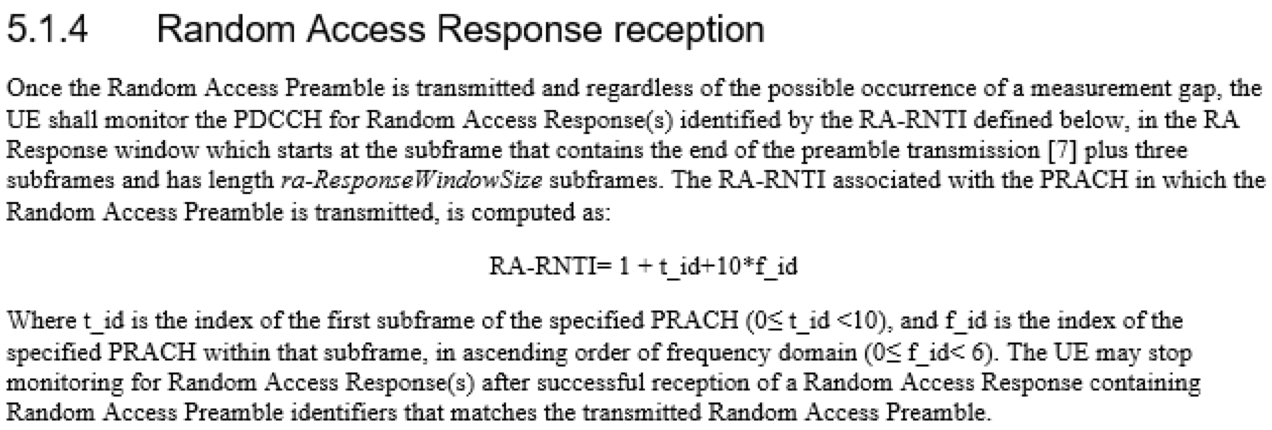


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

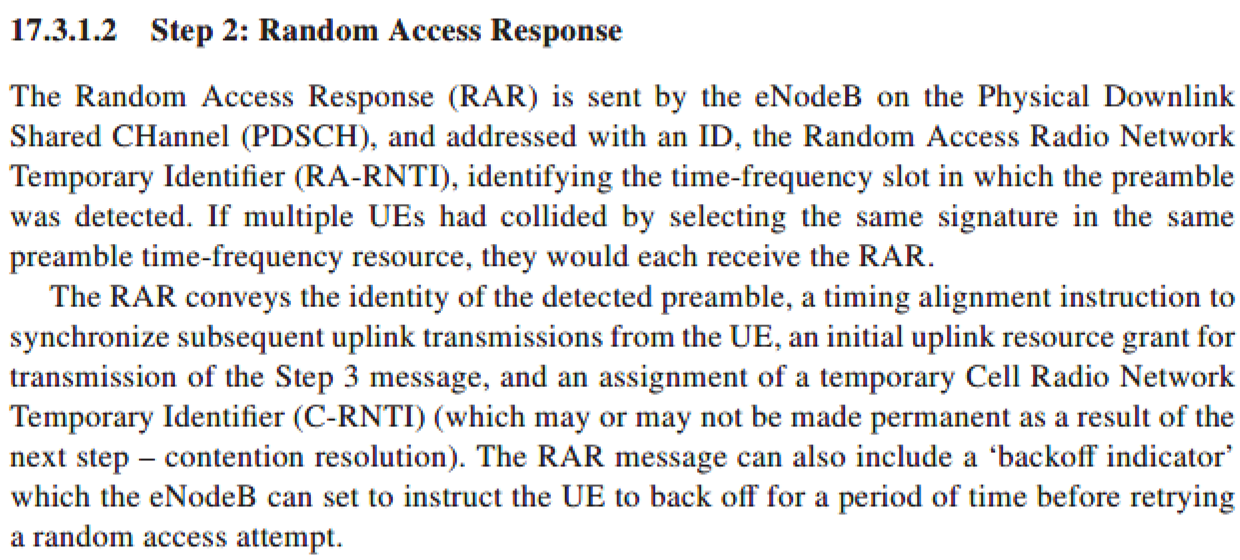
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI= 1 + t_id+10*f_id

Where t_id is the index of the first subframe of the specified PRACH ($0\leq$ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq$ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

US Patent No. 10,833,908: Claim 21(h)
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.



17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

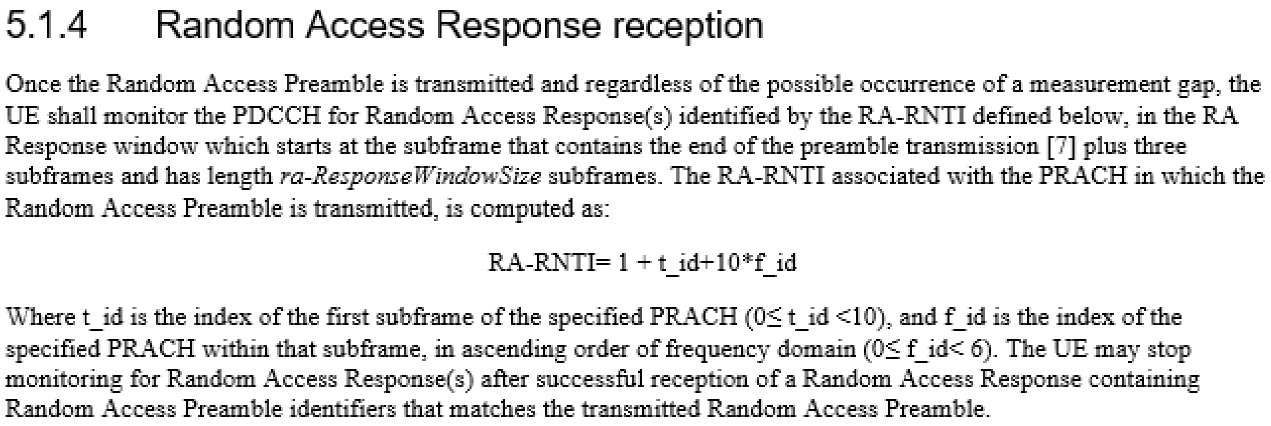
The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

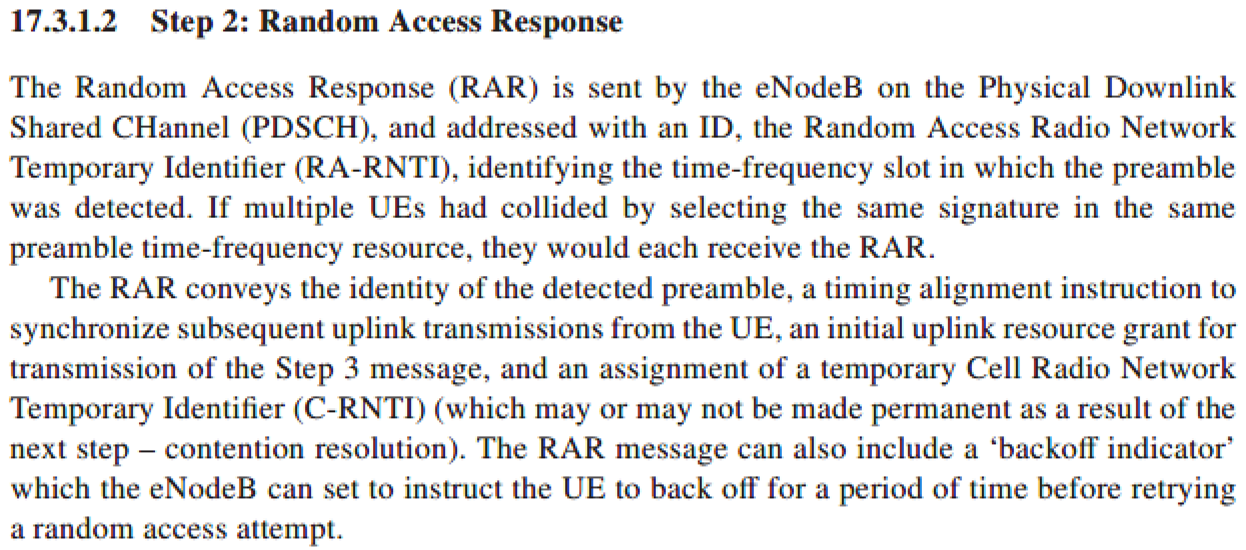
US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

22. The mobile station of claim 21, wherein:	*See* Claim 21.

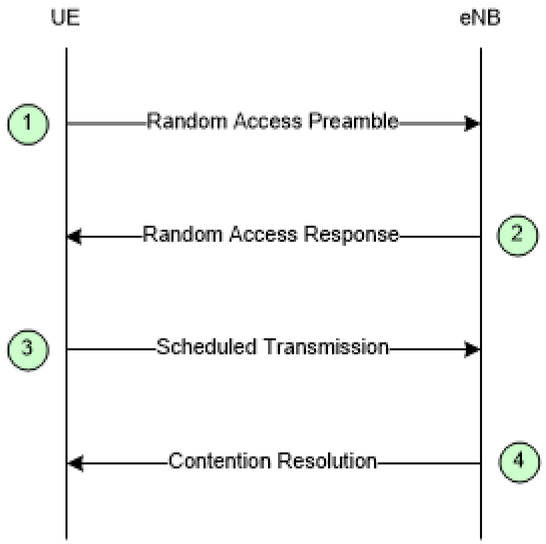
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	Nissan’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

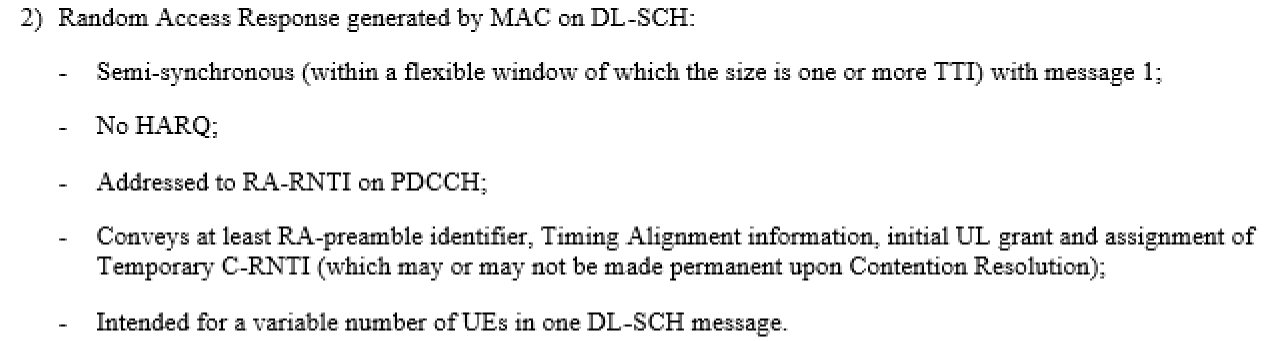
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Nissan’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:  **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

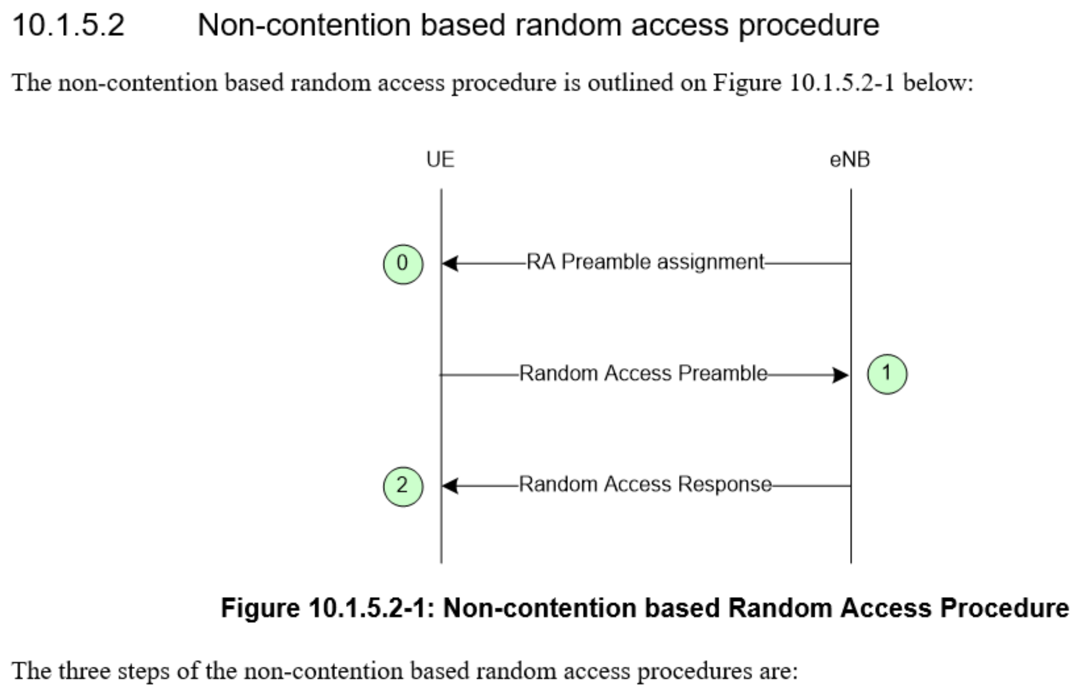
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



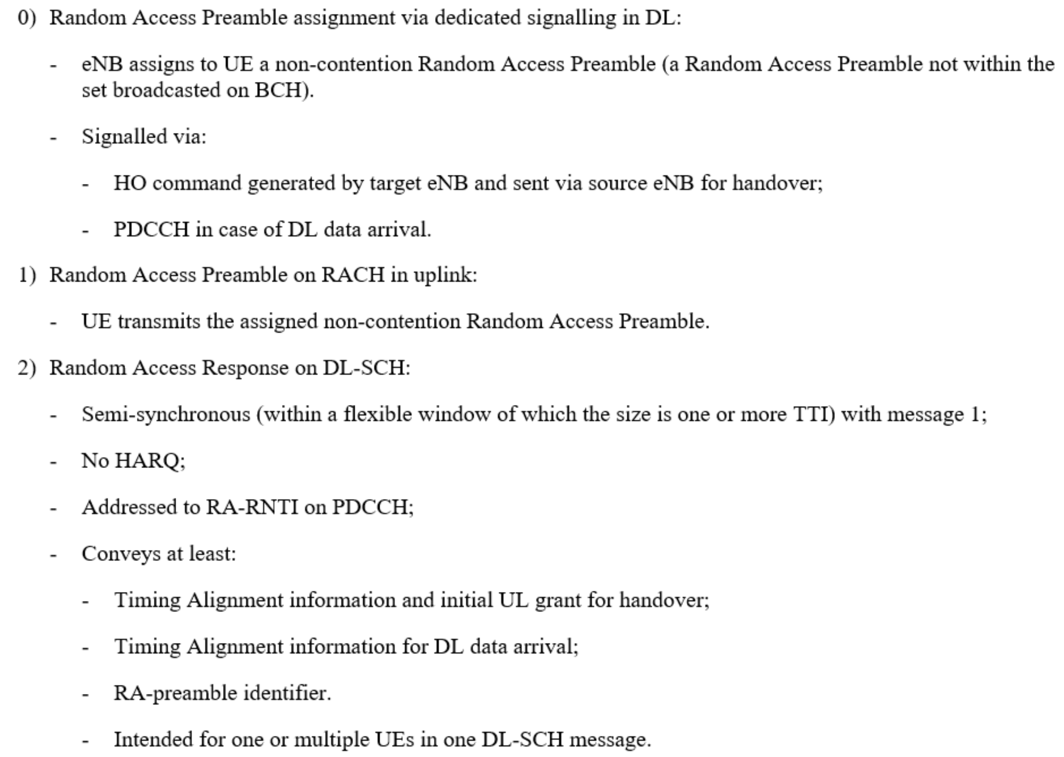
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

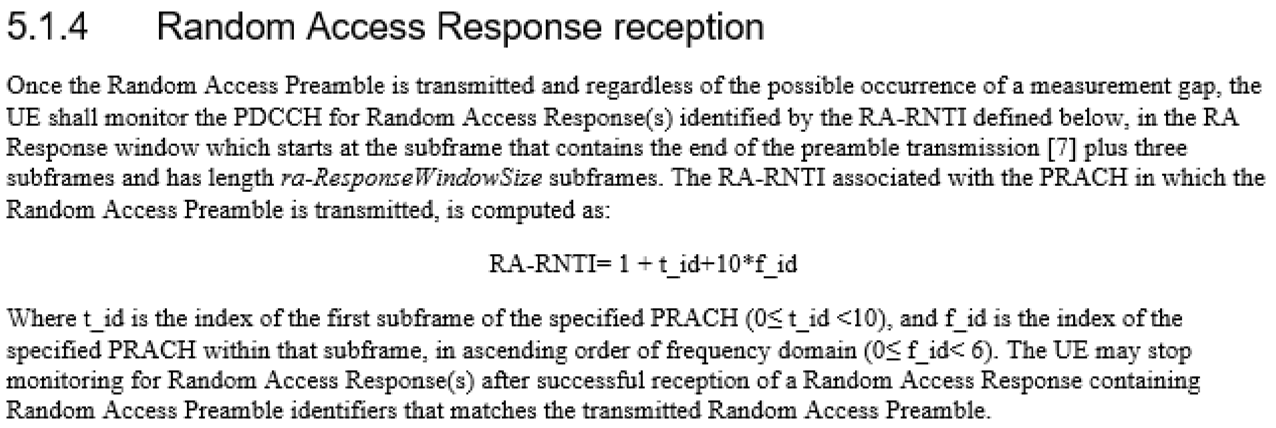
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

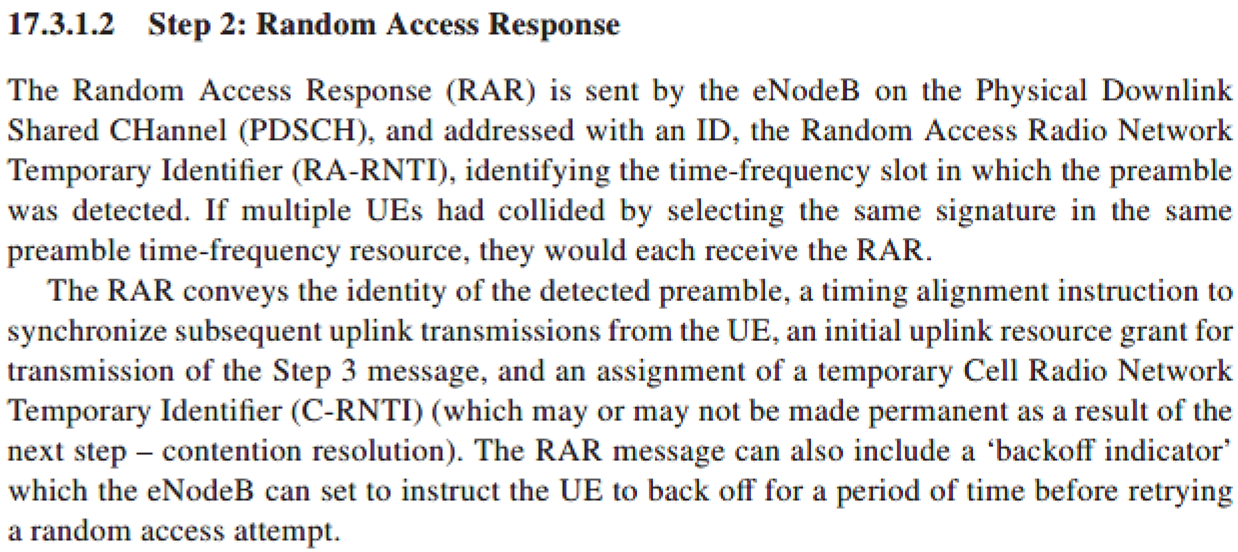
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

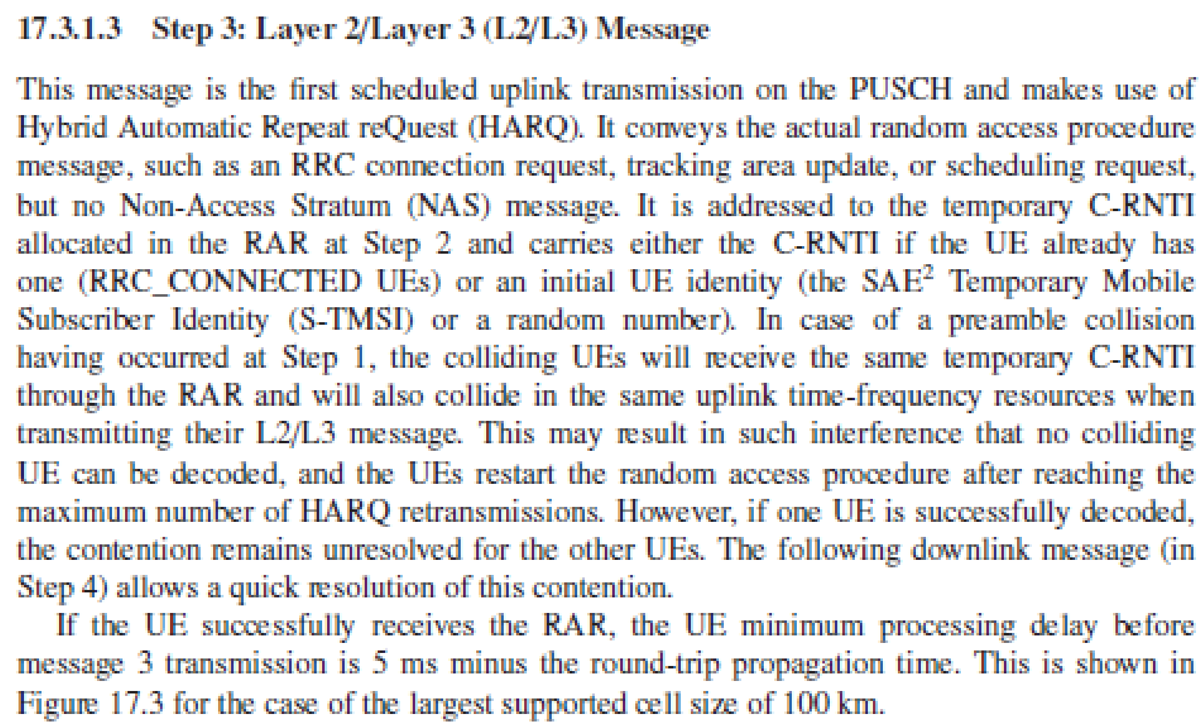
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

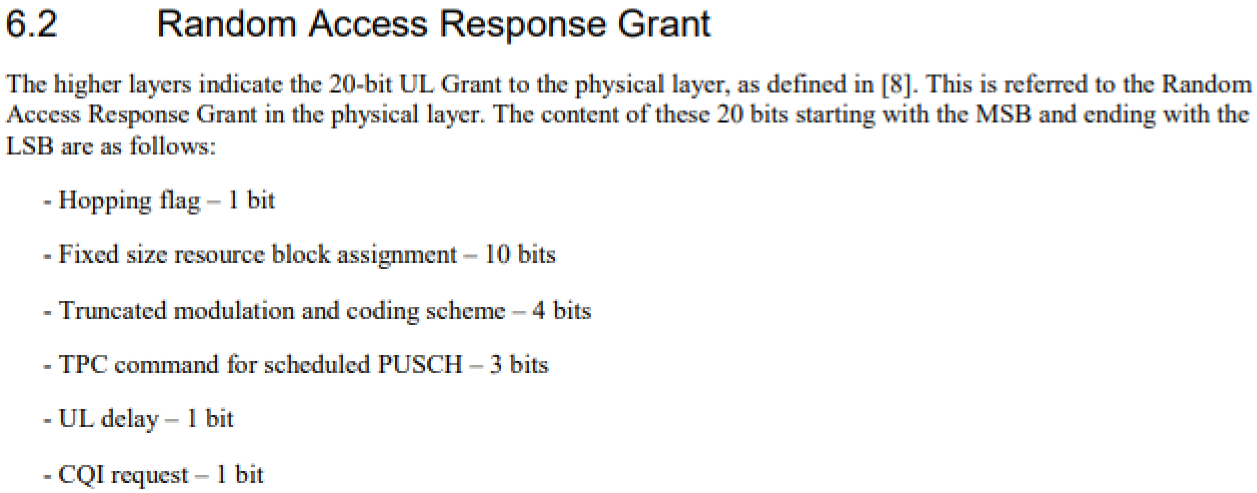
US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

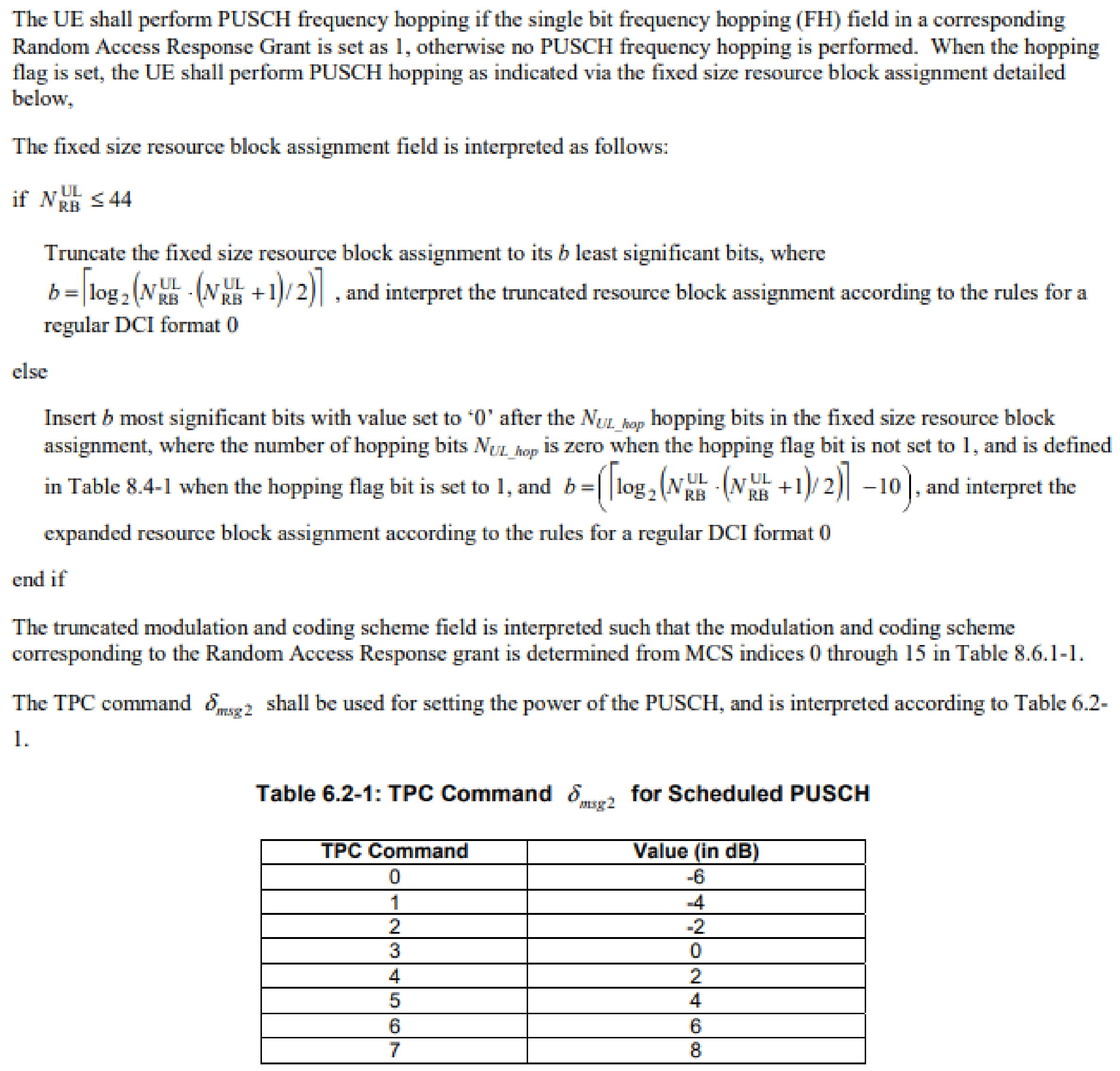
US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by Nissan's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
“The mobile station of claim 22, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

```
if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$
    Truncate the fixed size resource block assignment to its $b$ least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0
else
    Insert $b$ most significant bits with value set to ‘0’ after the $N_{UL\_hop}$ hopping bits in the fixed size resource block assignment, where the number of hopping bits $N_{UL\_hop}$ is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0
end if
```

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

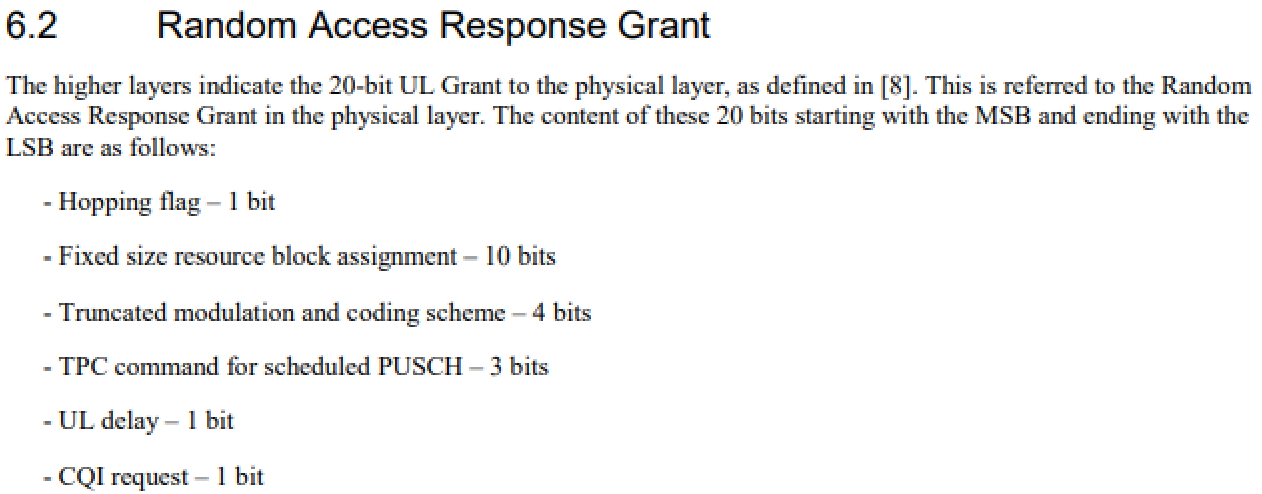
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

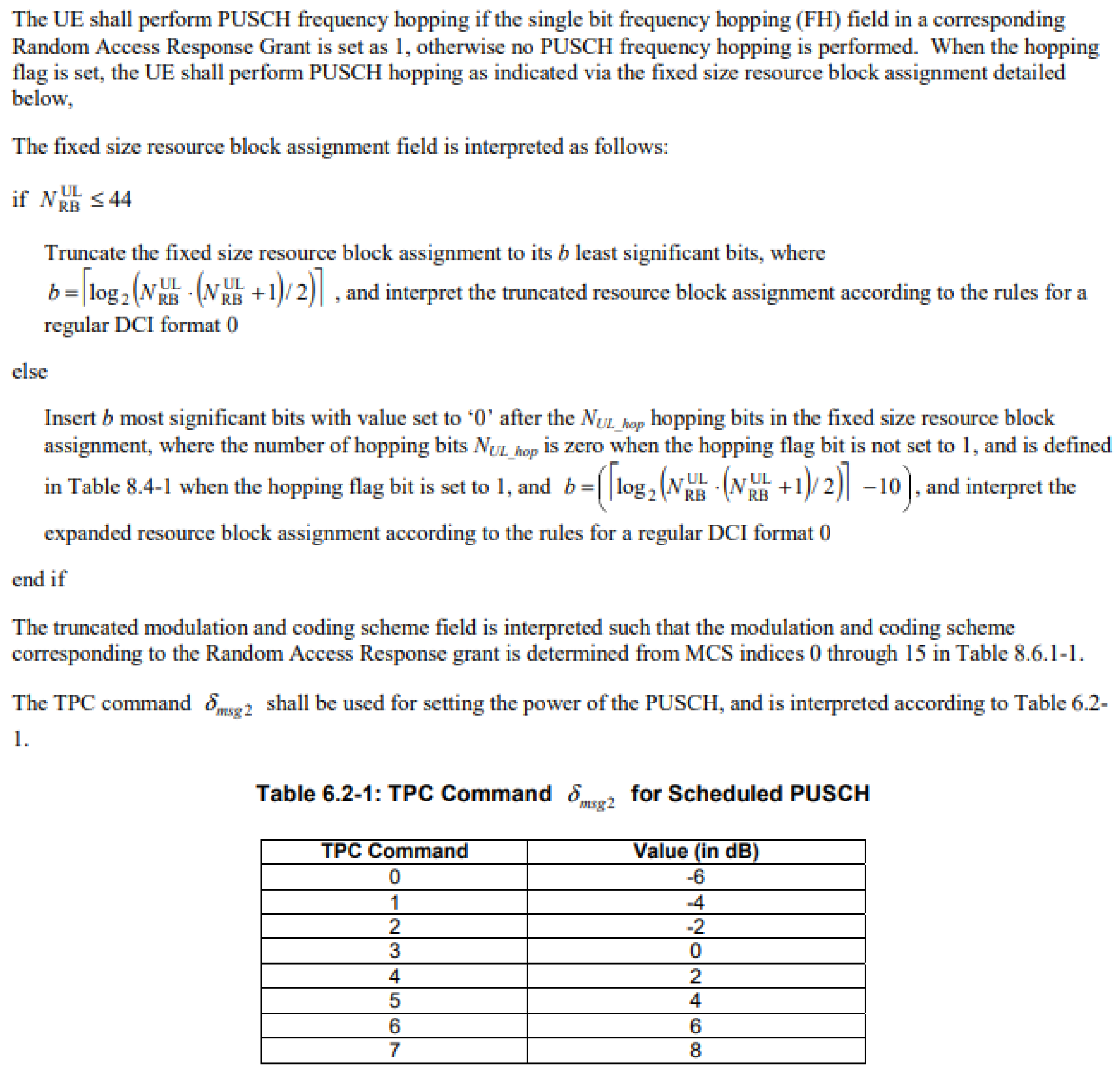
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	Nissan’s Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

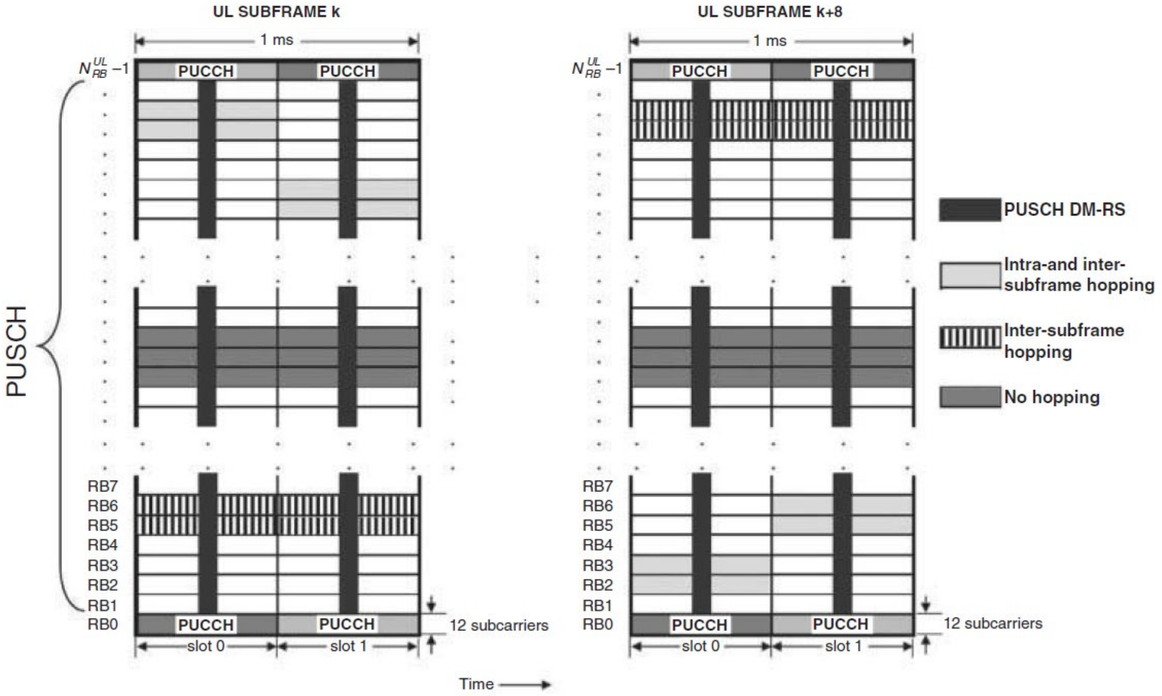
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

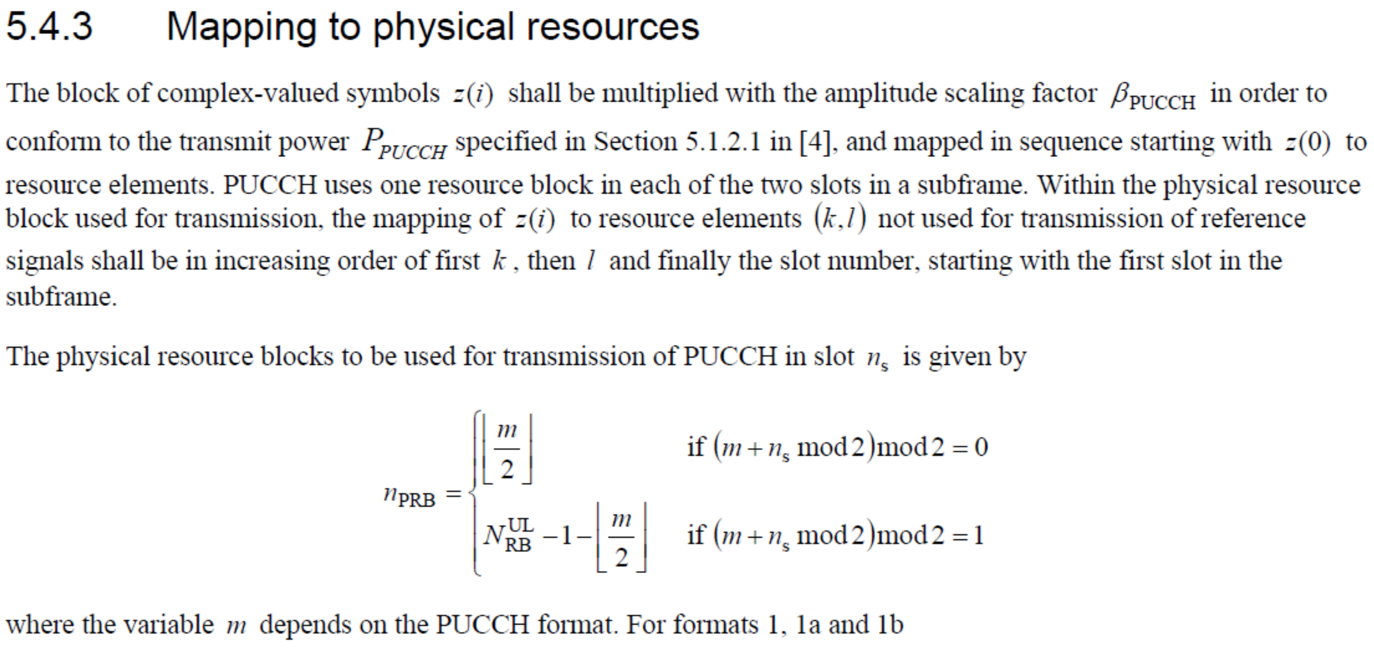
See also Claim 3.

US Patent No. 10,833,908: Claim 24
" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Nissan's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

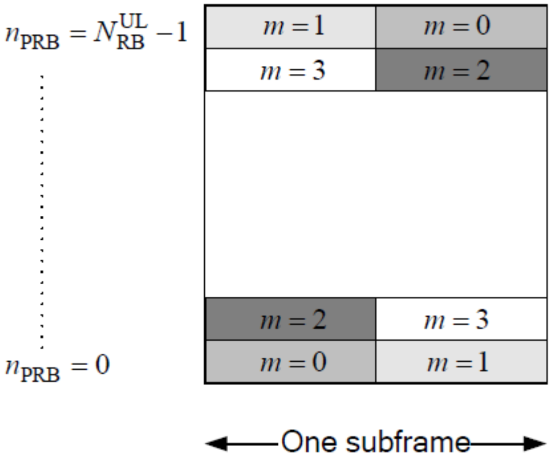
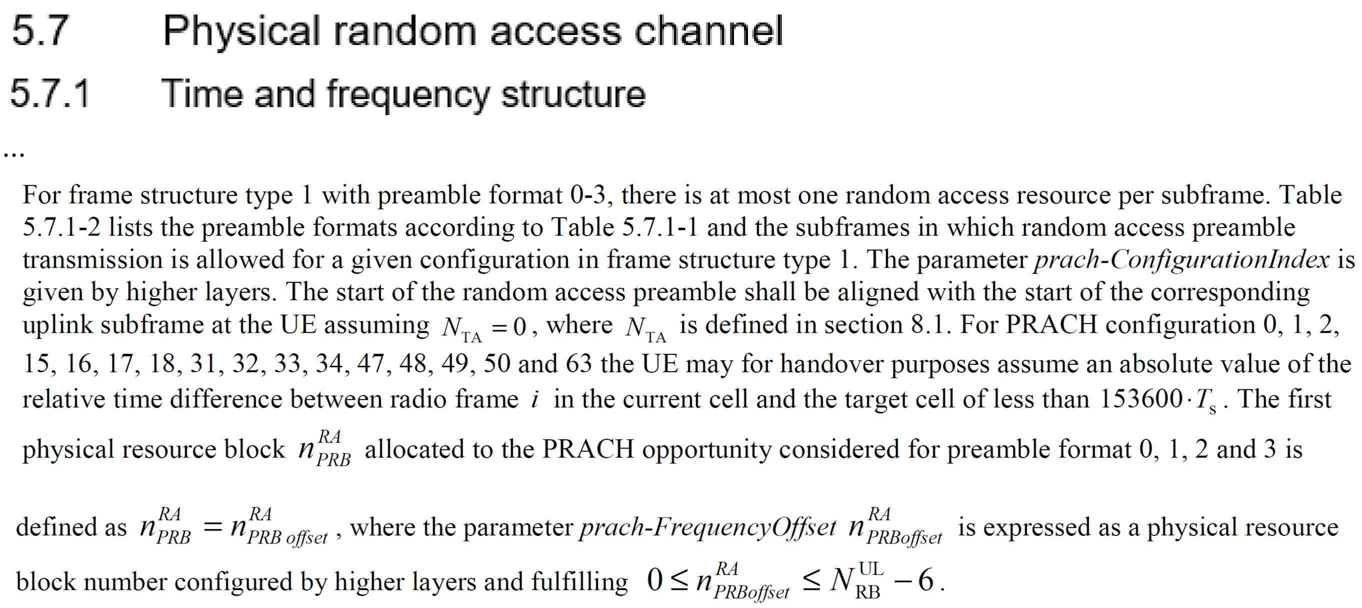


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

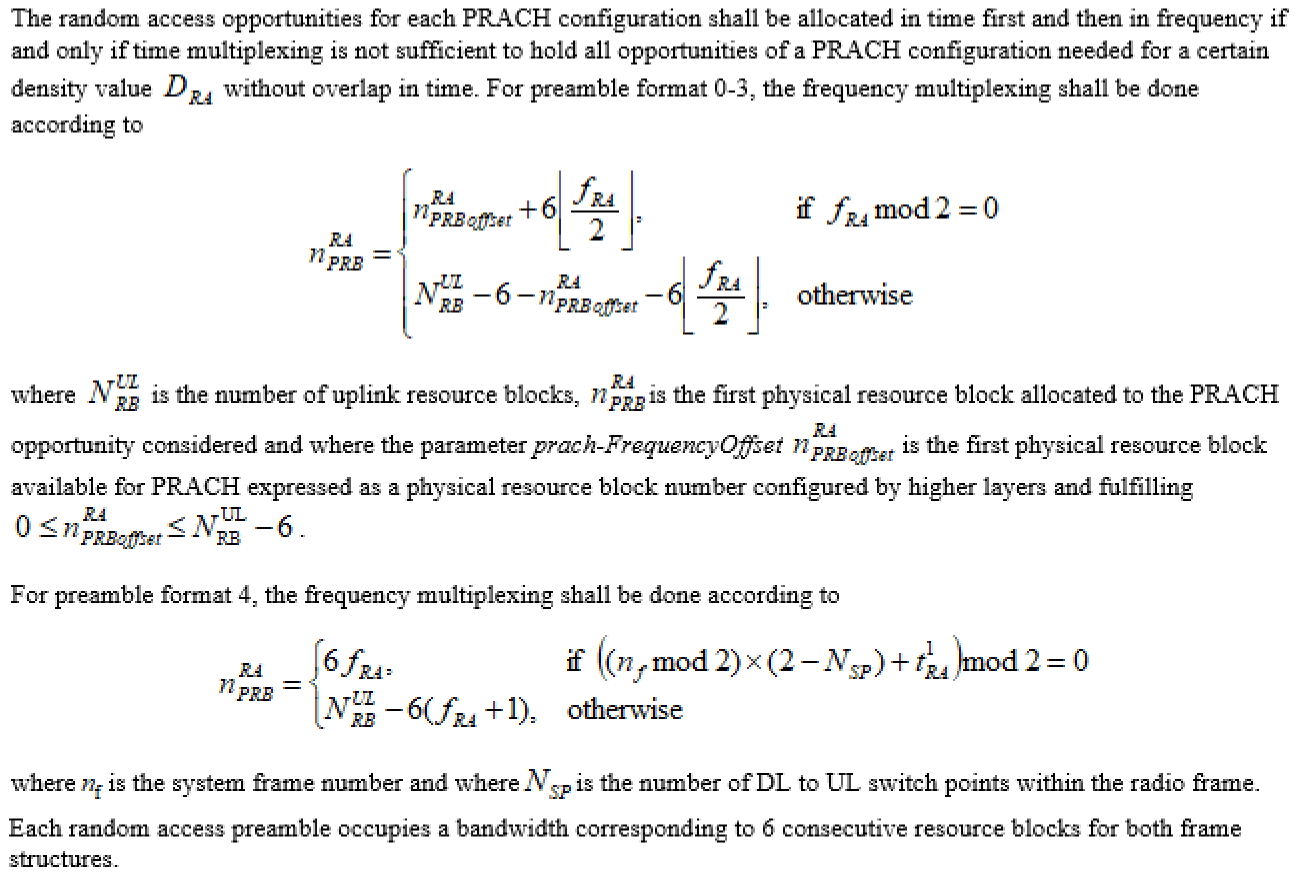
5.7.1 Time and frequency structure

…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.
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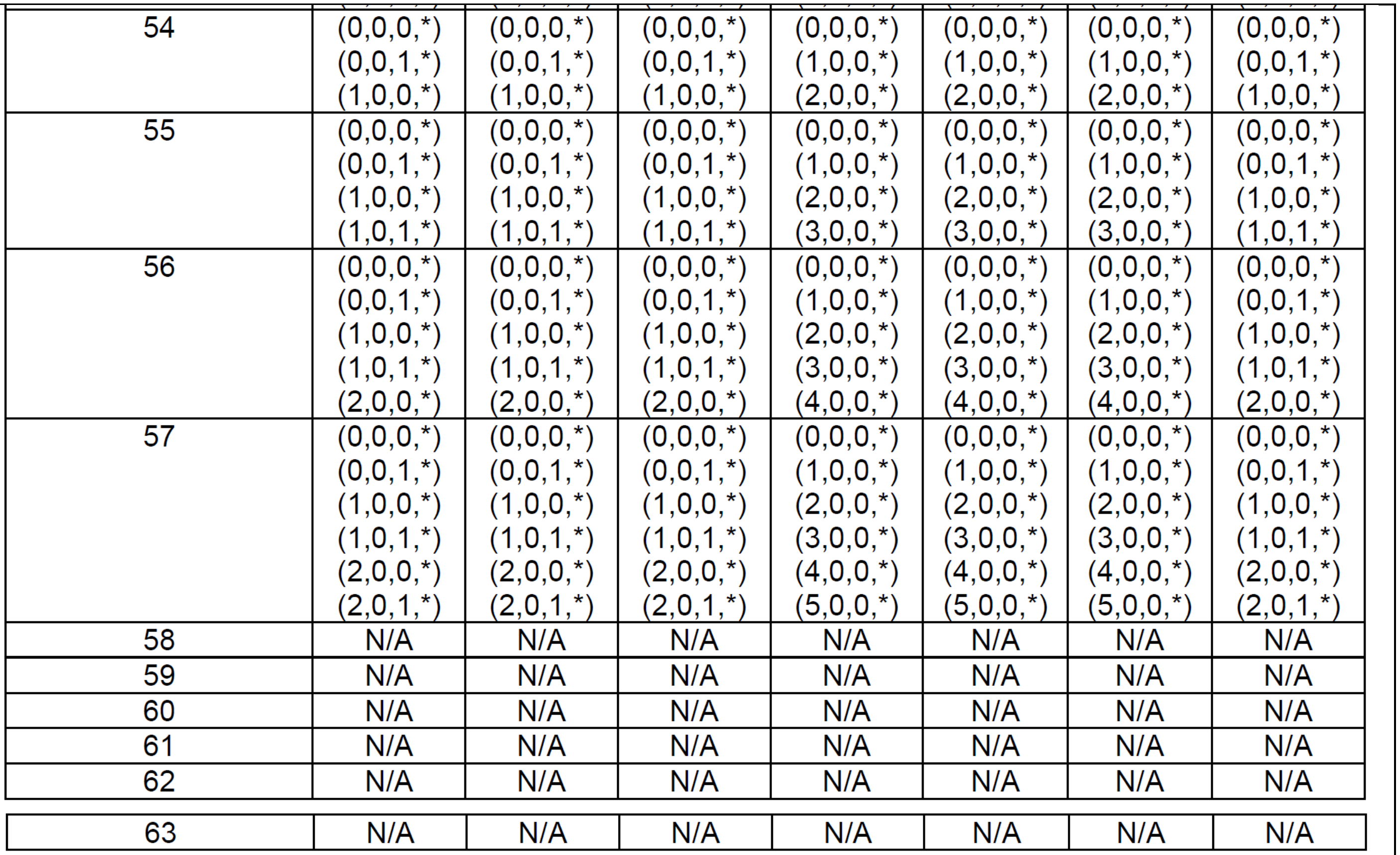
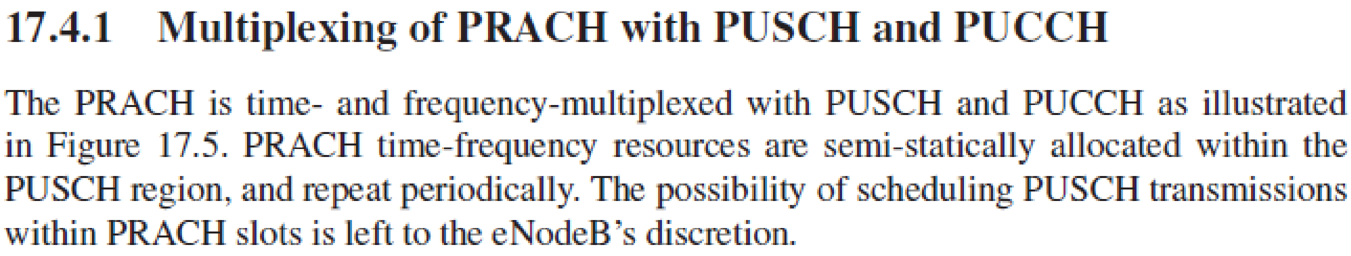
.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

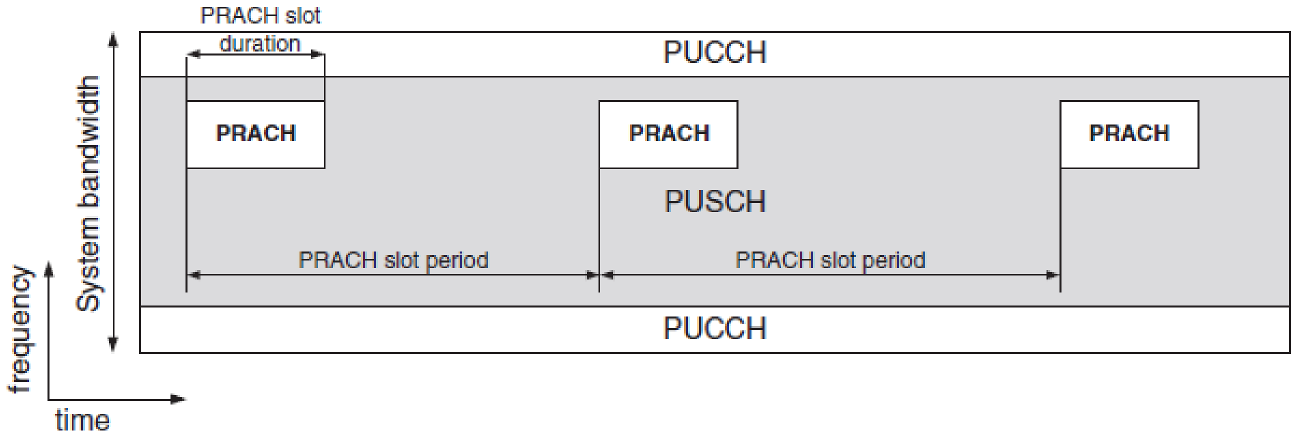
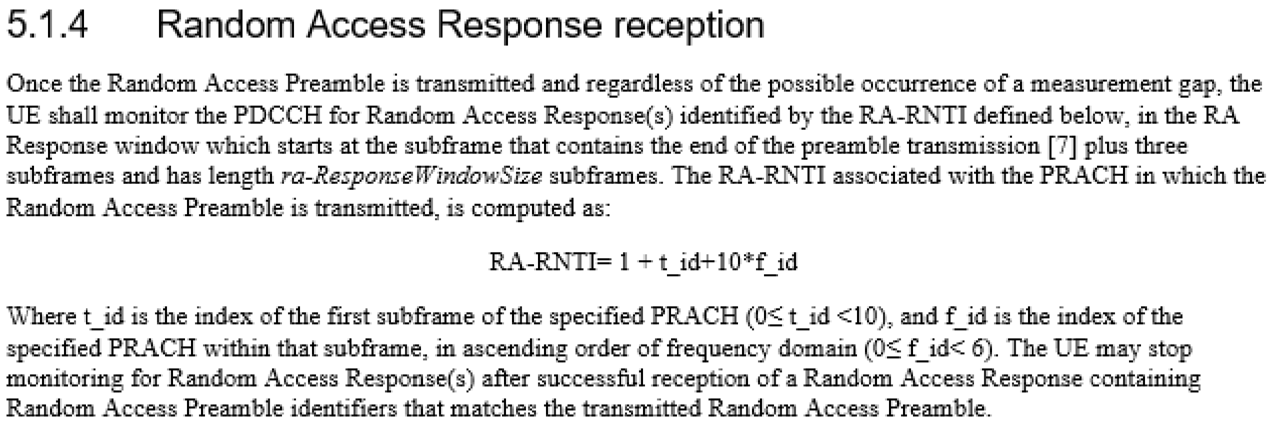
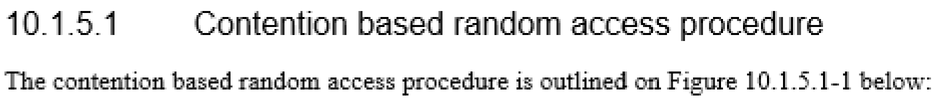
<table>
<tr><td></td><td>

Figure 17.5: PRACH multiplexing with PUSCH and PUCCH.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5.

See also Claim 4.</td></tr>
</table>

25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Nissan's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

“25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.”

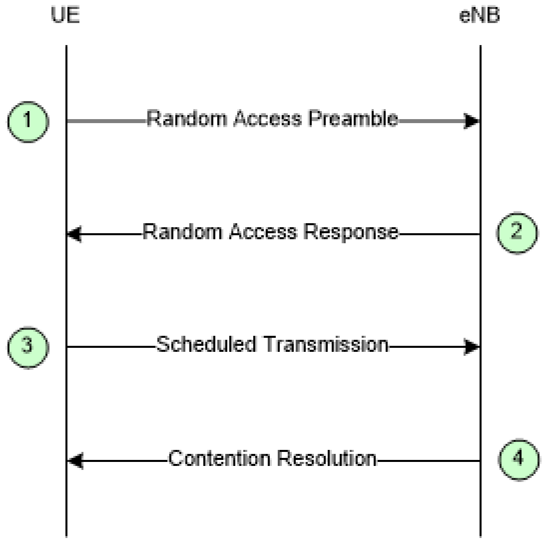
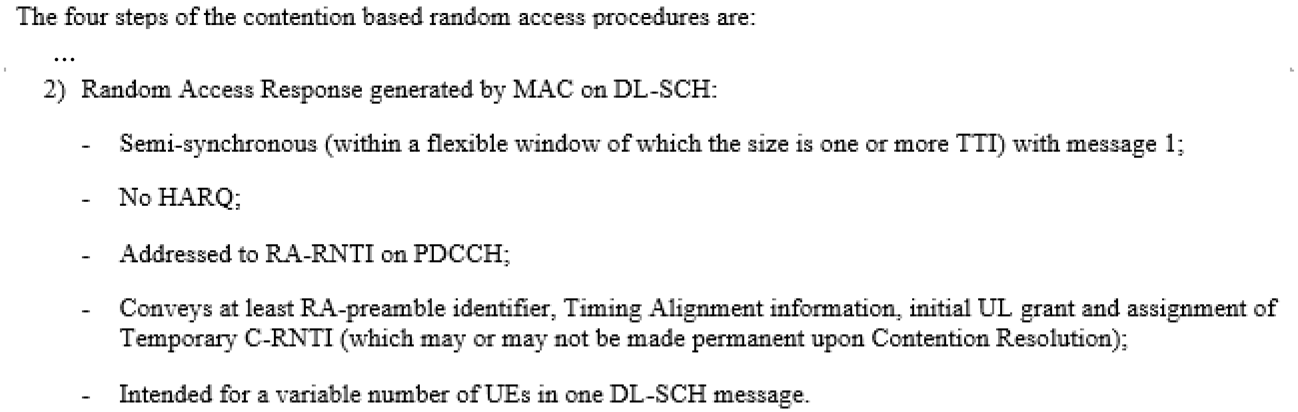


Figure 10.1.5.1-1: Contention based Random Access Procedure



The four steps of the contention based random access procedures are:

...

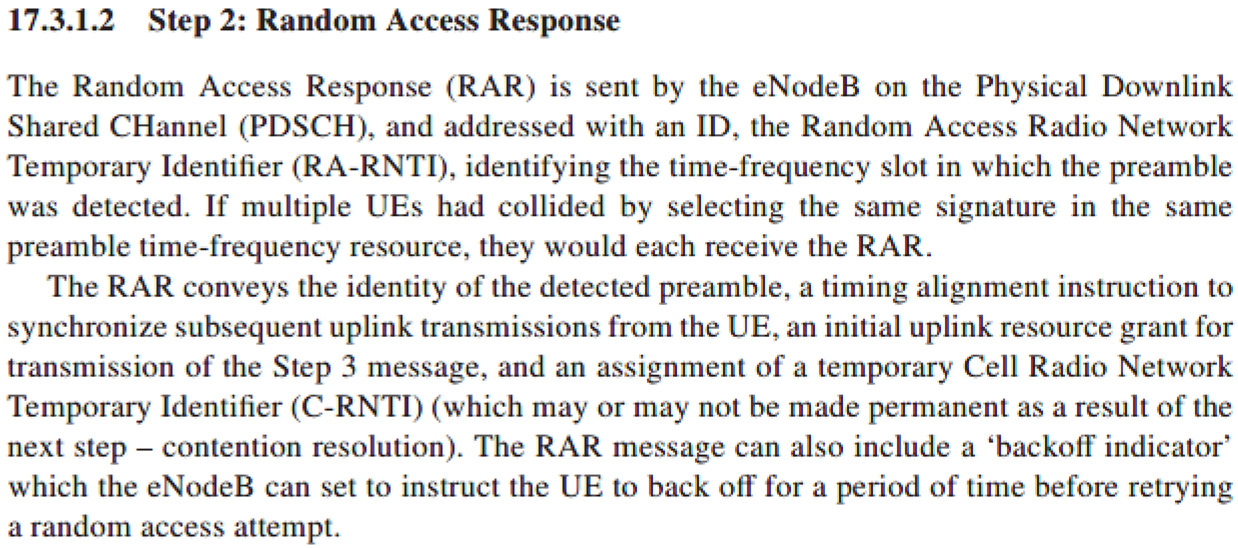
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Nissan's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

<table>
<tr><td>27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.</td><td>*See* Claim 1.

The frequency band used with Nissan's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,*

For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.

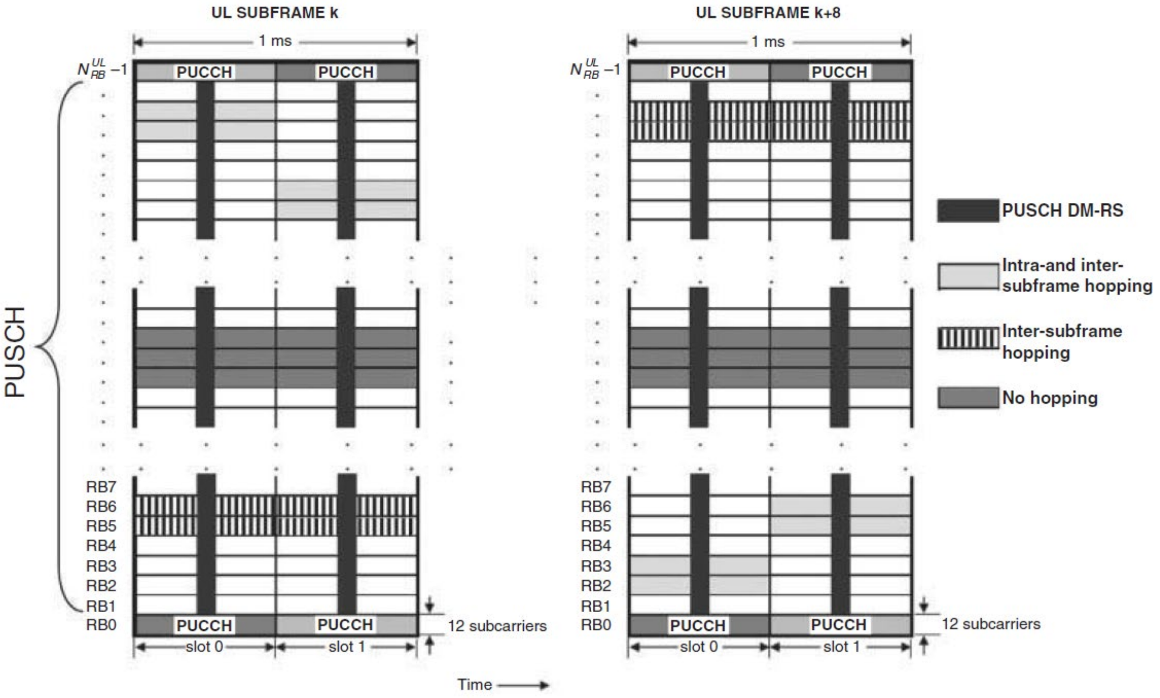


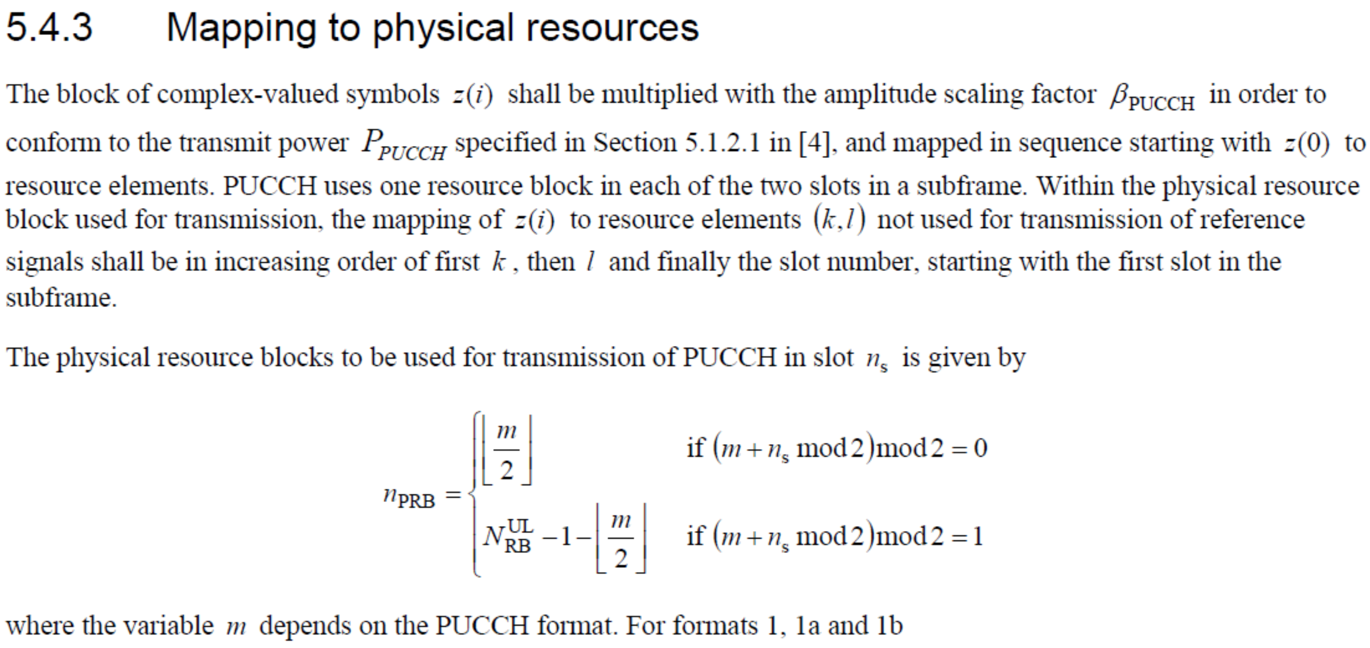
Figure 16.3: Uplink physical data channel processing.</td></tr>
</table>

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

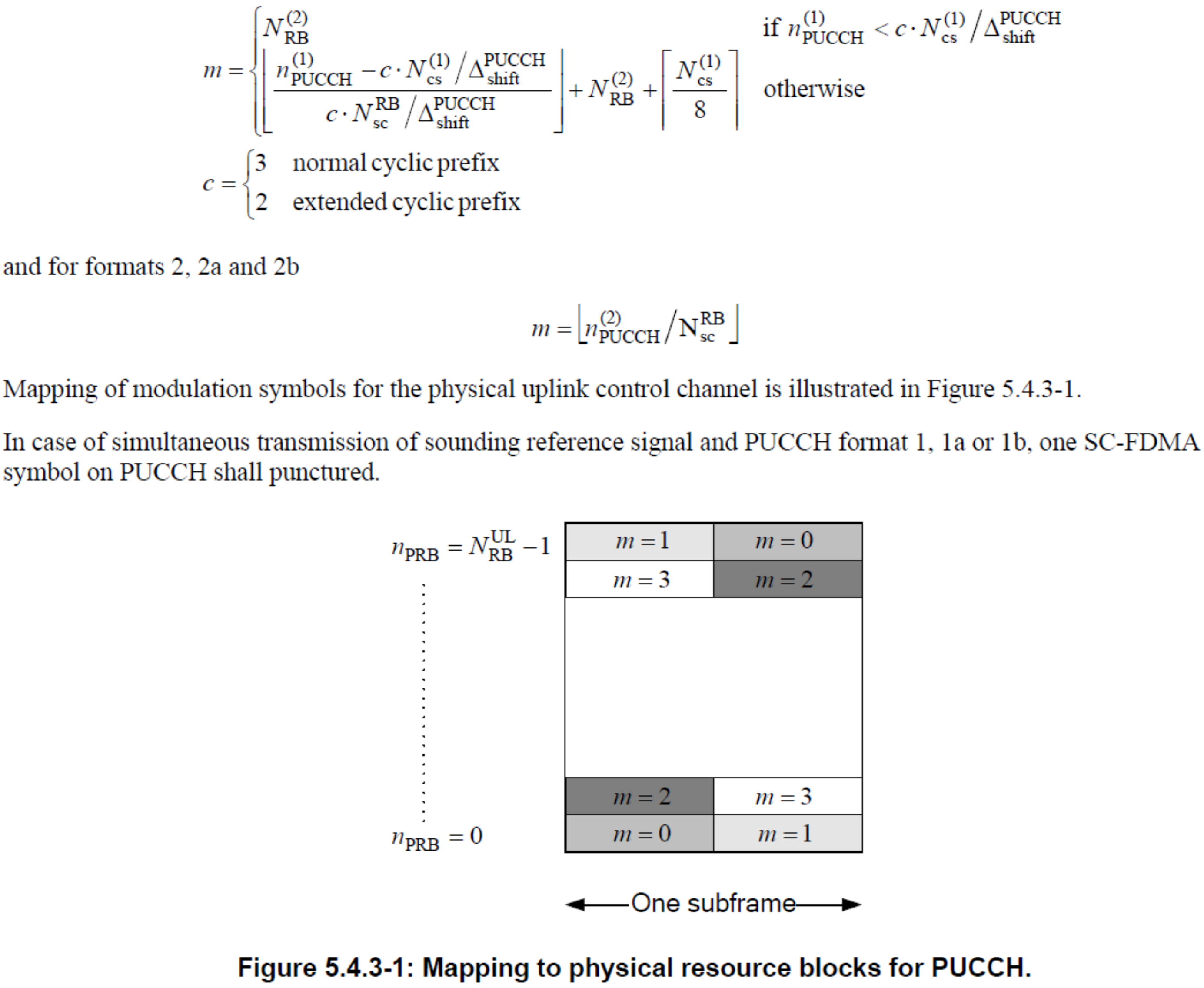
The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m+n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m+n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

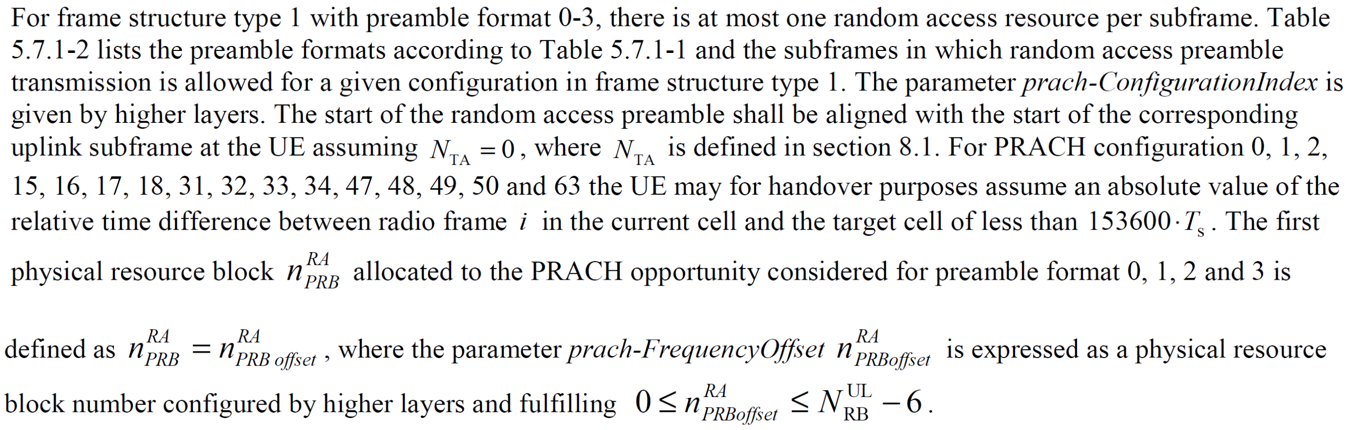
$n_{\mathrm{PRB}} = N_{\mathrm{RB}}^{\mathrm{UL}} - 1$	$m = 1$	$m = 0$
	$m = 3$	$m = 2$
⋮		
	$m = 2$	$m = 3$
$n_{\mathrm{PRB}} = 0$	$m = 0$	$m = 1$

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

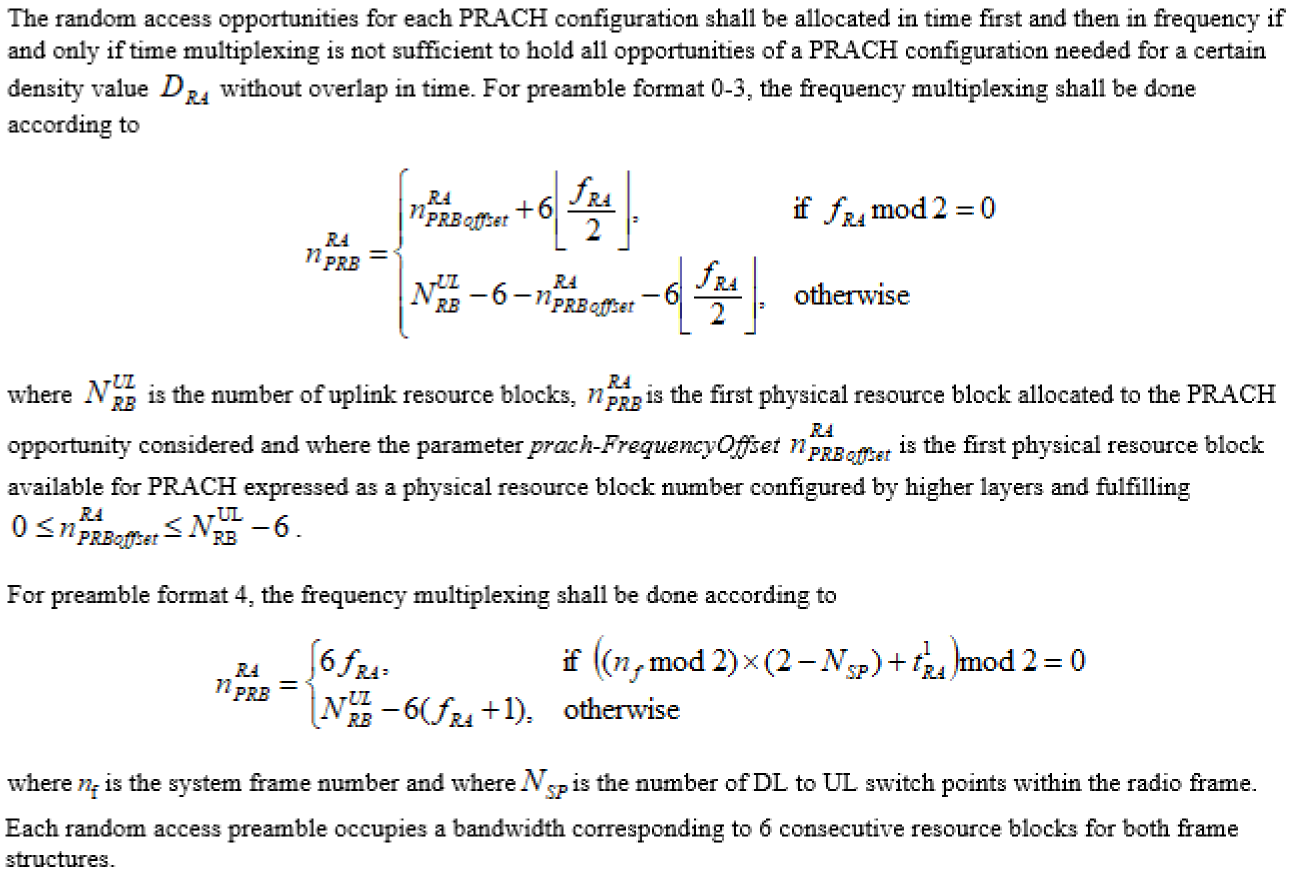
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure …  For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600\cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \leq n_{PRBoffset}^{RA} \leq N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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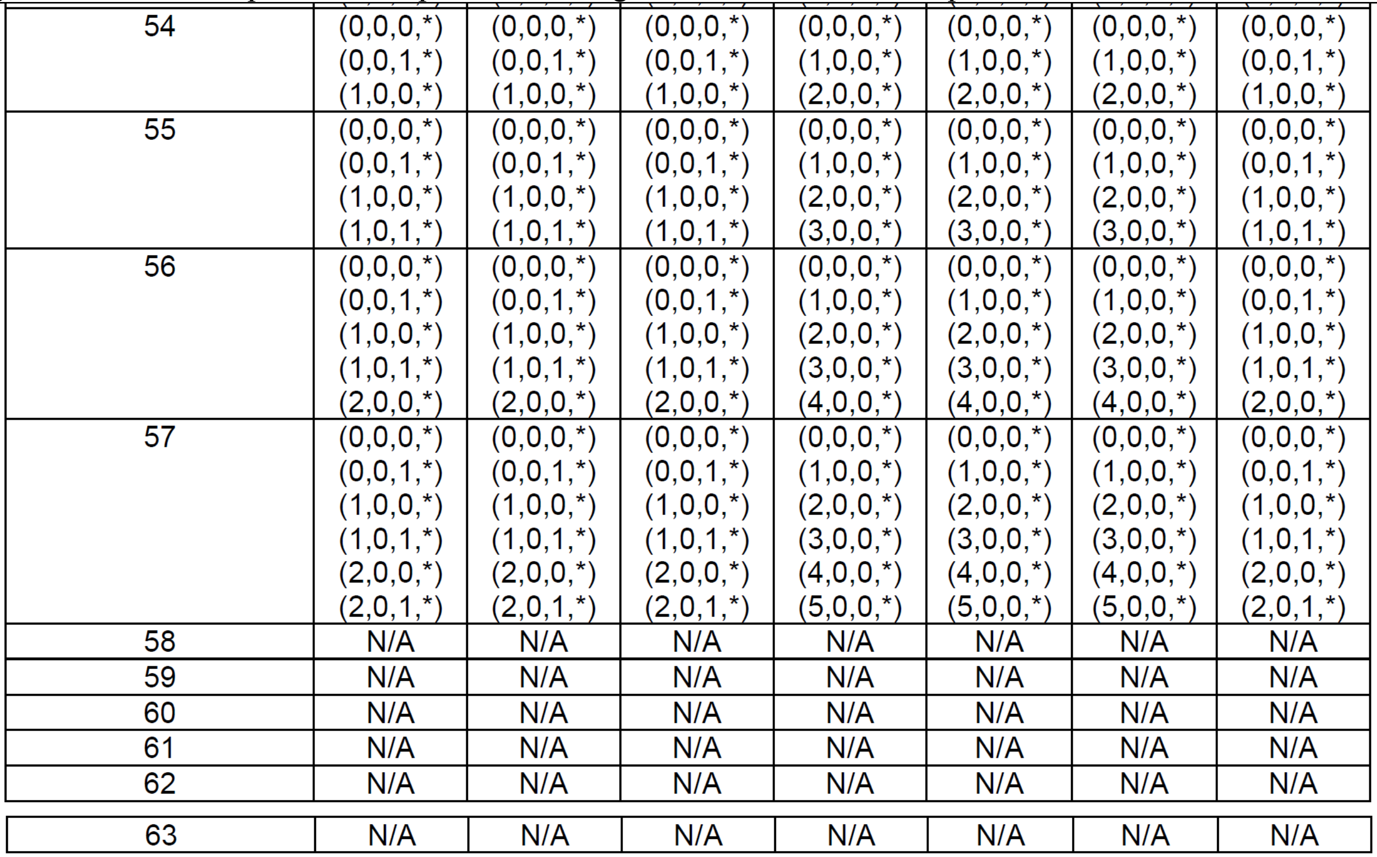
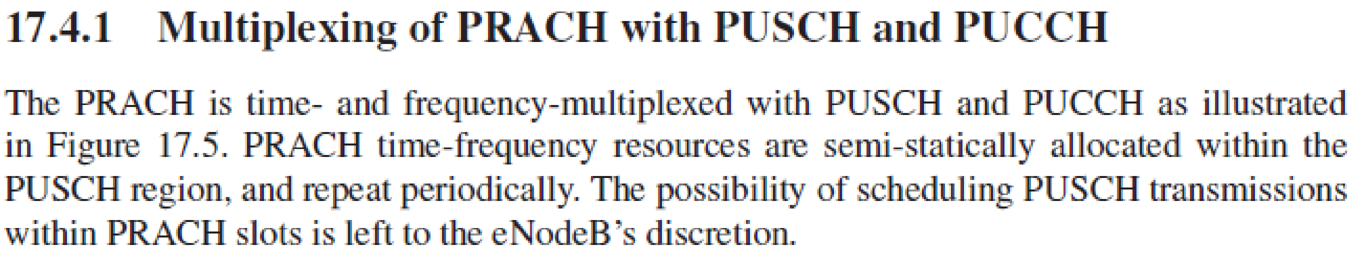
US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

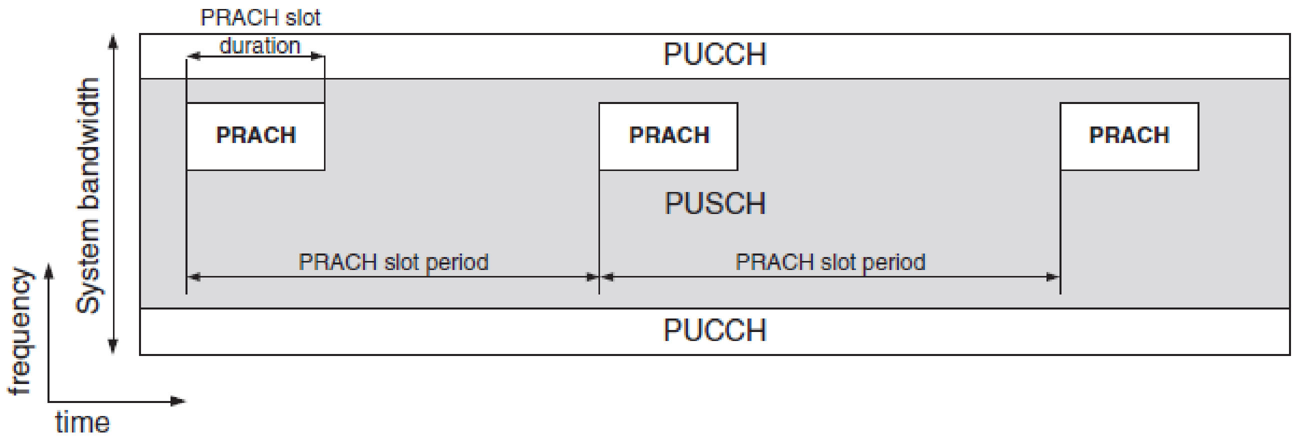


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

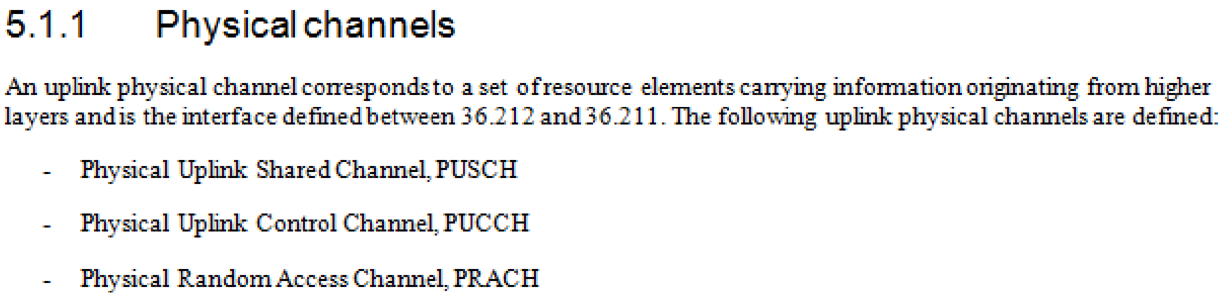
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

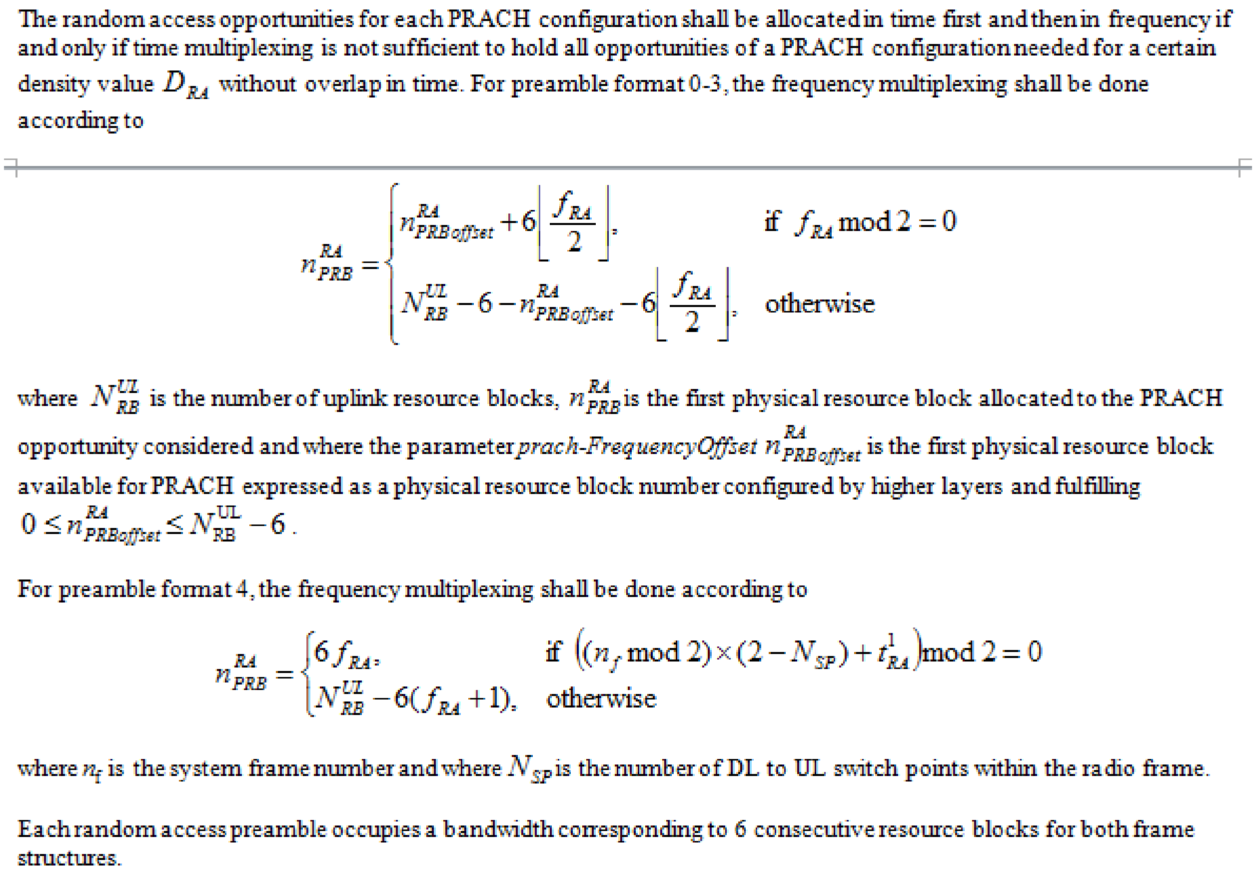
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with Nissan’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28

"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

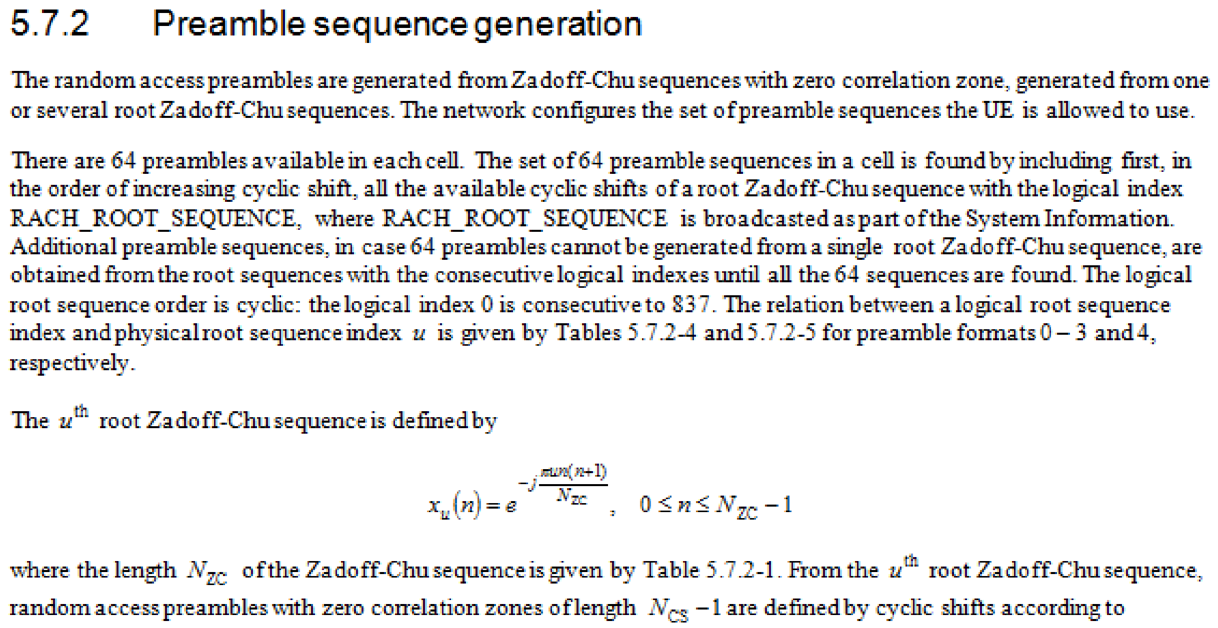
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

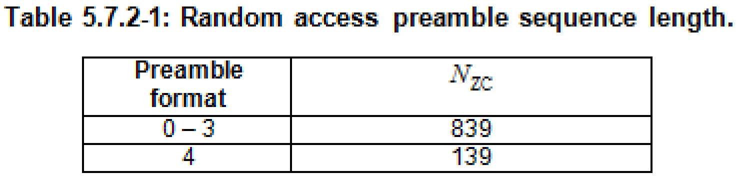
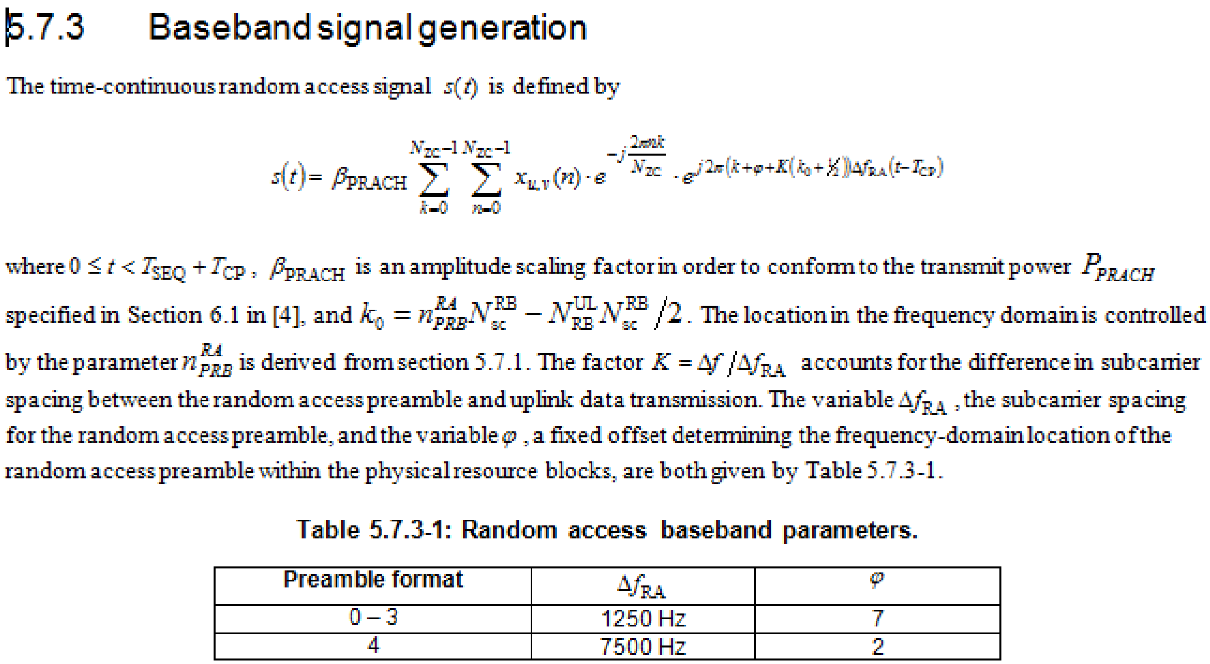


Table 5.7.2-1: Random access preamble sequence length.

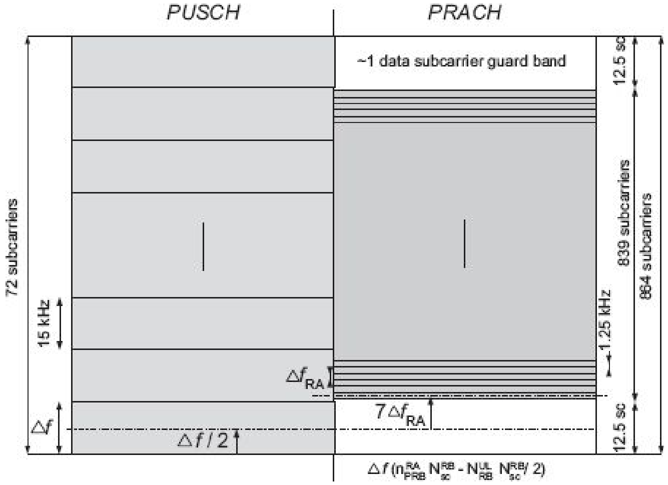
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

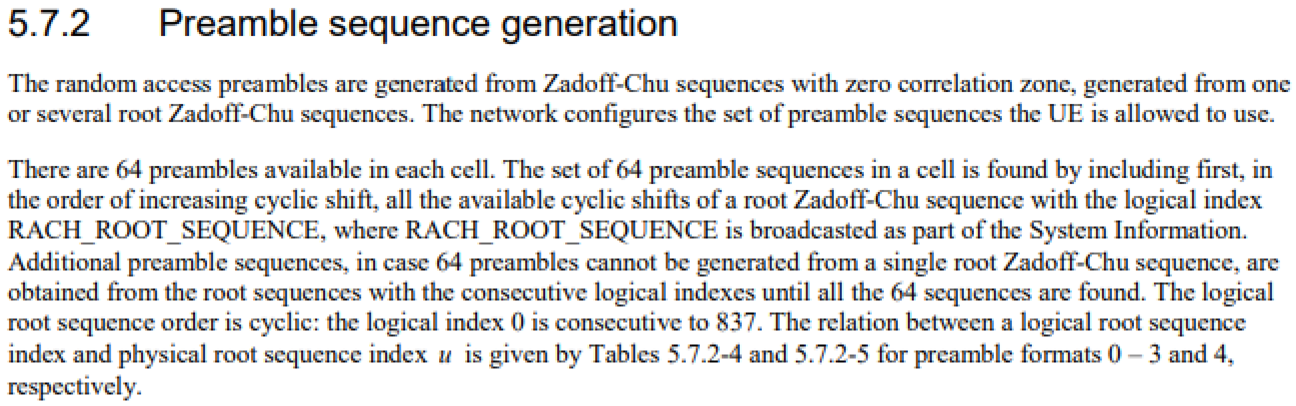
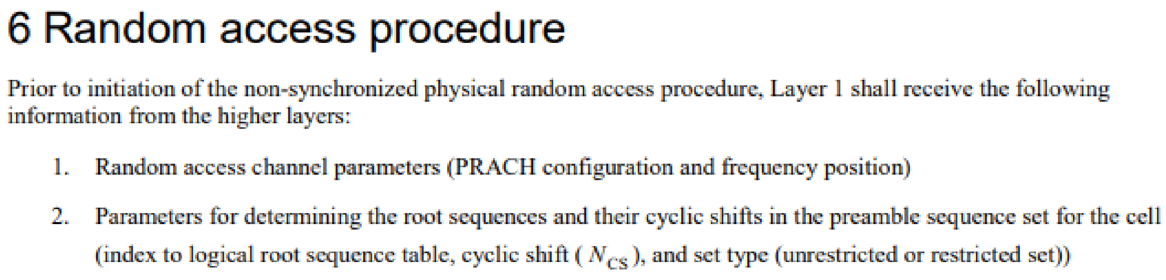
US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

	 **5.7.3 Baseband signal generation** The time-continuous random access signal $s(t)$ is defined by $$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$ where $0\leq t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1. **Table 5.7.3-1: Random access baseband parameters.** Preamble format | Δf_{RA} | φ 0 – 3 | 1250 Hz | 7 4 | 7500 Hz | 2 See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Nissan's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                        -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

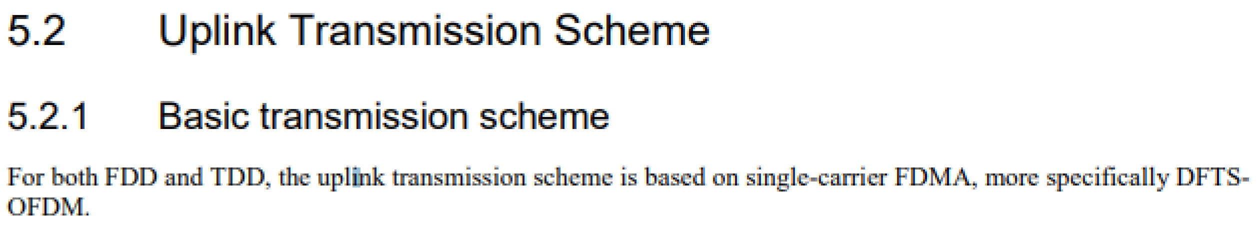
RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

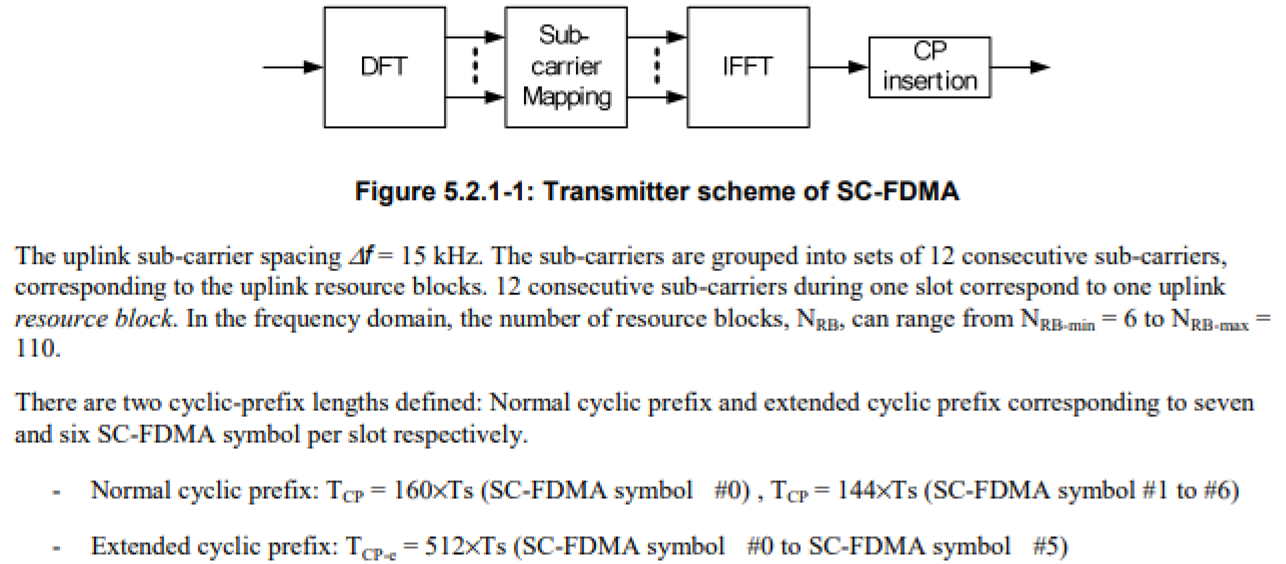
See also Claim 9.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 Nissan's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Nissan's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

US Patent No. 10,833,908: Claim 30
"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

	 **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

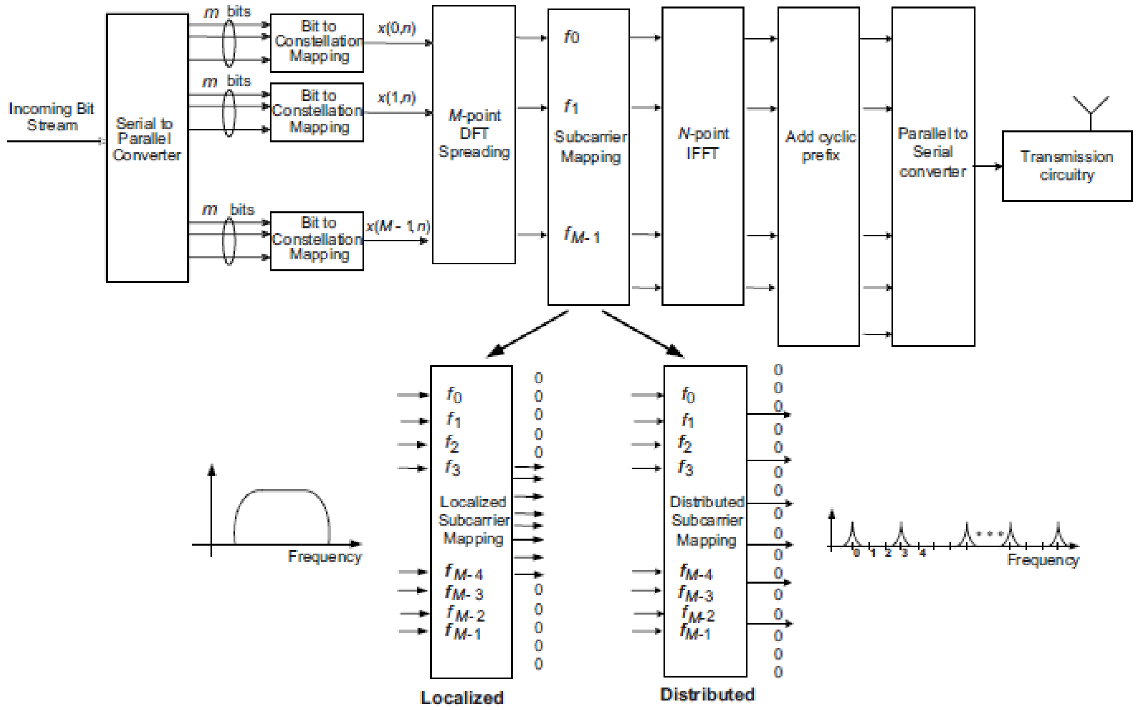


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

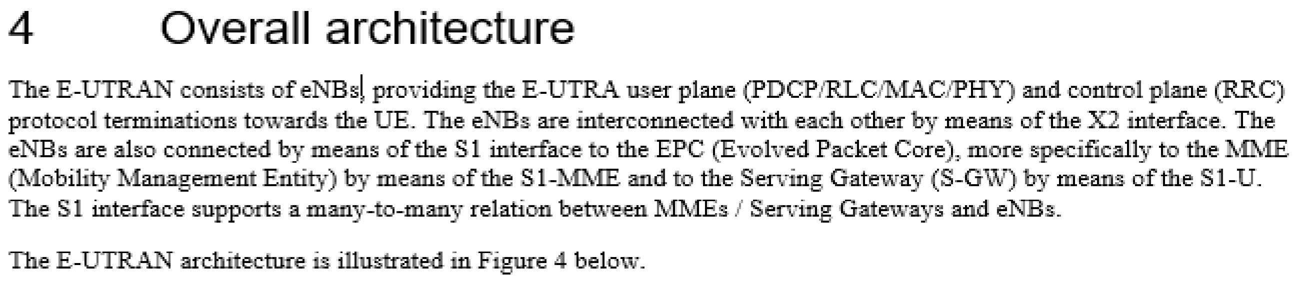
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

See also Claim 10.

Plaintiff's Infringement Contentions to Toyota

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, Toyota's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* Toyota's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Toyota offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

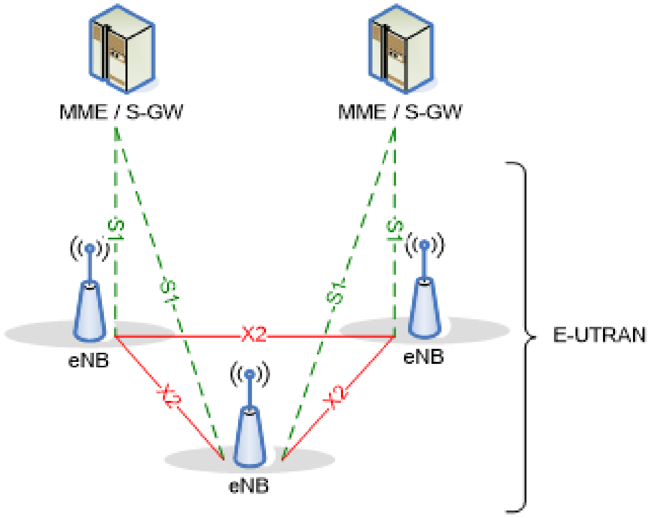
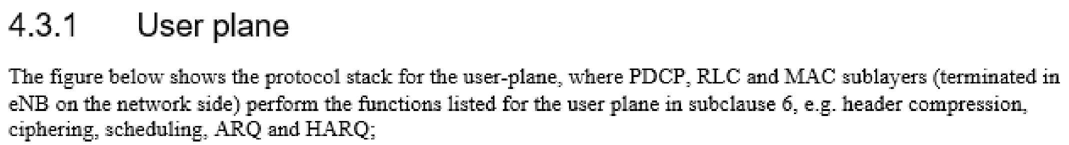


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

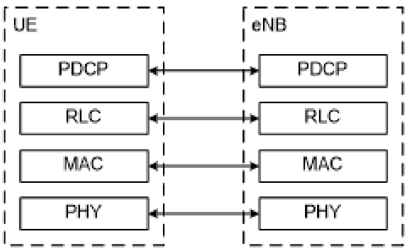


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

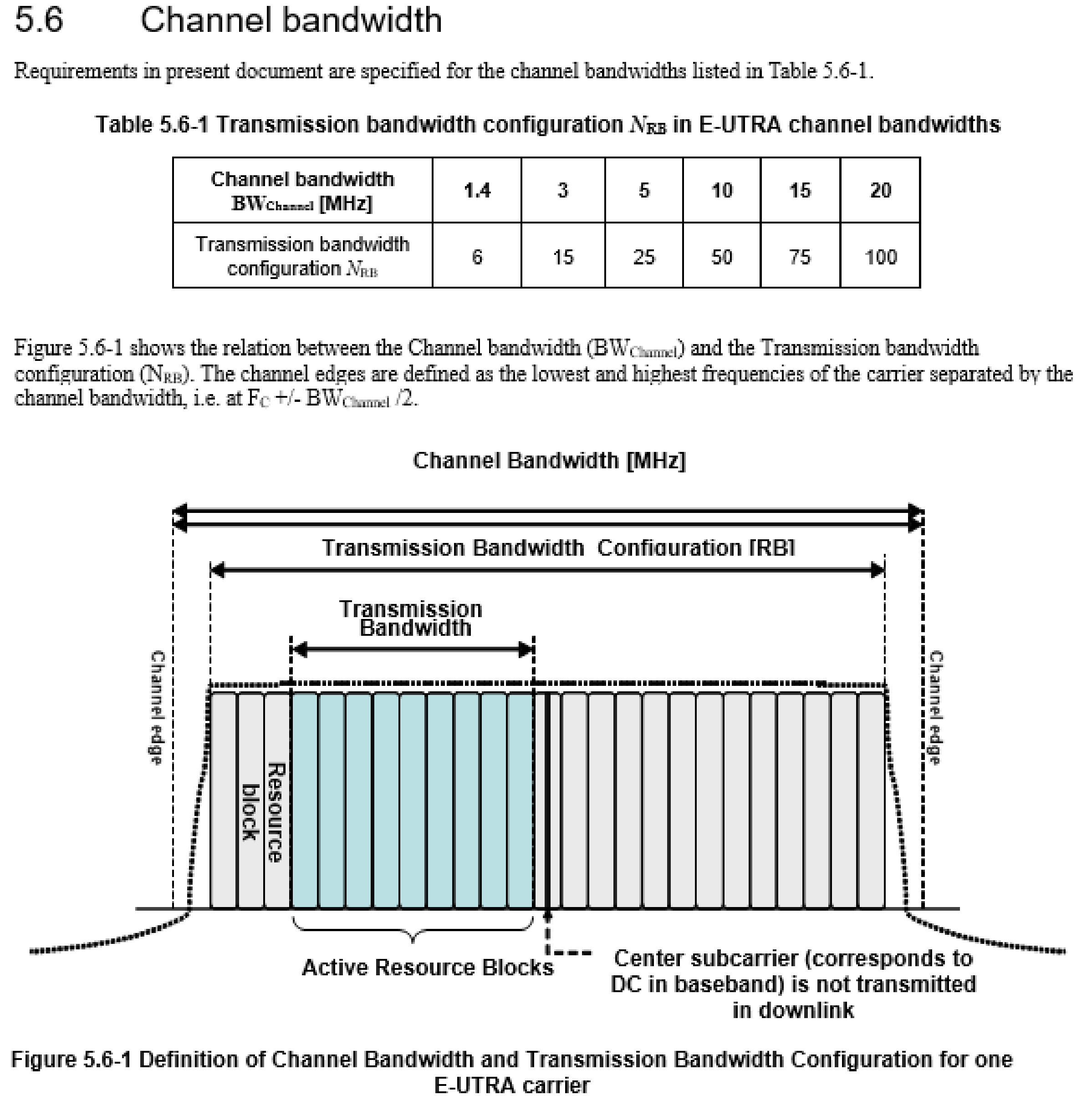
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Toyota's Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, Toyota's Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

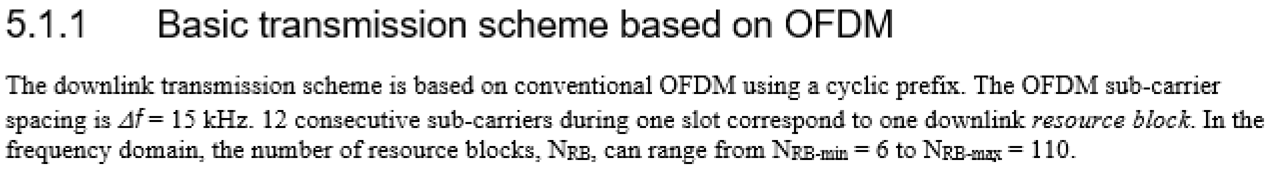
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

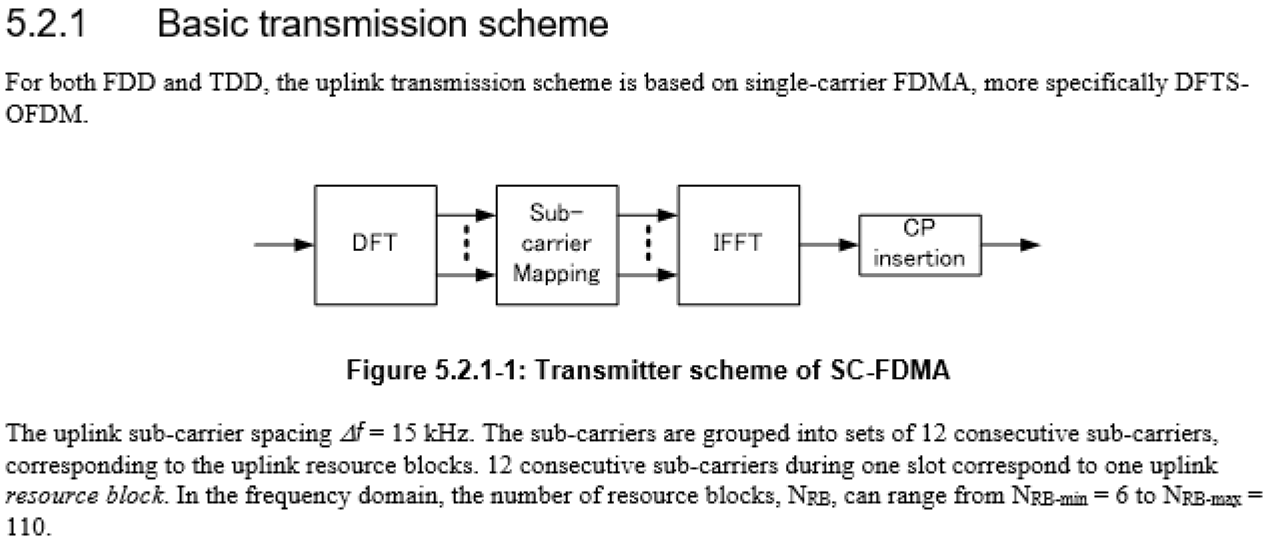
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

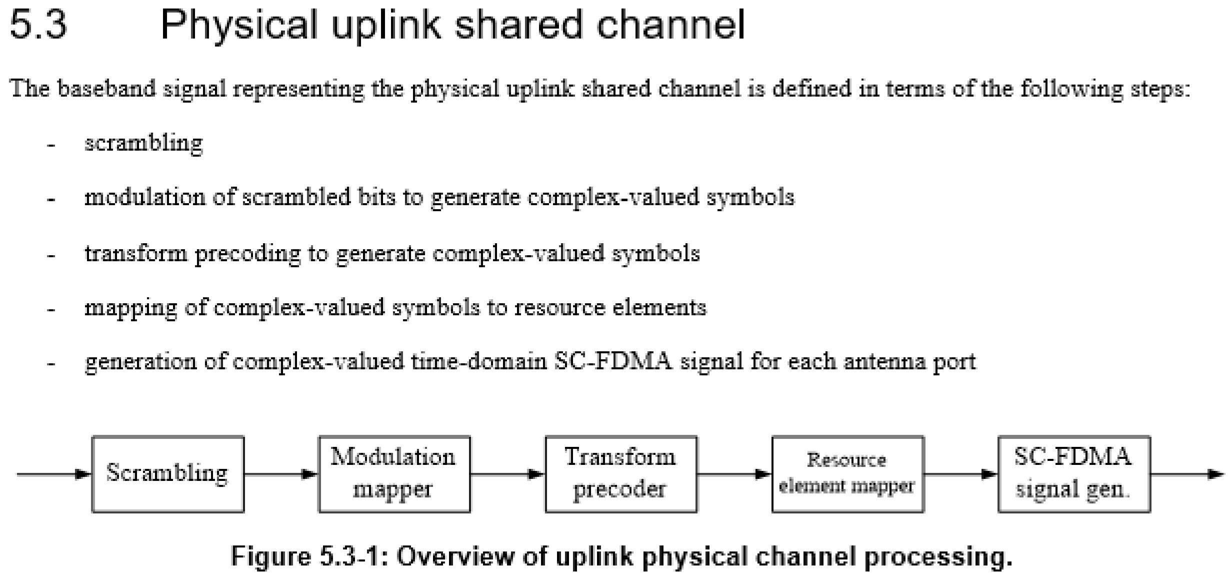
The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.3 Physical uplink shared channel

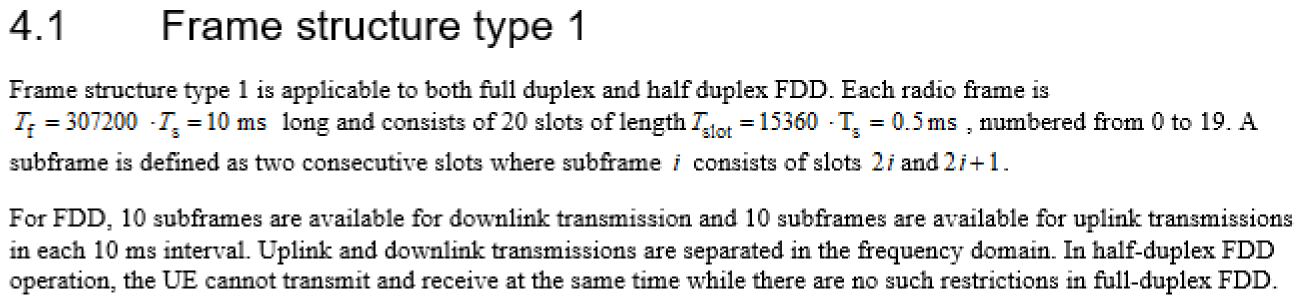
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\text{ ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\text{ ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

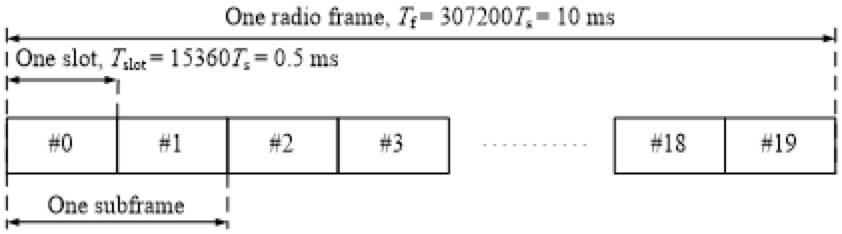
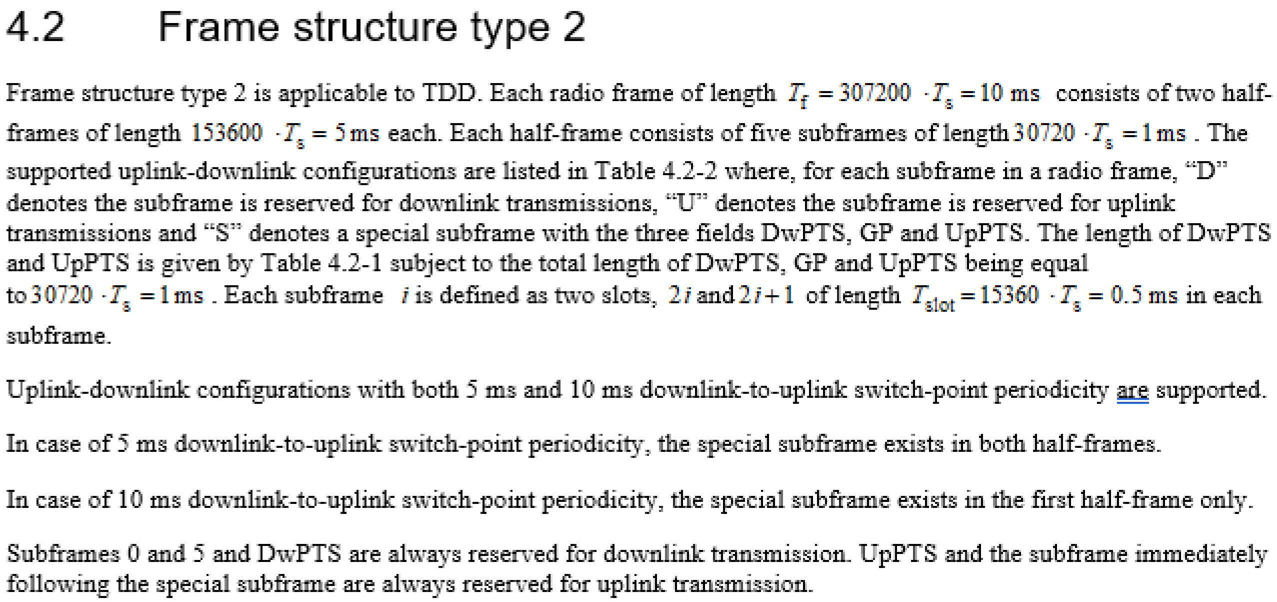


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

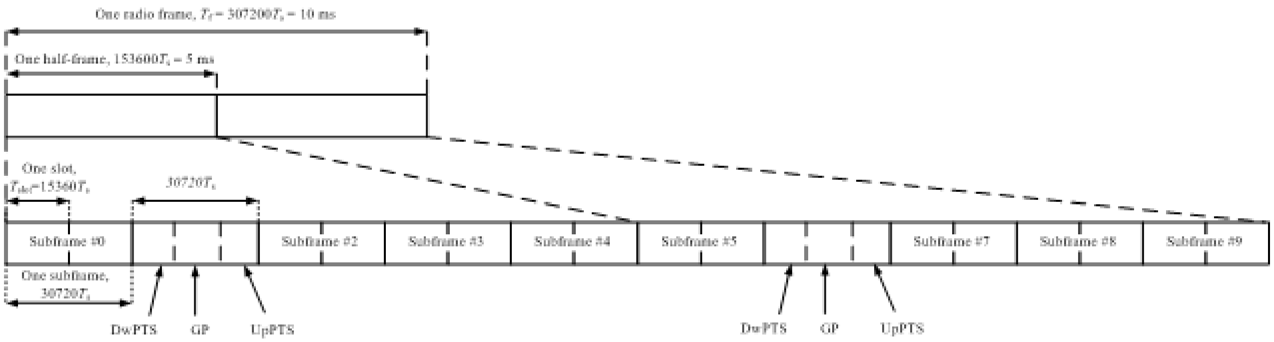
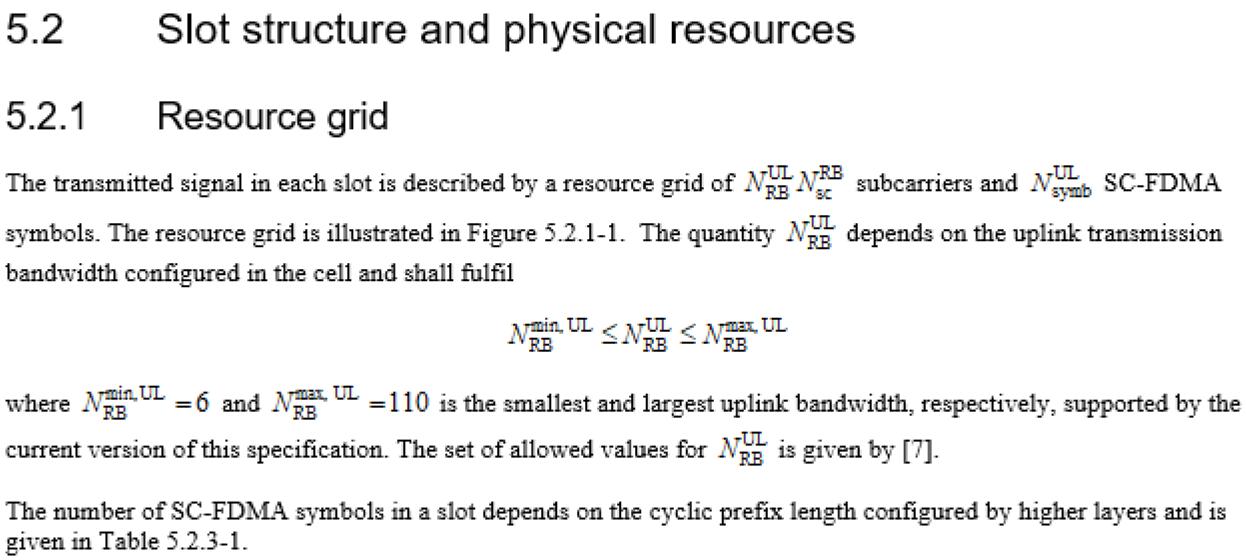


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{RB}^{UL} N_{sc}^{RB}$ subcarriers and N_{symb}^{UL} SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity N_{RB}^{UL} depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{RB}^{min,UL} \le N_{RB}^{UL} \le N_{RB}^{max,UL}$$

where $N_{RB}^{min,UL} = 6$ and $N_{RB}^{max,UL} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for N_{RB}^{UL} is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

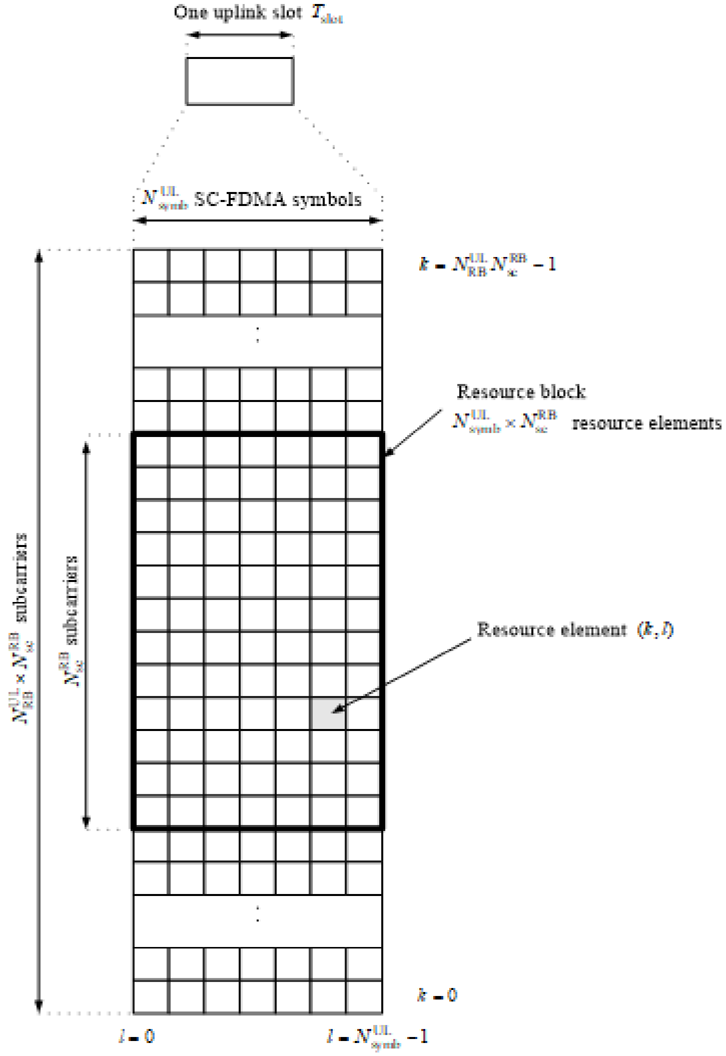
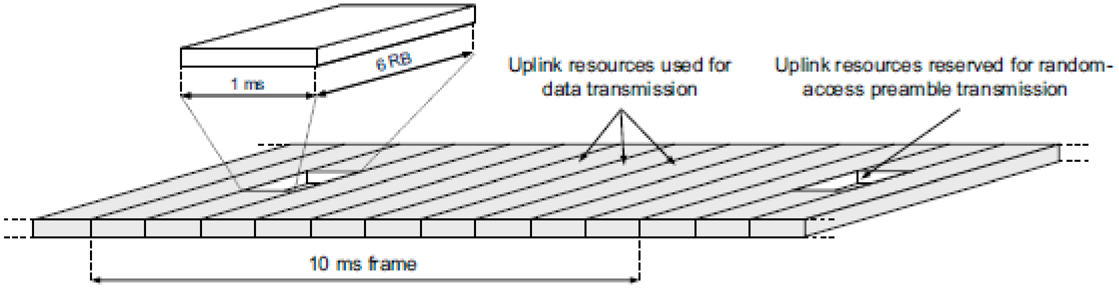


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 1(b)

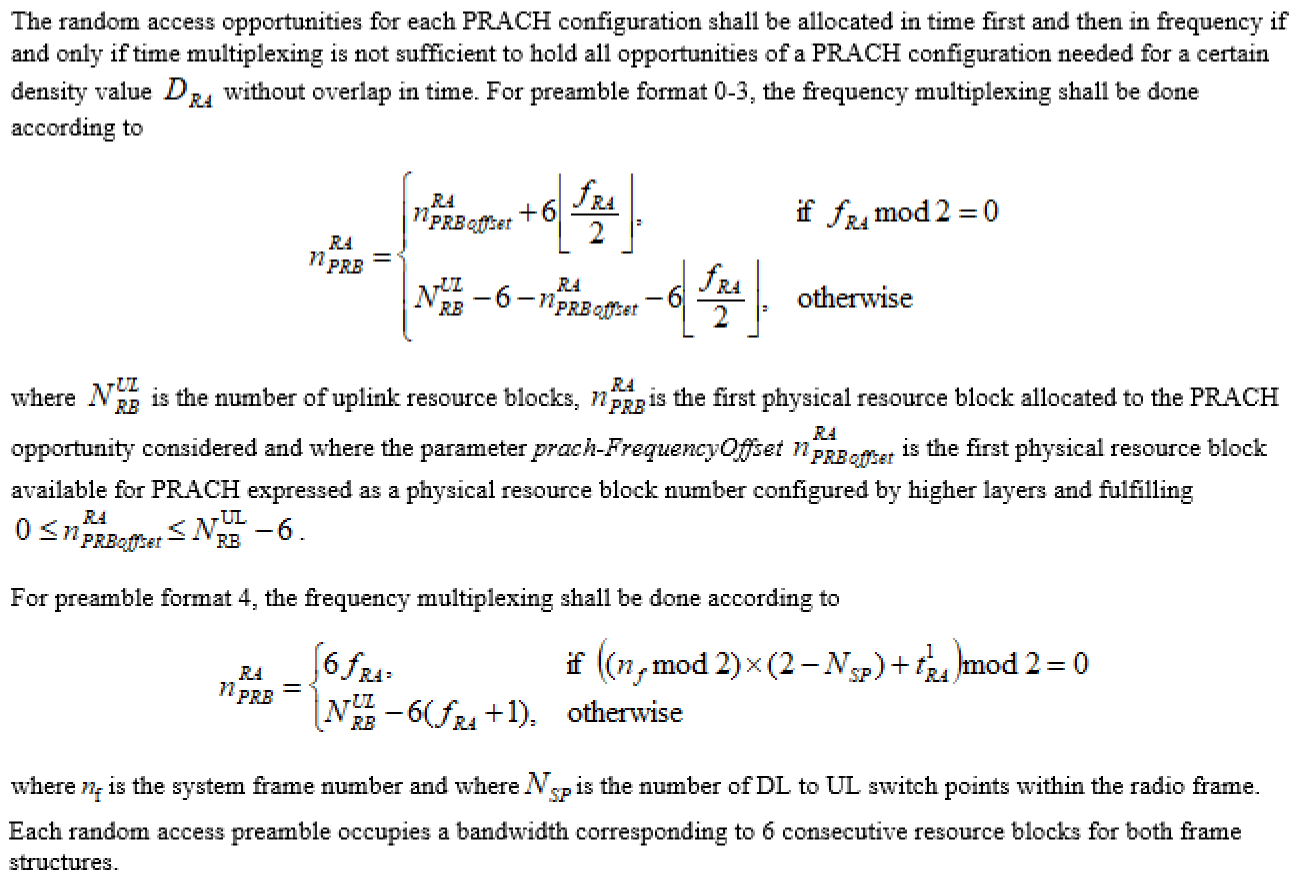
"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

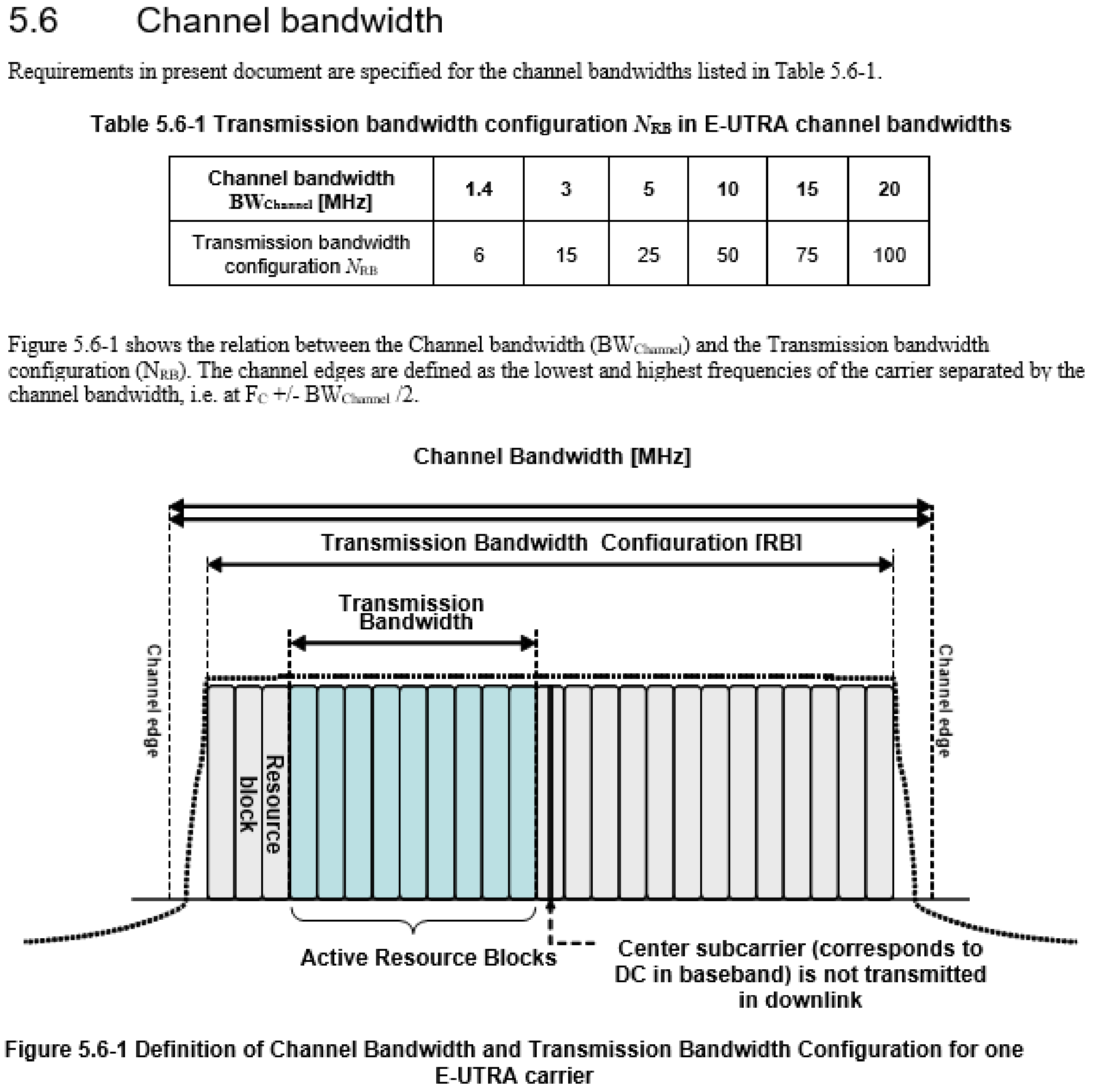
transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	Toyota’s Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)

"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

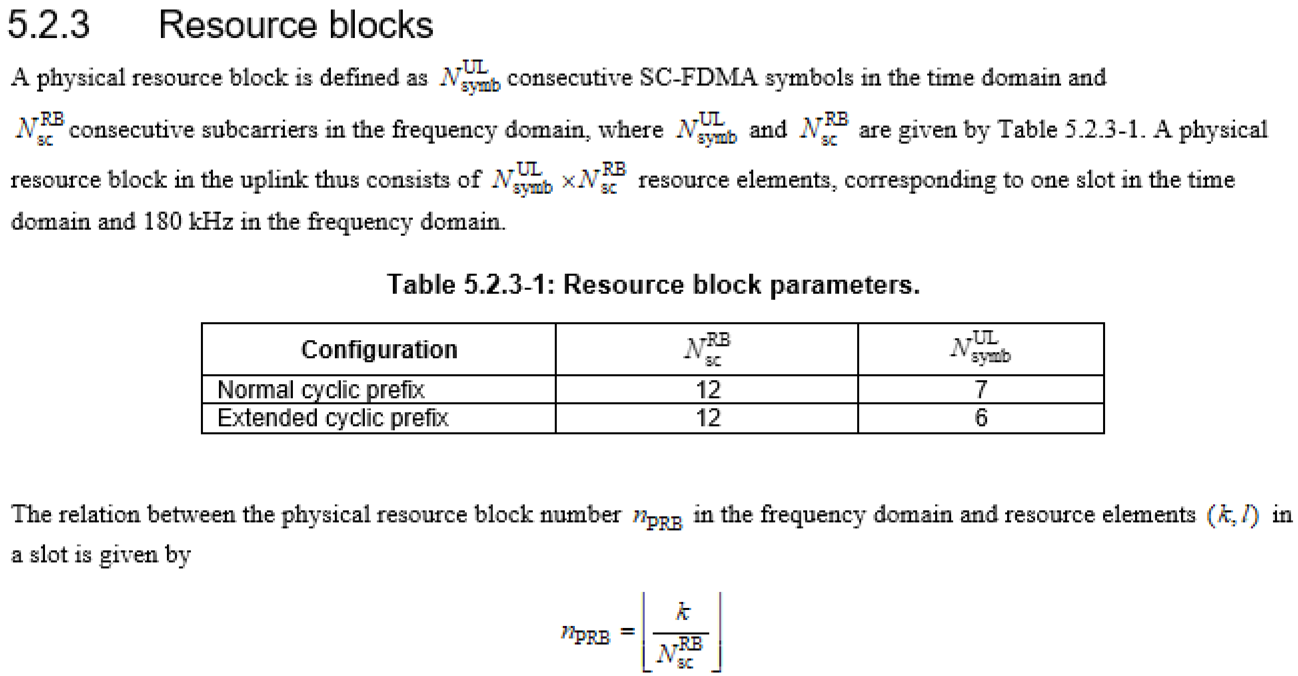
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

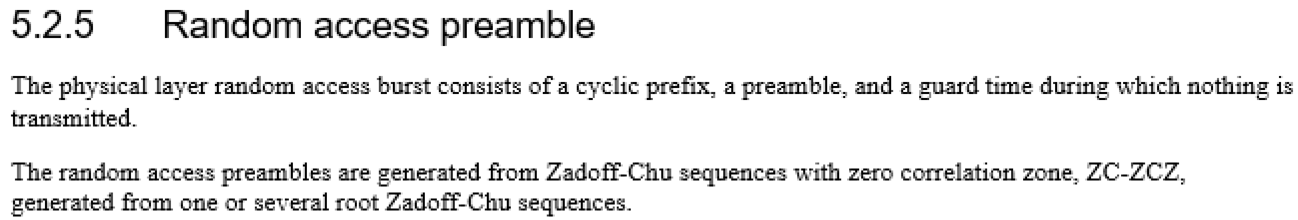
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

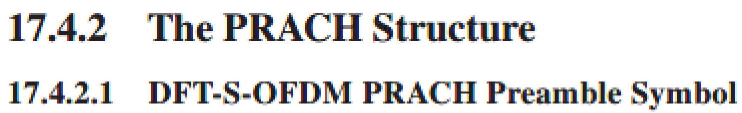


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.



17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

...

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

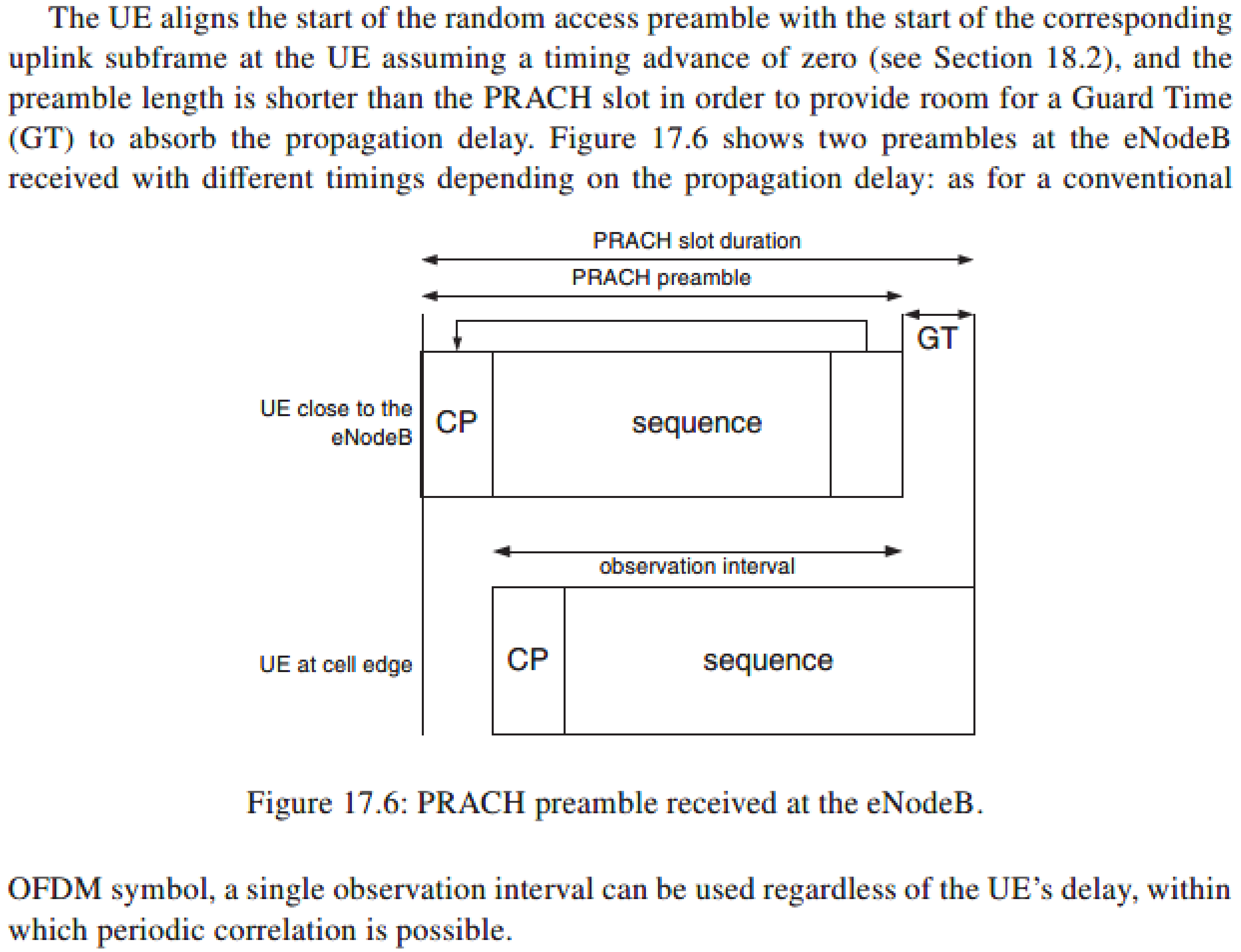
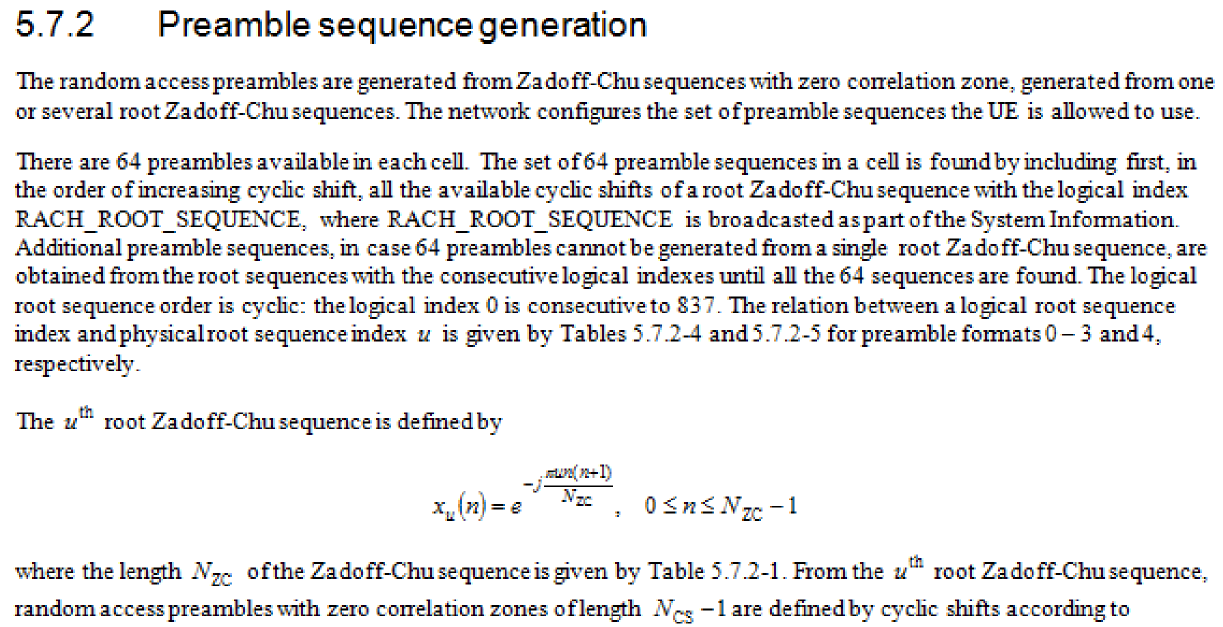

The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible.

Figure 17.6: PRACH preamble received at the eNodeB.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378.

The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

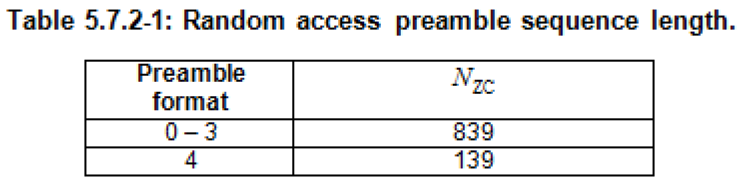
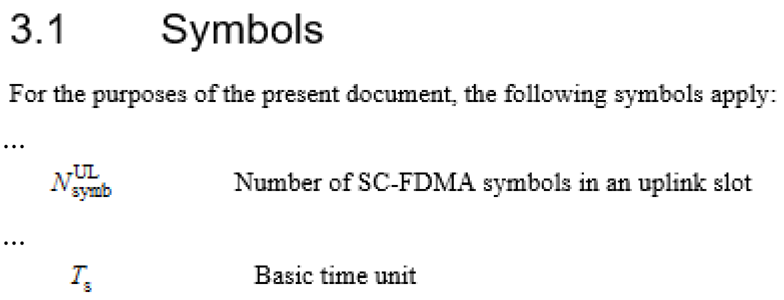
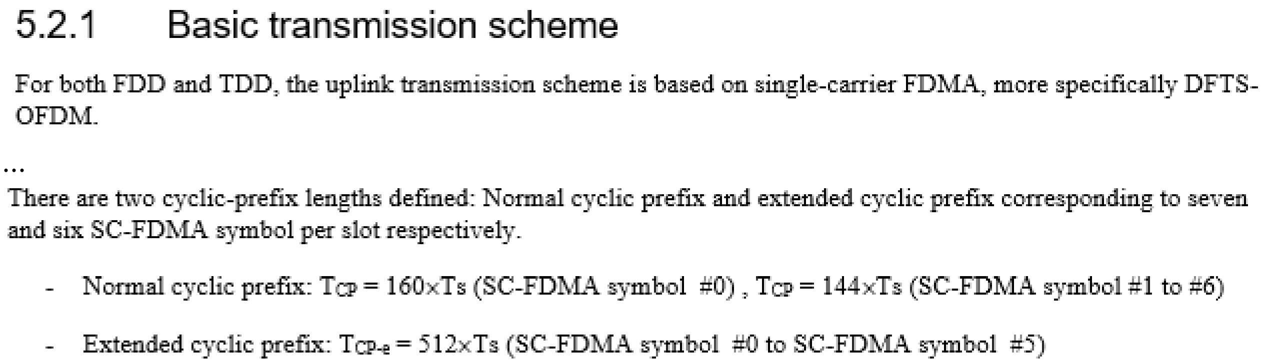


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using Toyota's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

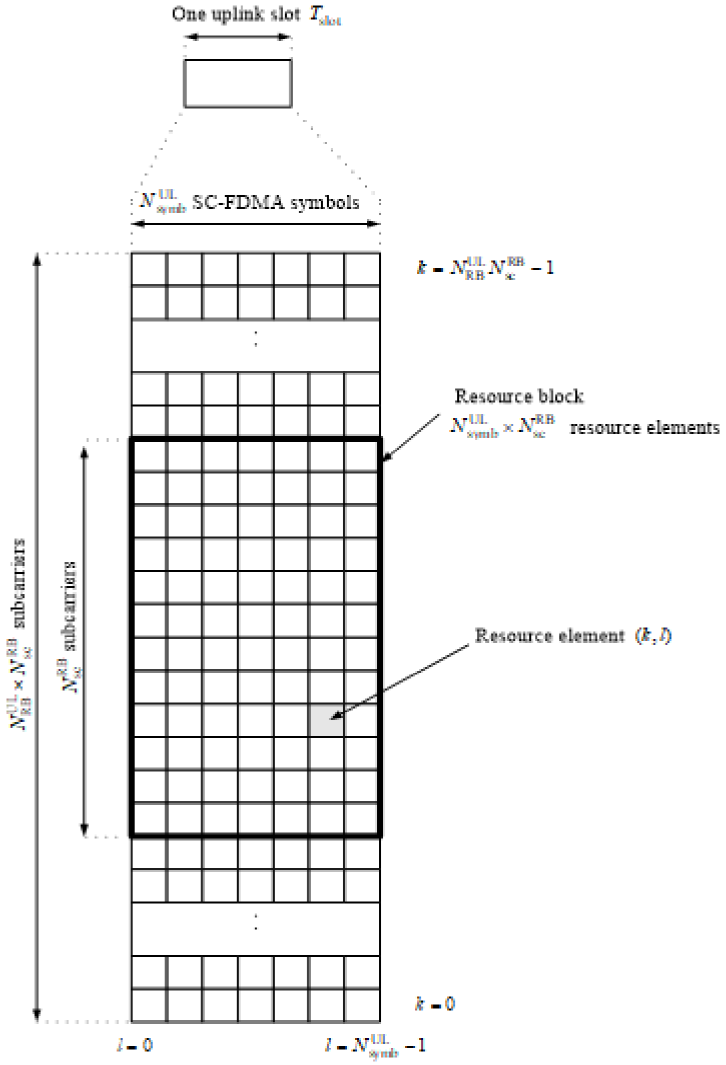
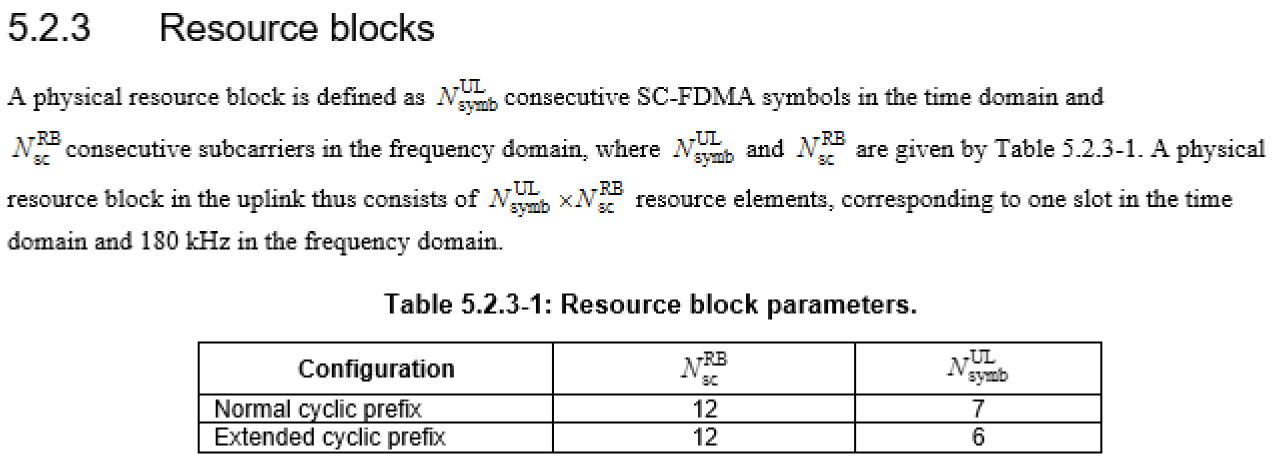


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

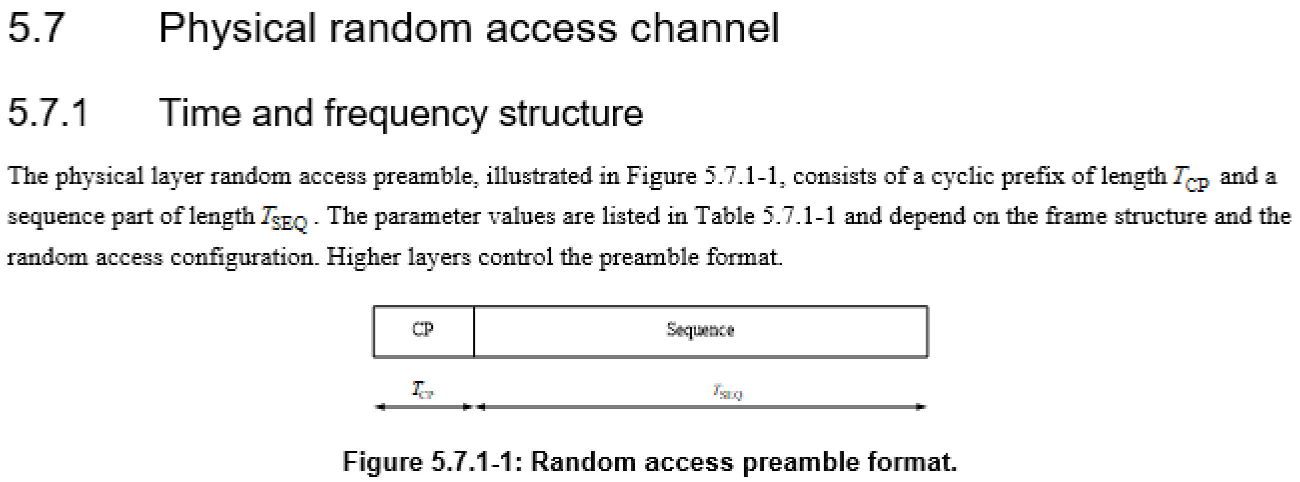
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

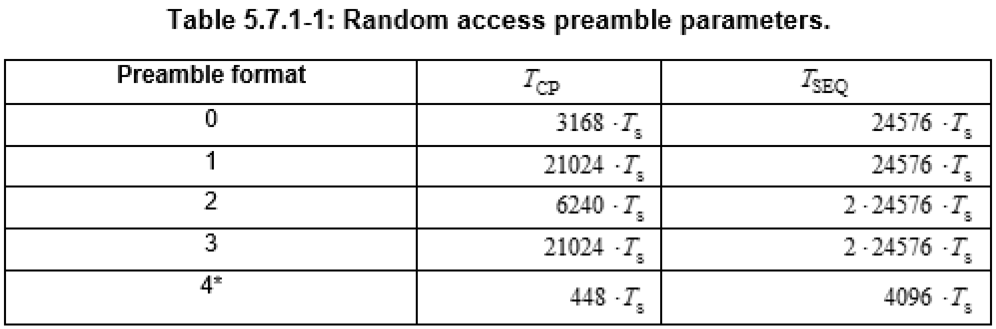
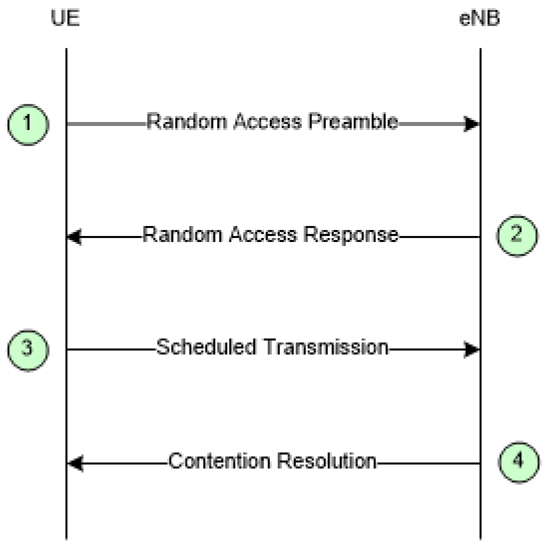


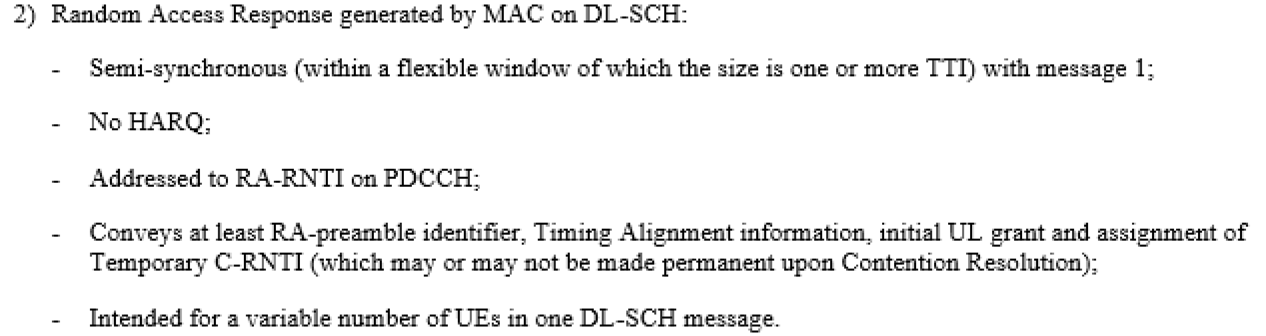
Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

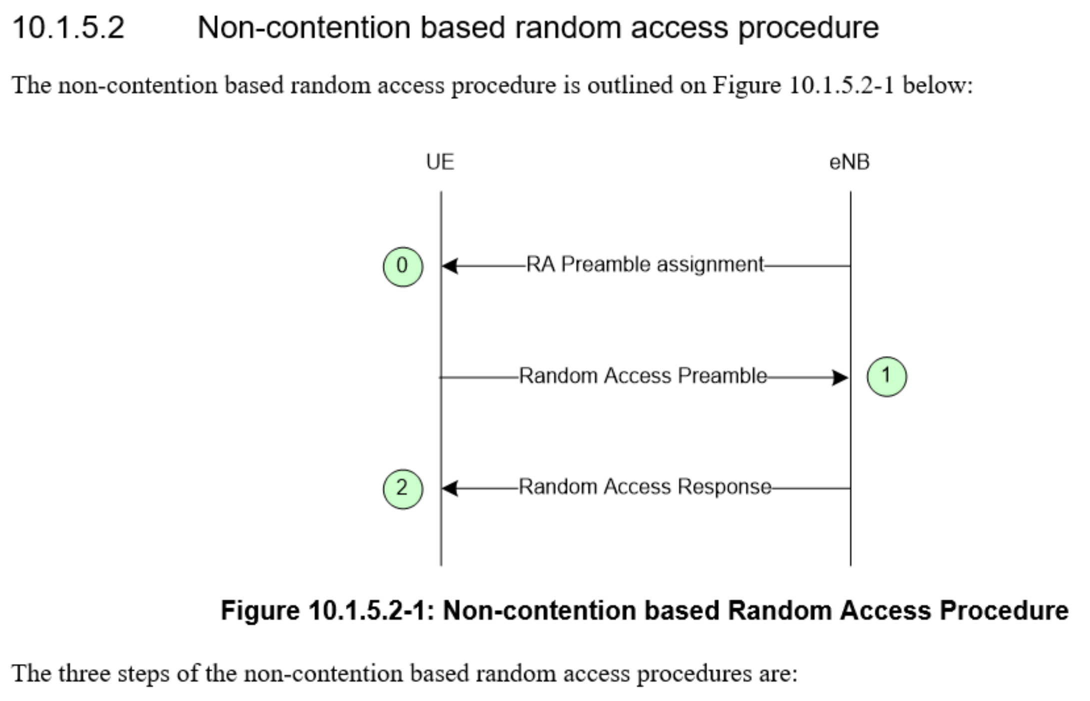
a receiver configured to receive, from the base station, a response message.	Toyota's Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:  **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



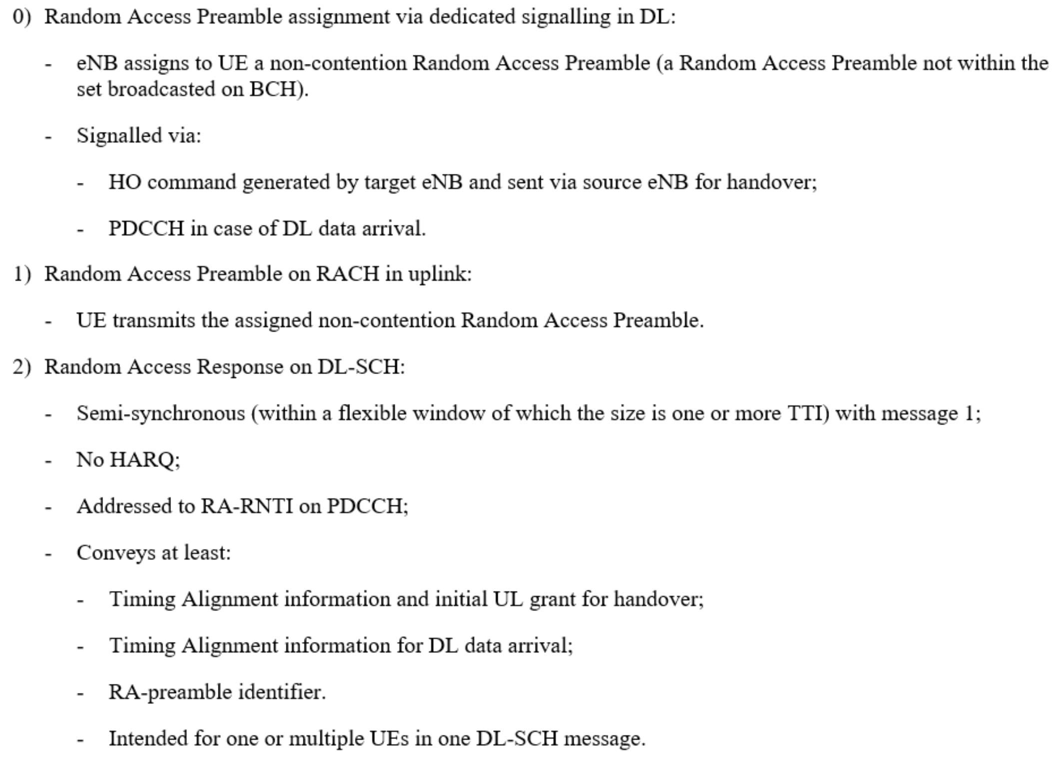
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

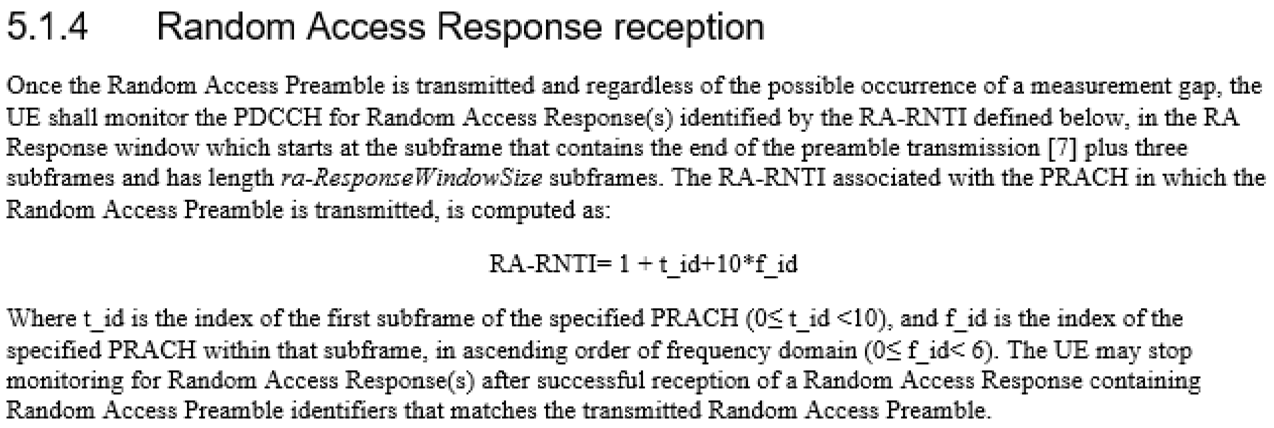
US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.


5.1.4 Random Access Response reception

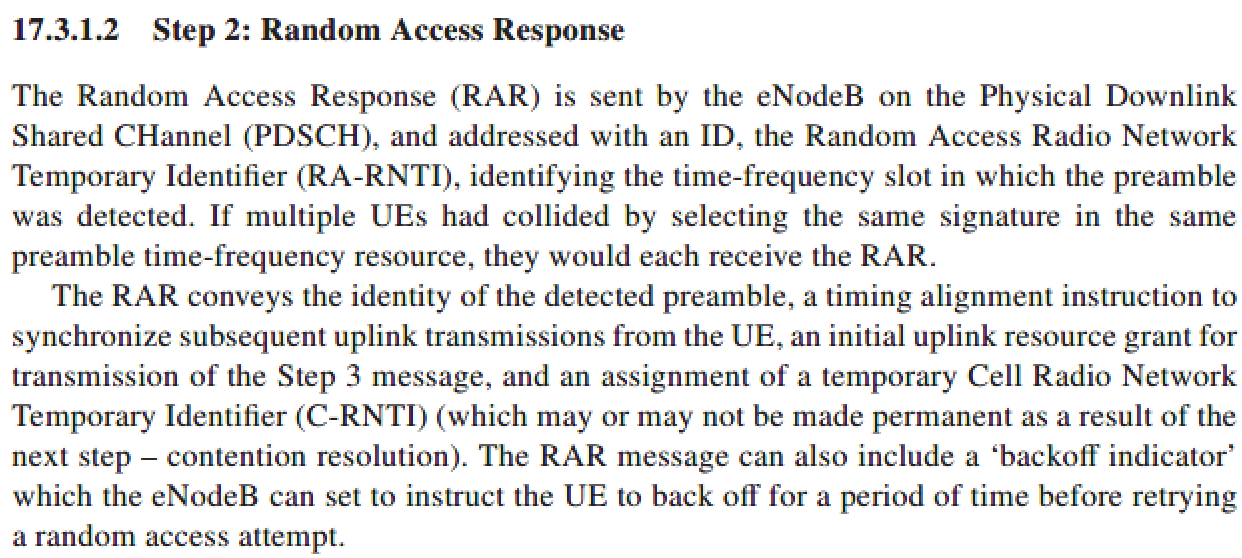
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

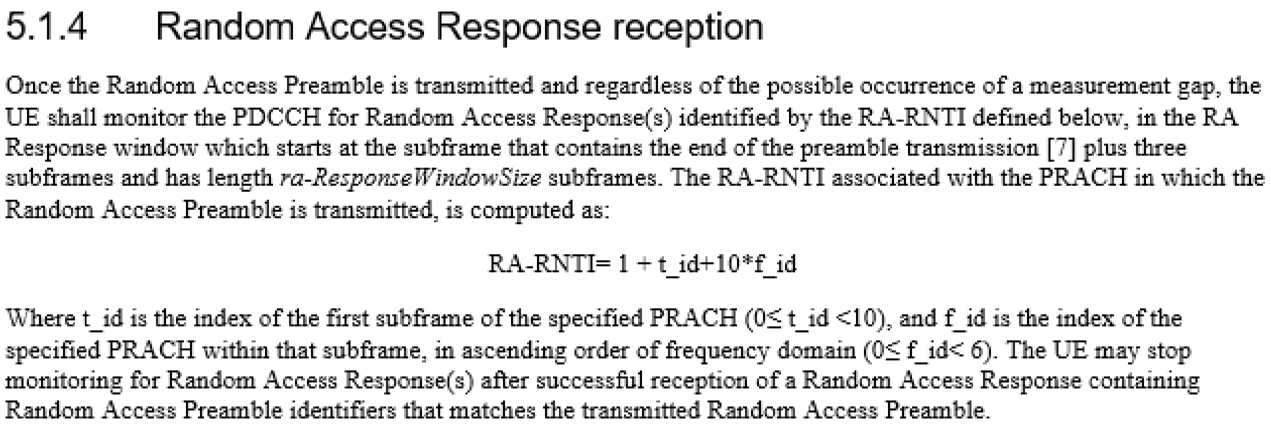
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

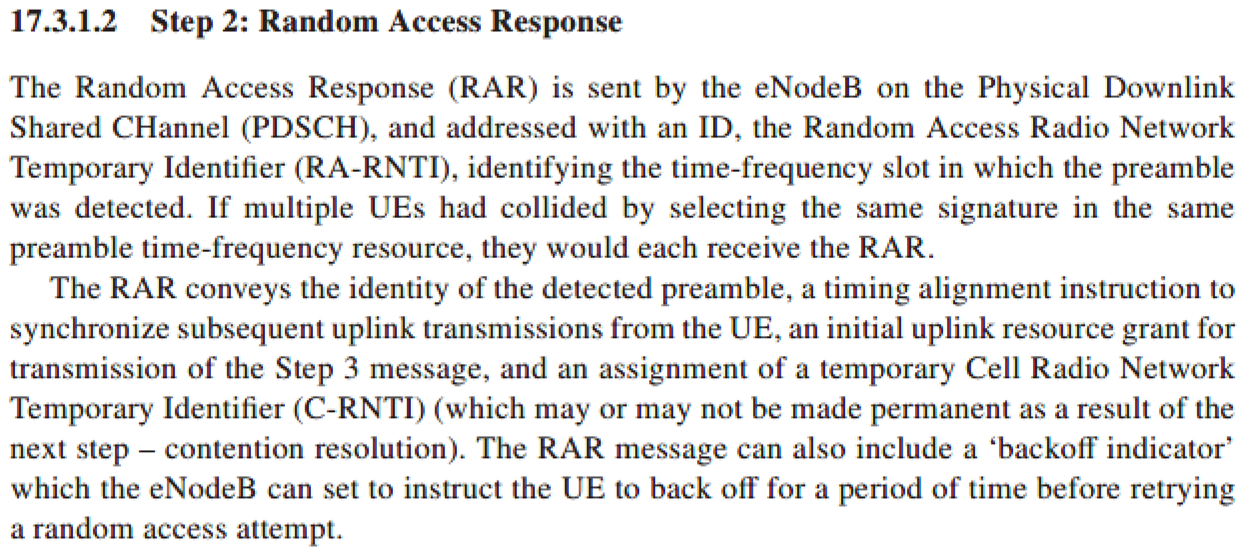
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

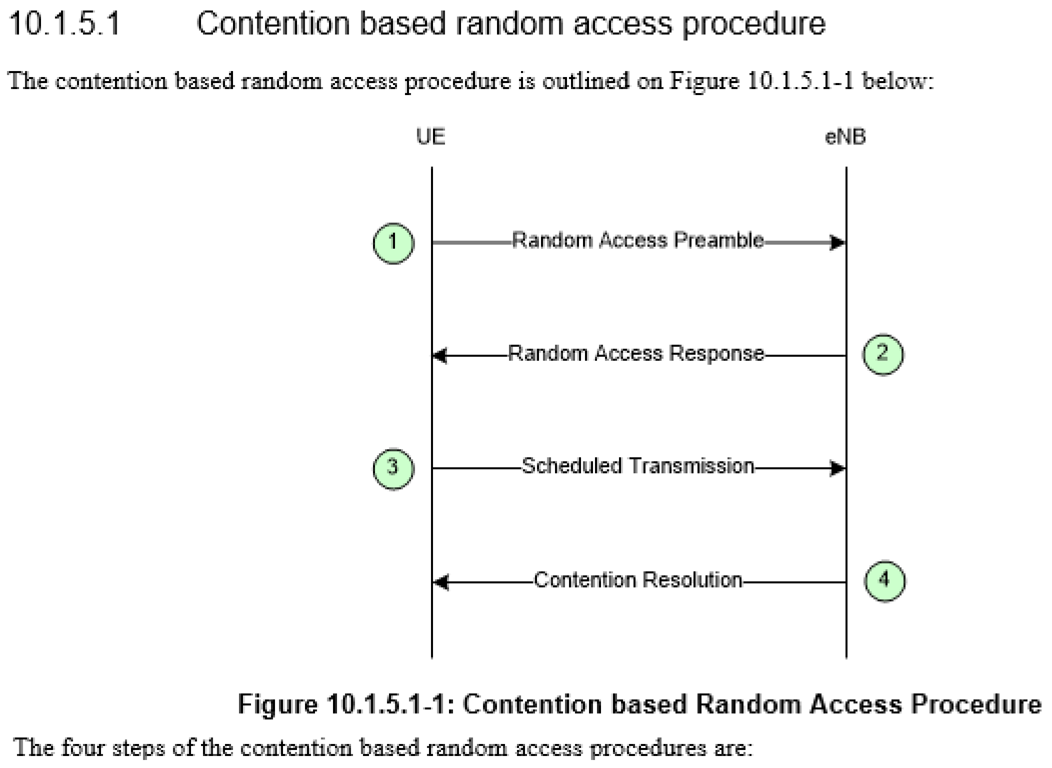
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

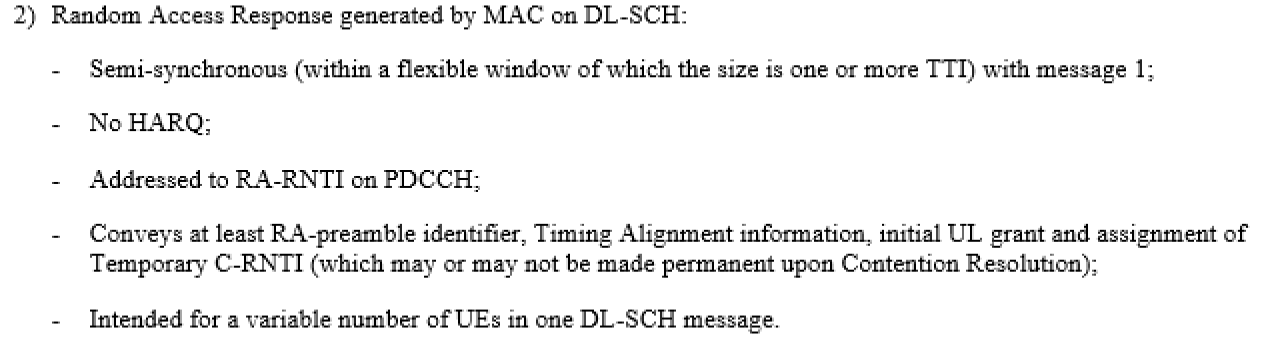
the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of Toyota’s Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\le t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\le f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

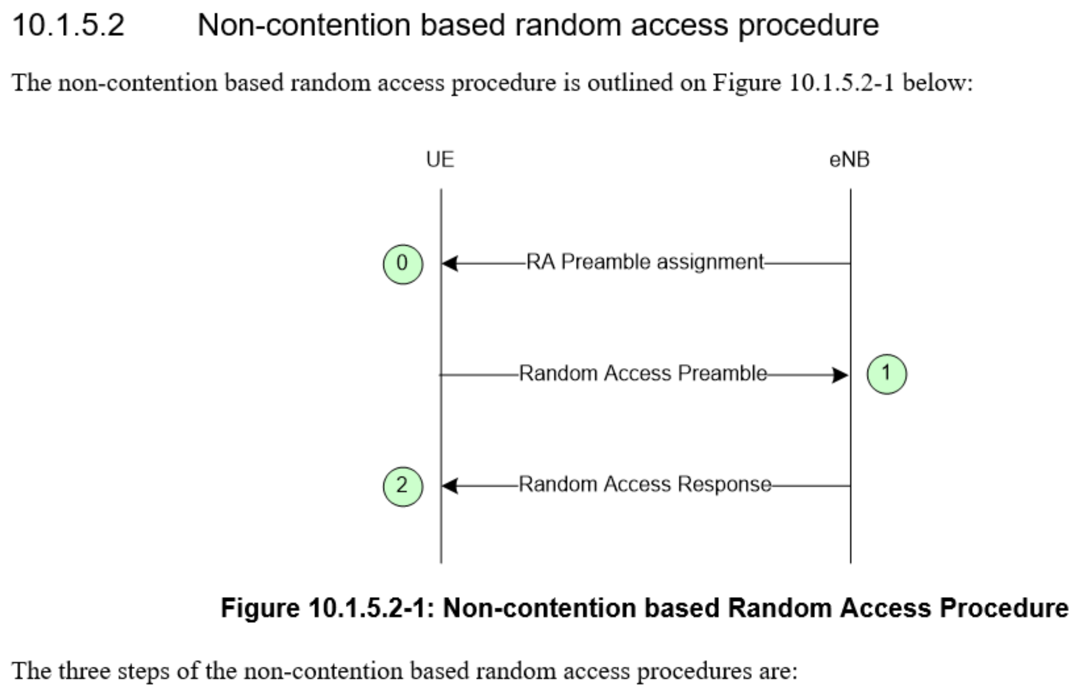
on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in Toyota's Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.*, When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: ...



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



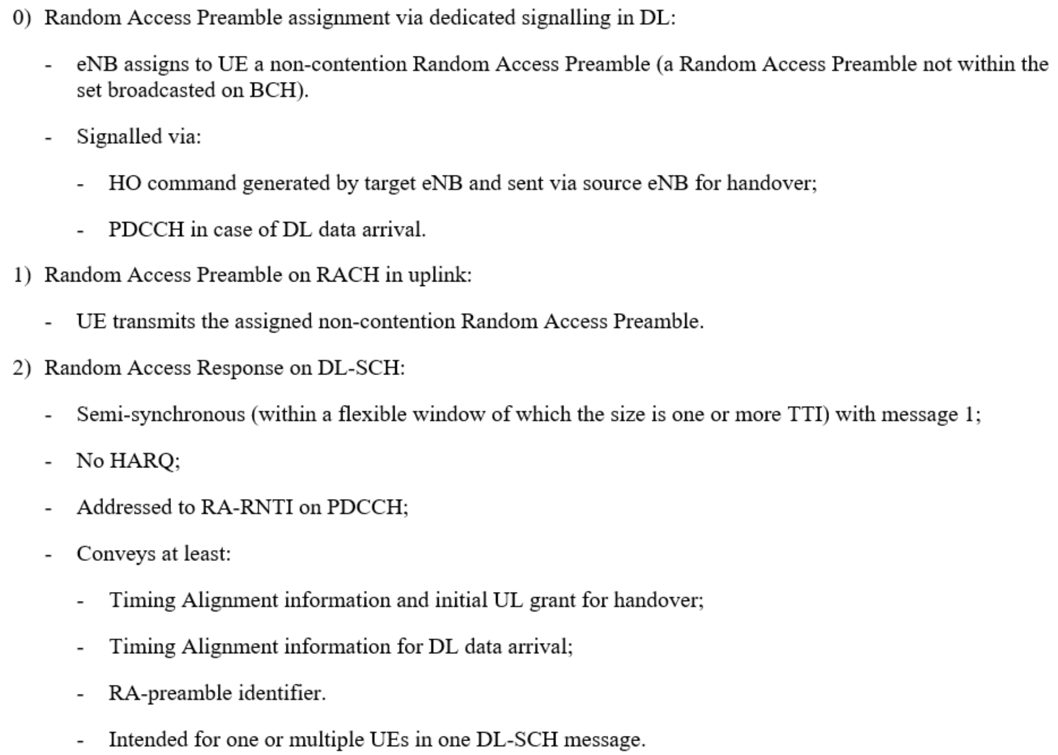
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

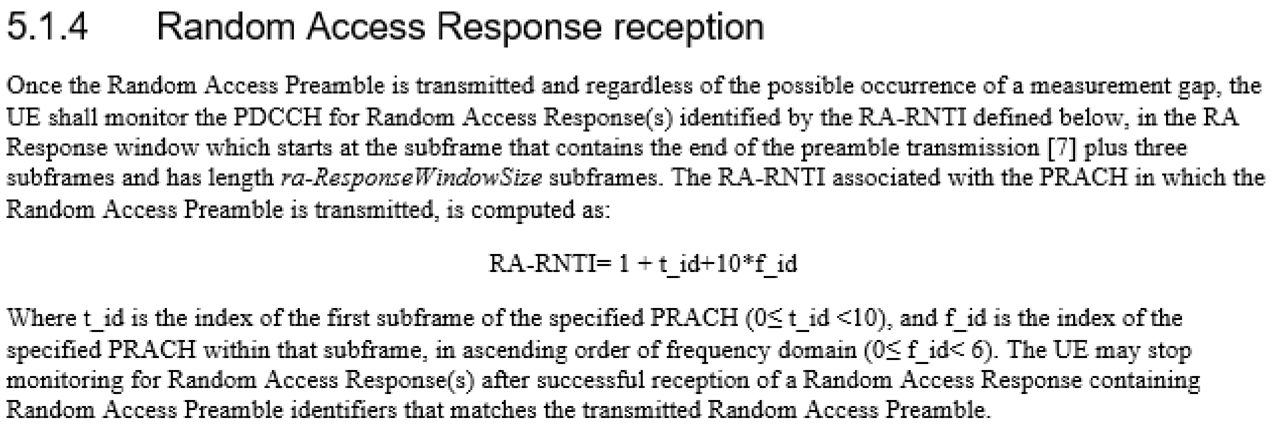
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

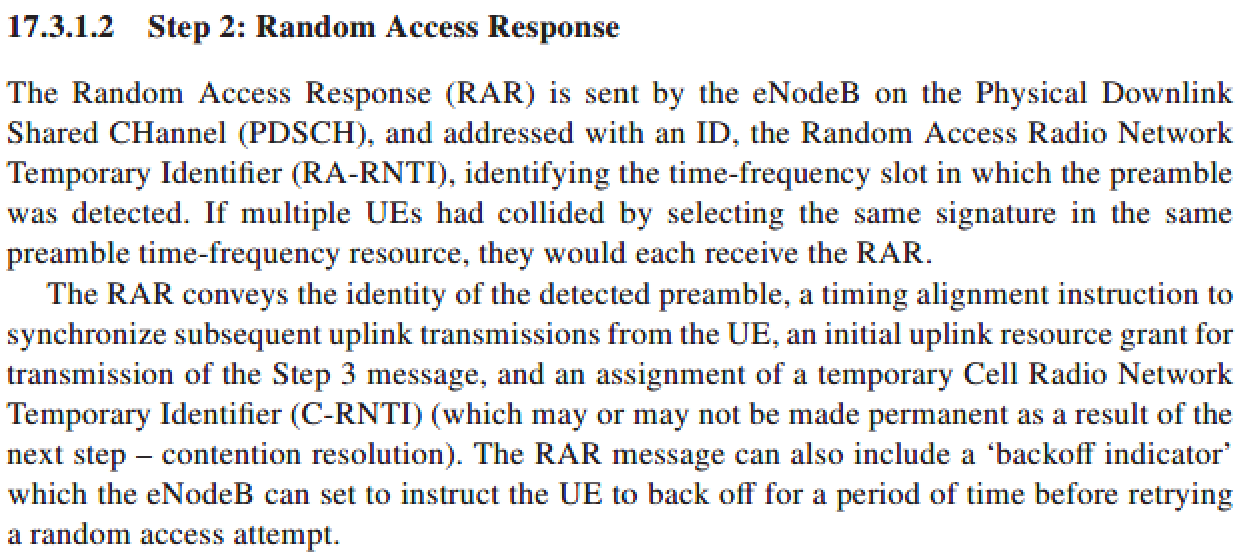
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

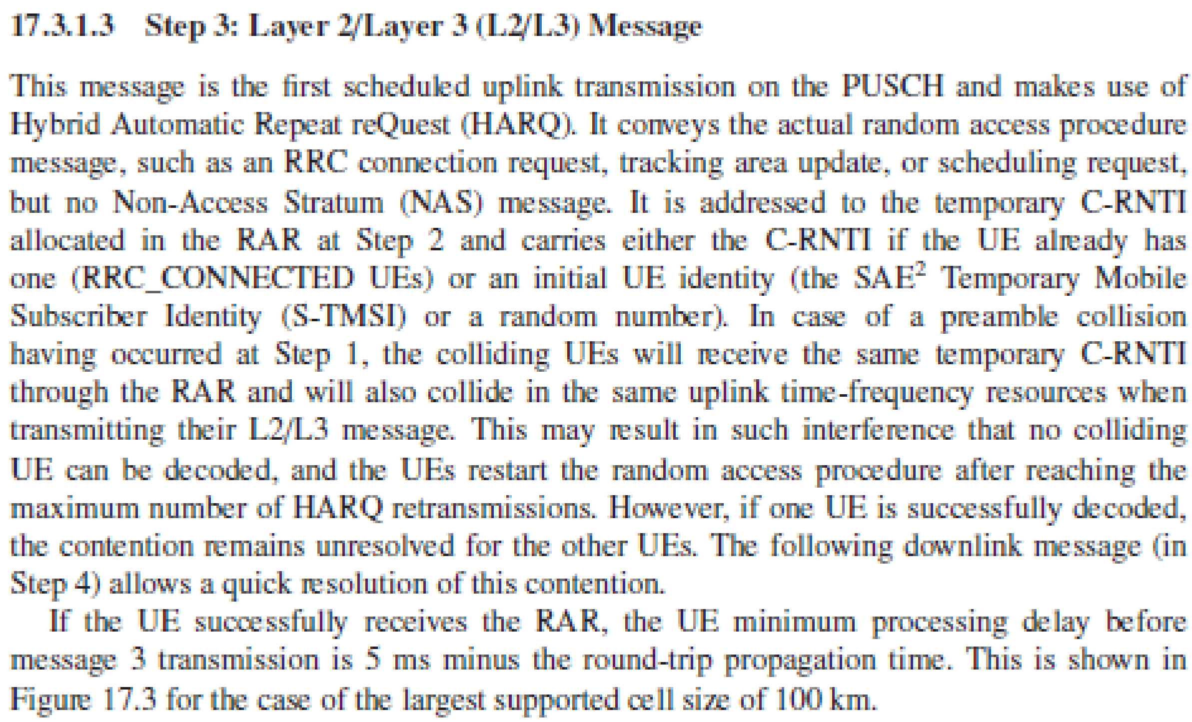
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

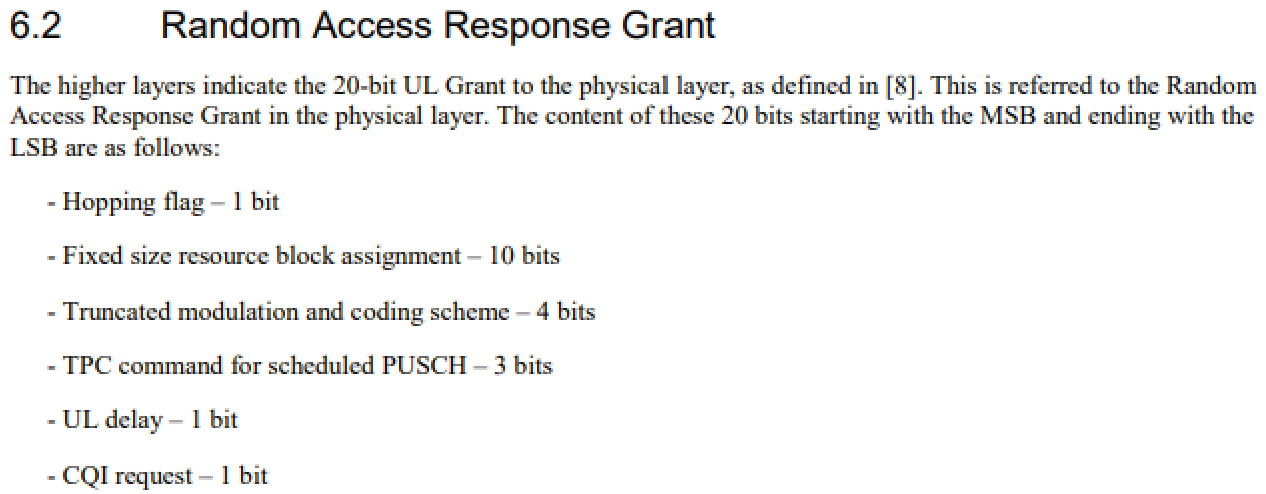
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

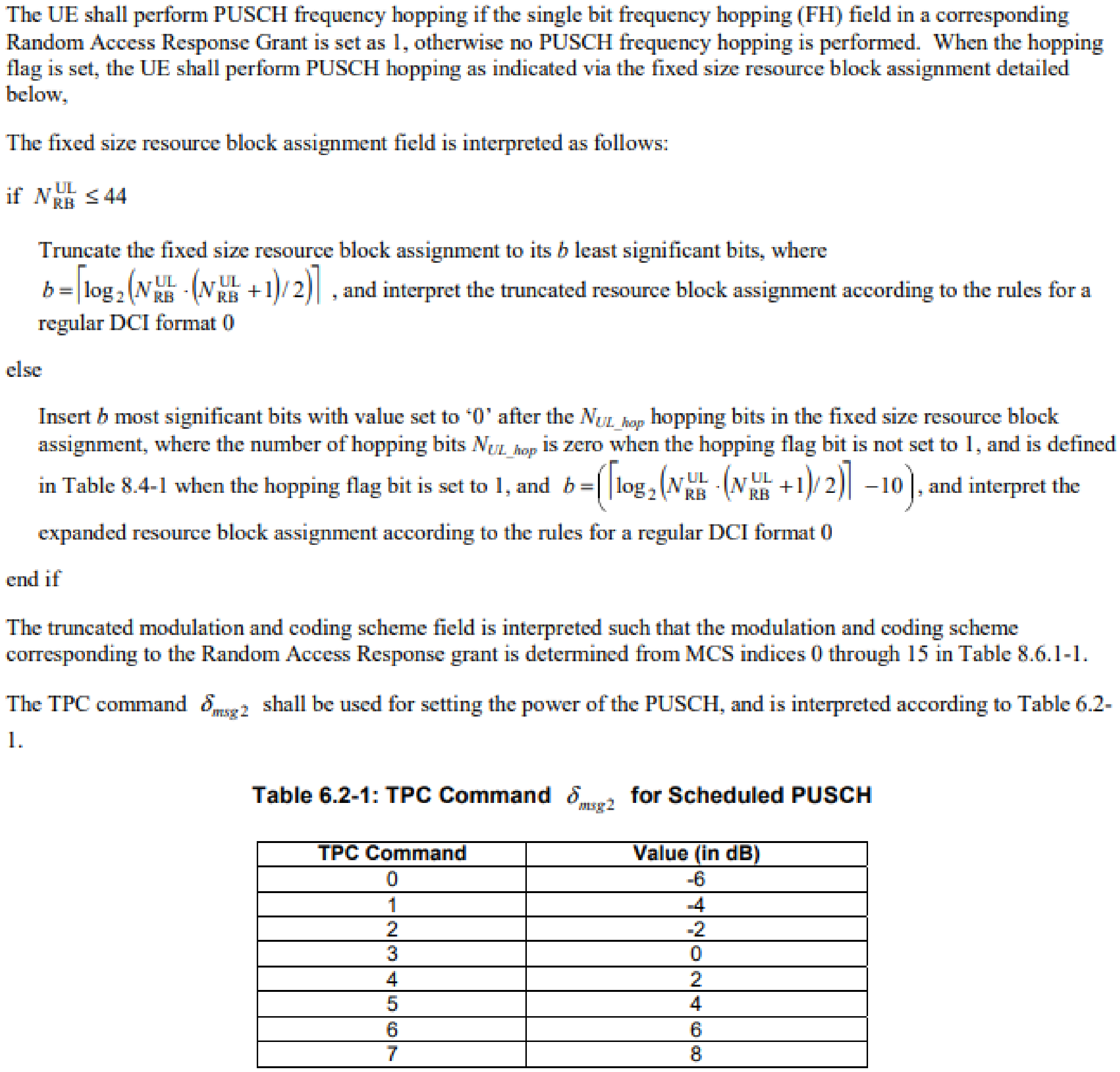
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of Toyota's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
“The mobile station of claim 2, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

```
if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$
    Truncate the fixed size resource block assignment to its $b$ least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil$ , and interpret the truncated resource block assignment according to the rules for a regular DCI format 0
else
    Insert $b$ most significant bits with value set to ‘0’ after the $N_{UL\_hop}$ hopping bits in the fixed size resource block assignment, where the number of hopping bits $N_{UL\_hop}$ is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left( \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0
end if
```

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

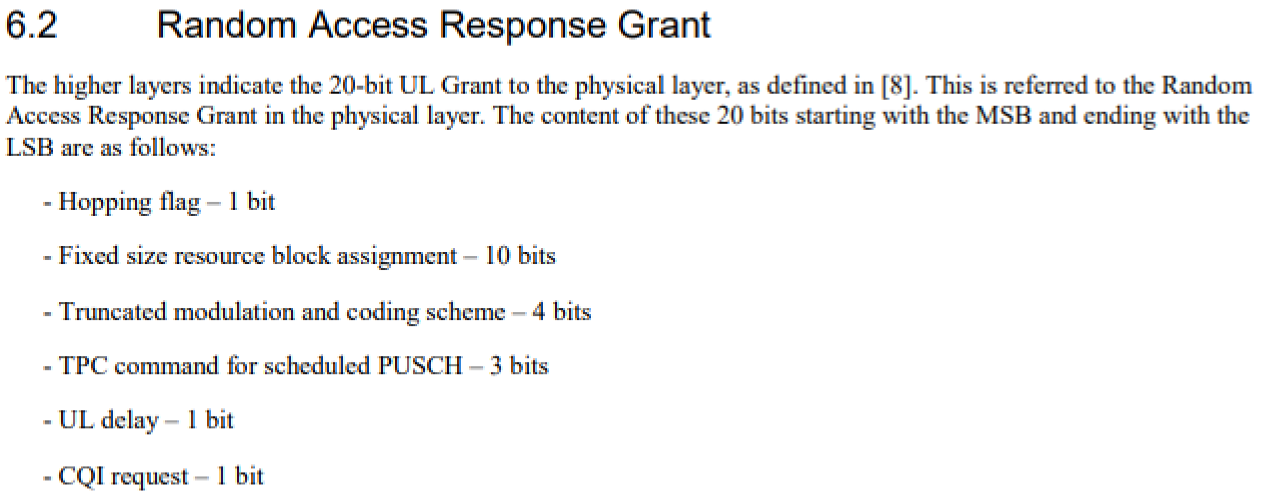
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

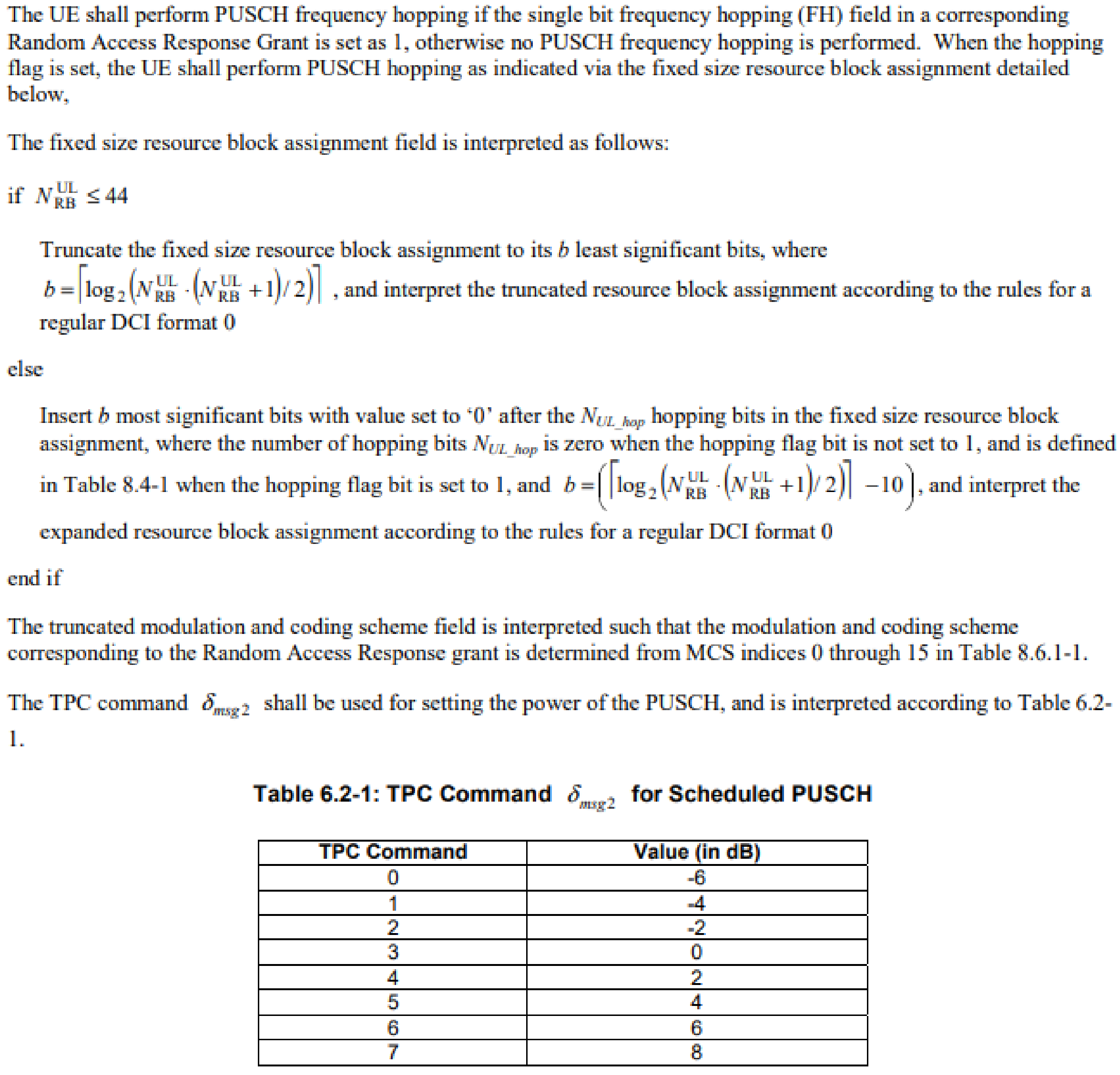
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of Toyota’s Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

```
if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$
    Truncate the fixed size resource block assignment to its $b$ least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$ , and interpret the truncated resource block assignment according to the rules for a regular DCI format 0
else
    Insert $b$ most significant bits with value set to ‘0’ after the $N_{UL\_hop}$ hopping bits in the fixed size resource block assignment, where the number of hopping bits $N_{UL\_hop}$ is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0
end if
```

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

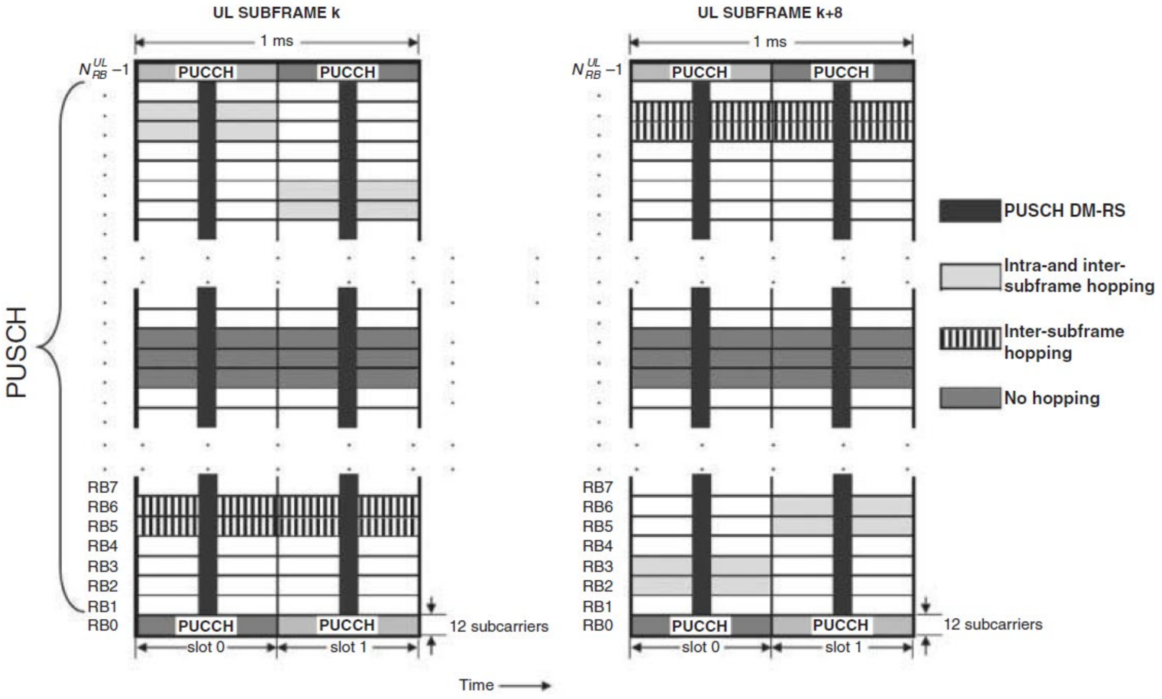
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

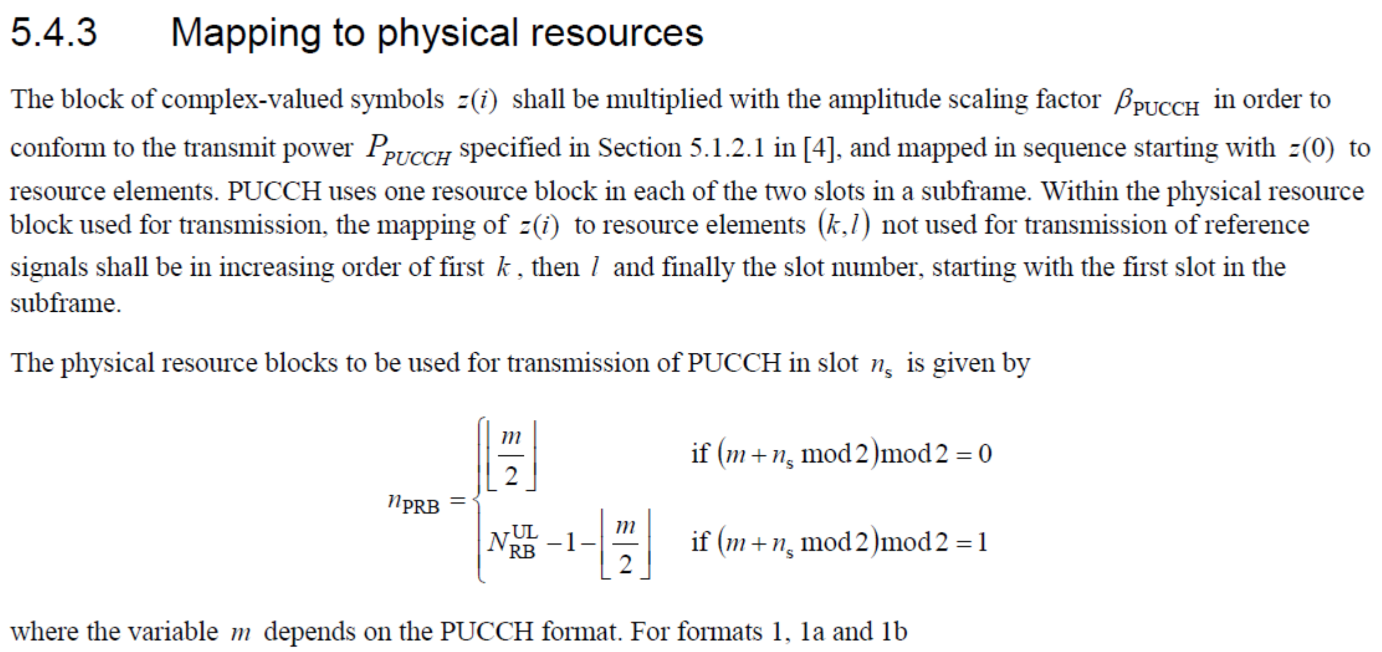
US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of Toyota’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

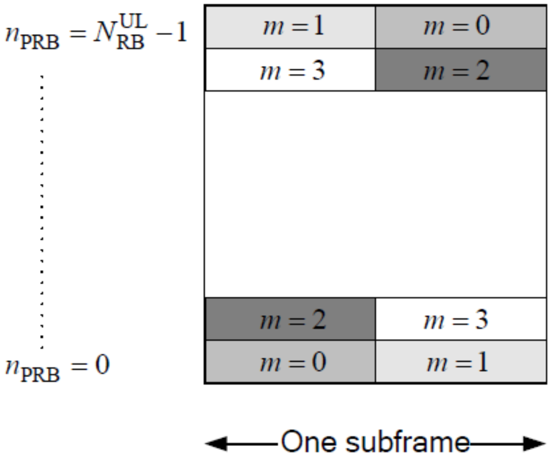


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

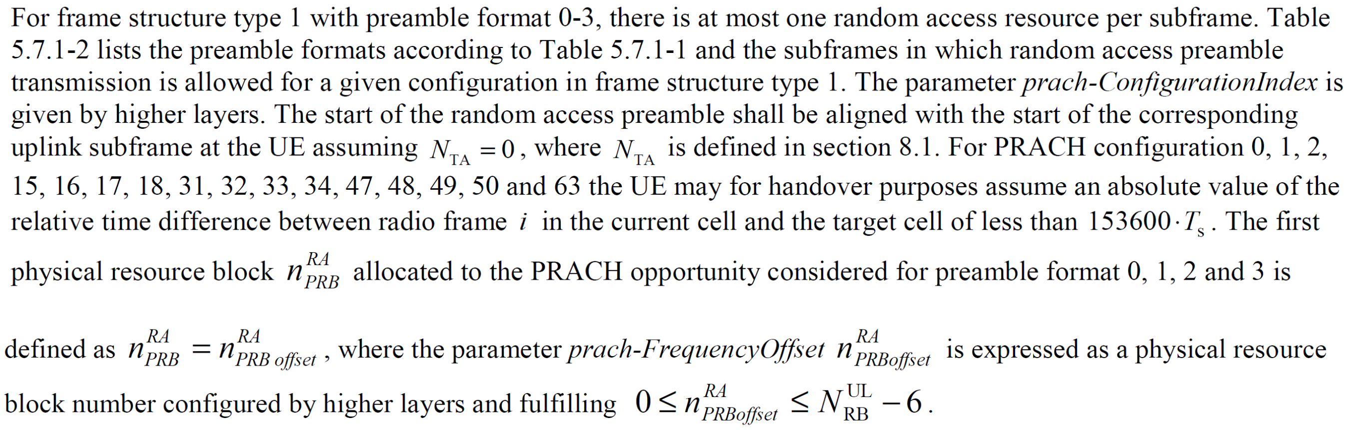
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

…



For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 4
“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

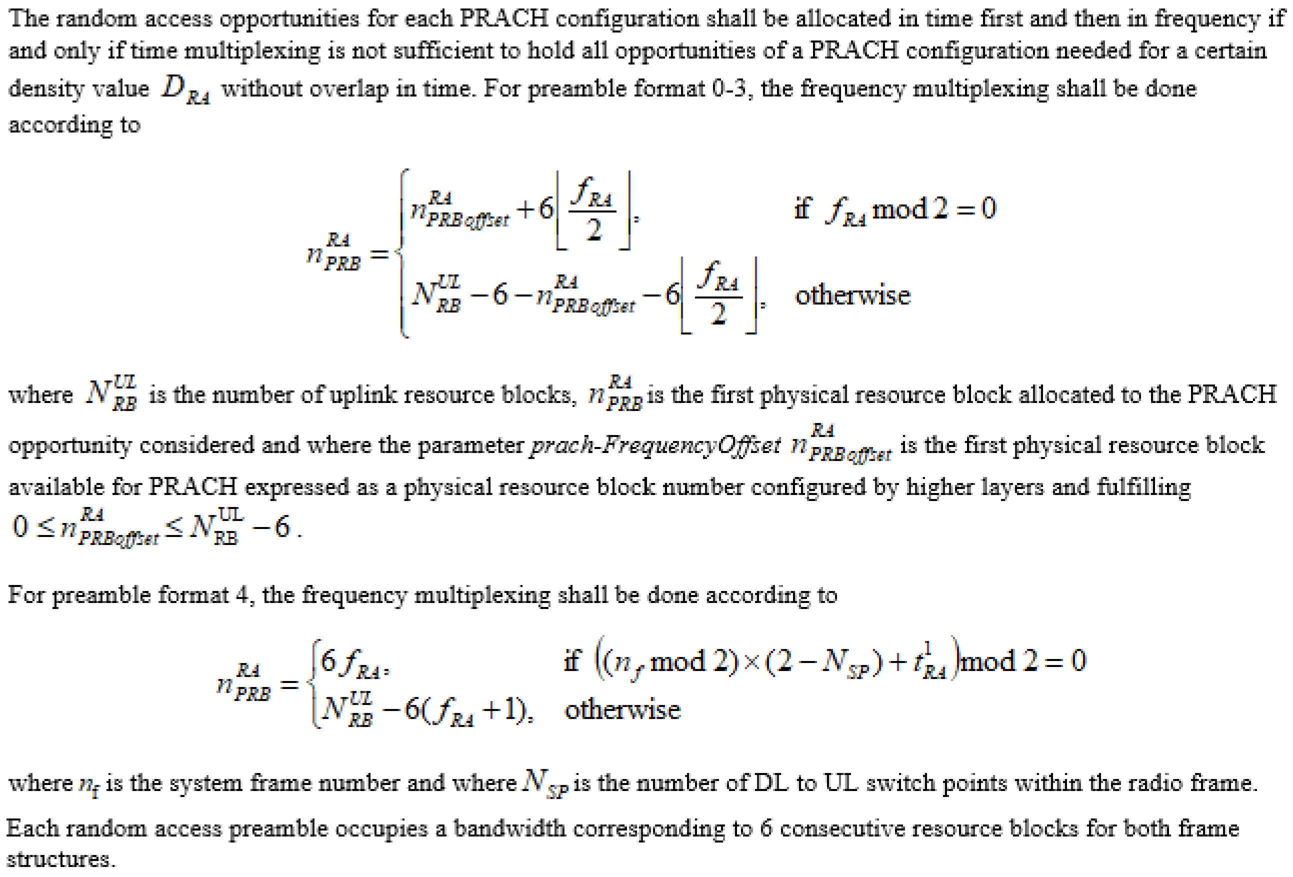
	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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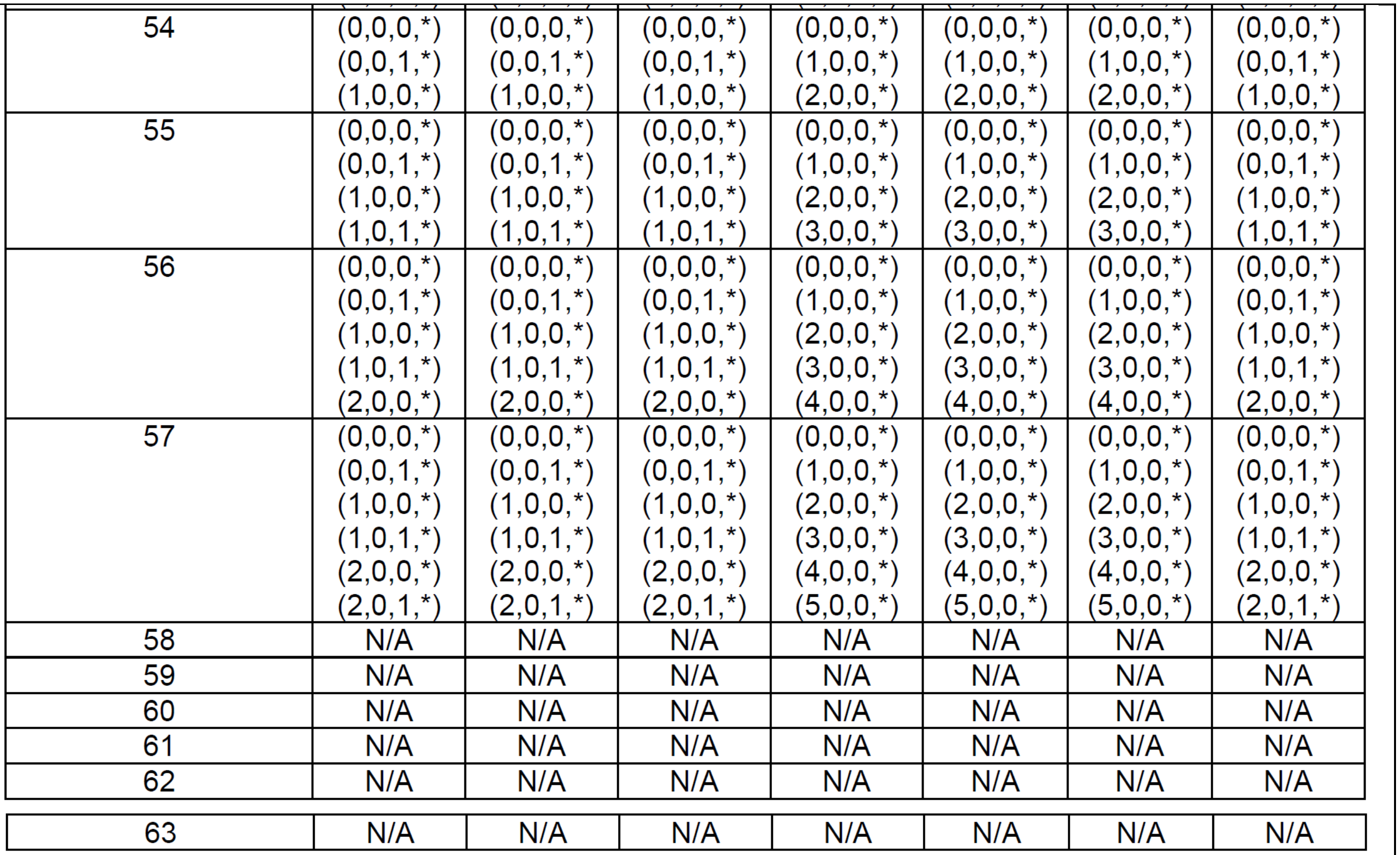
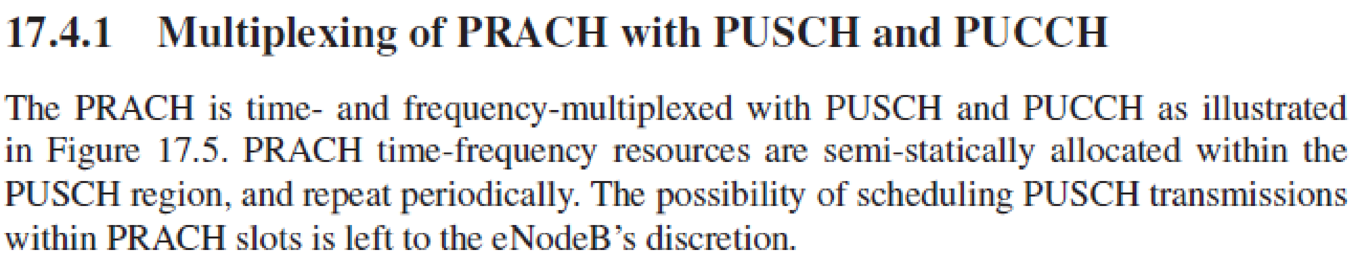


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

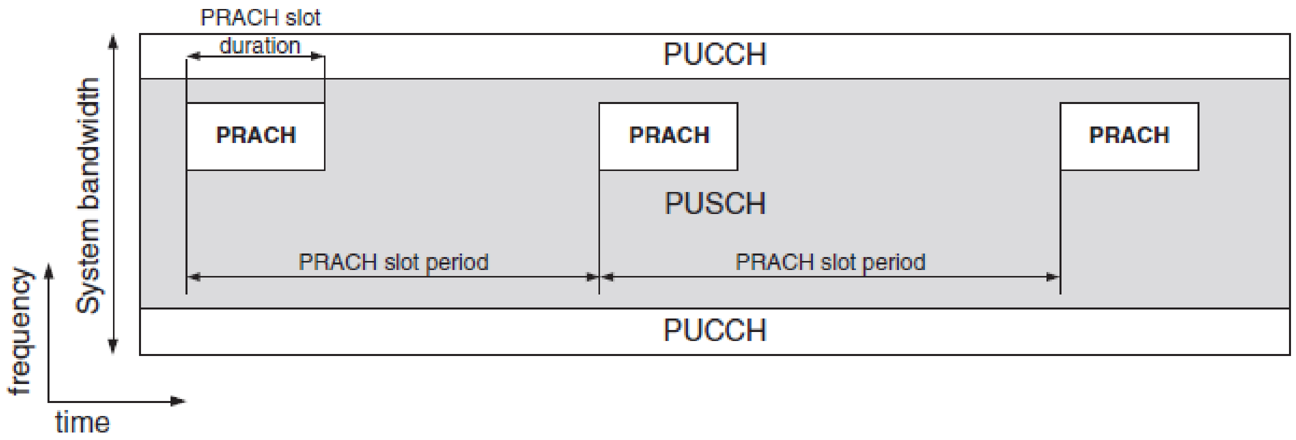
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



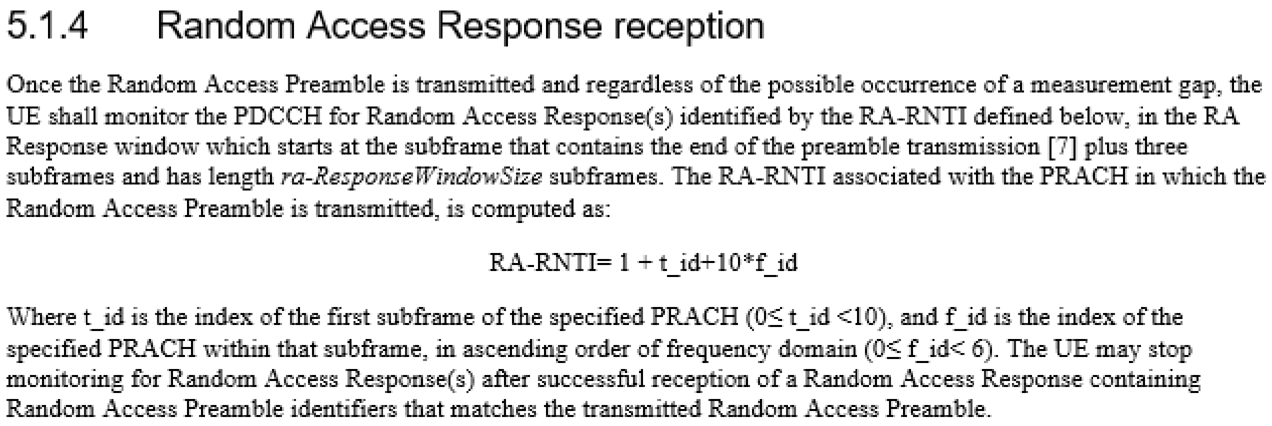
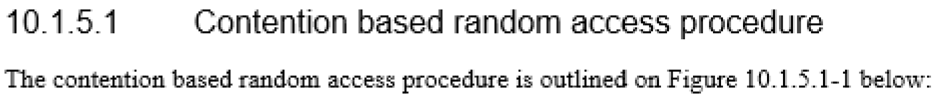
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

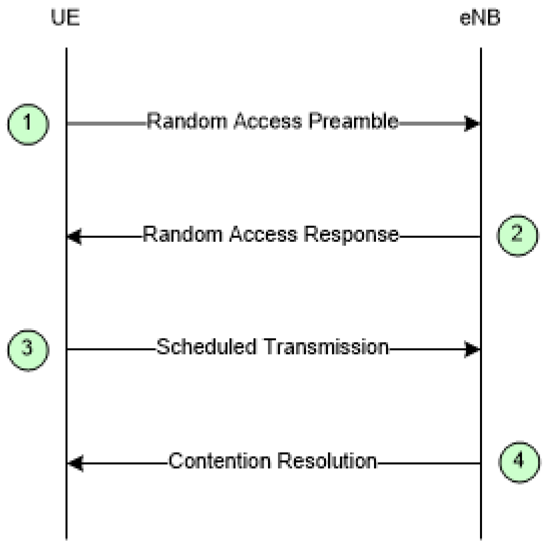
US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

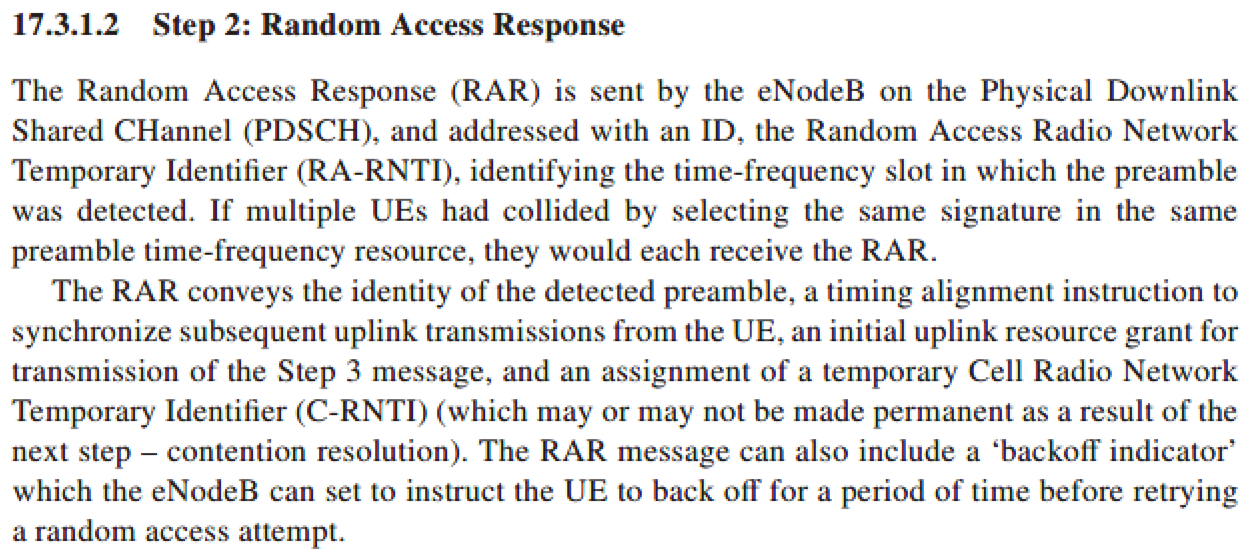
US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Toyota’s Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  **5.1.4 Random Access Response reception** Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **10.1.5.1 Contention based random access procedure** The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

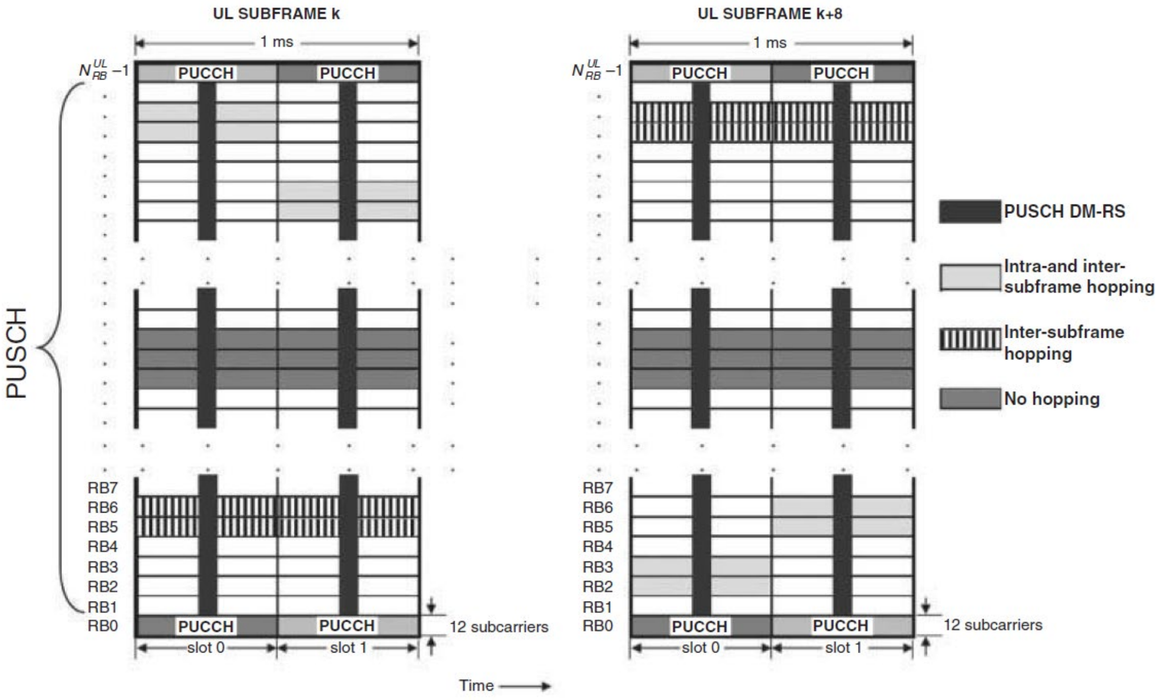
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 6
"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Toyota's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

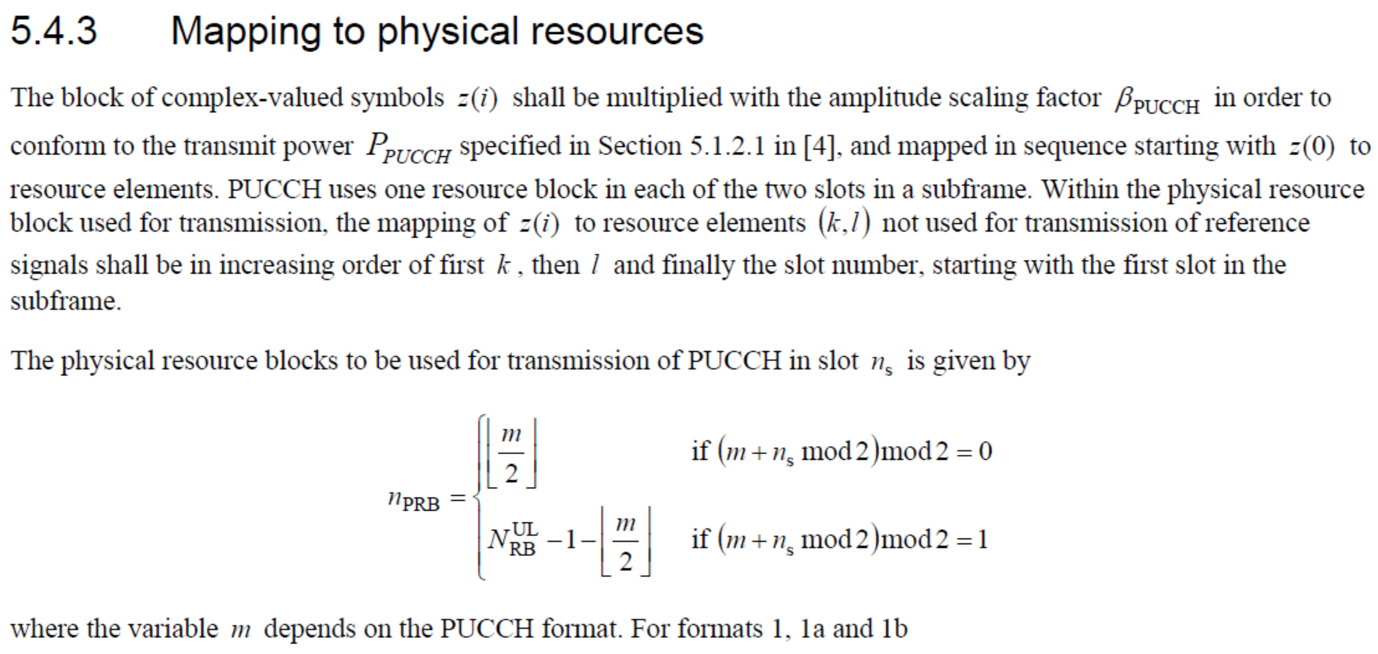
US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Toyota's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

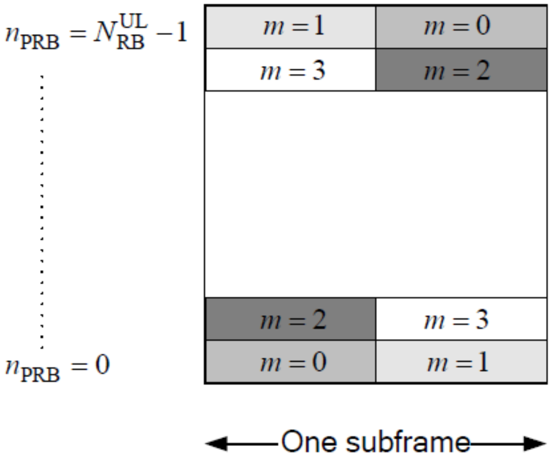


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 7

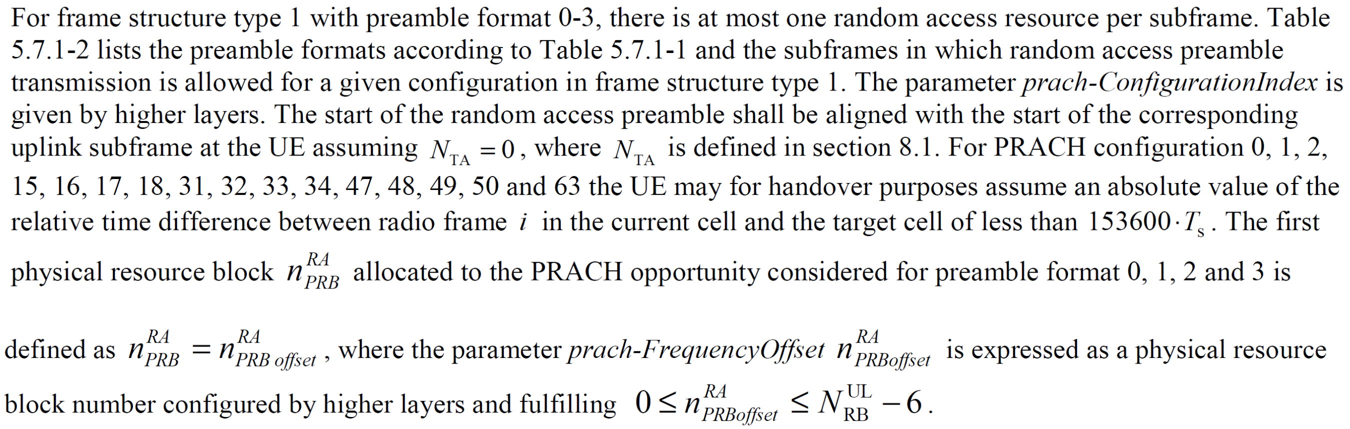
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

…

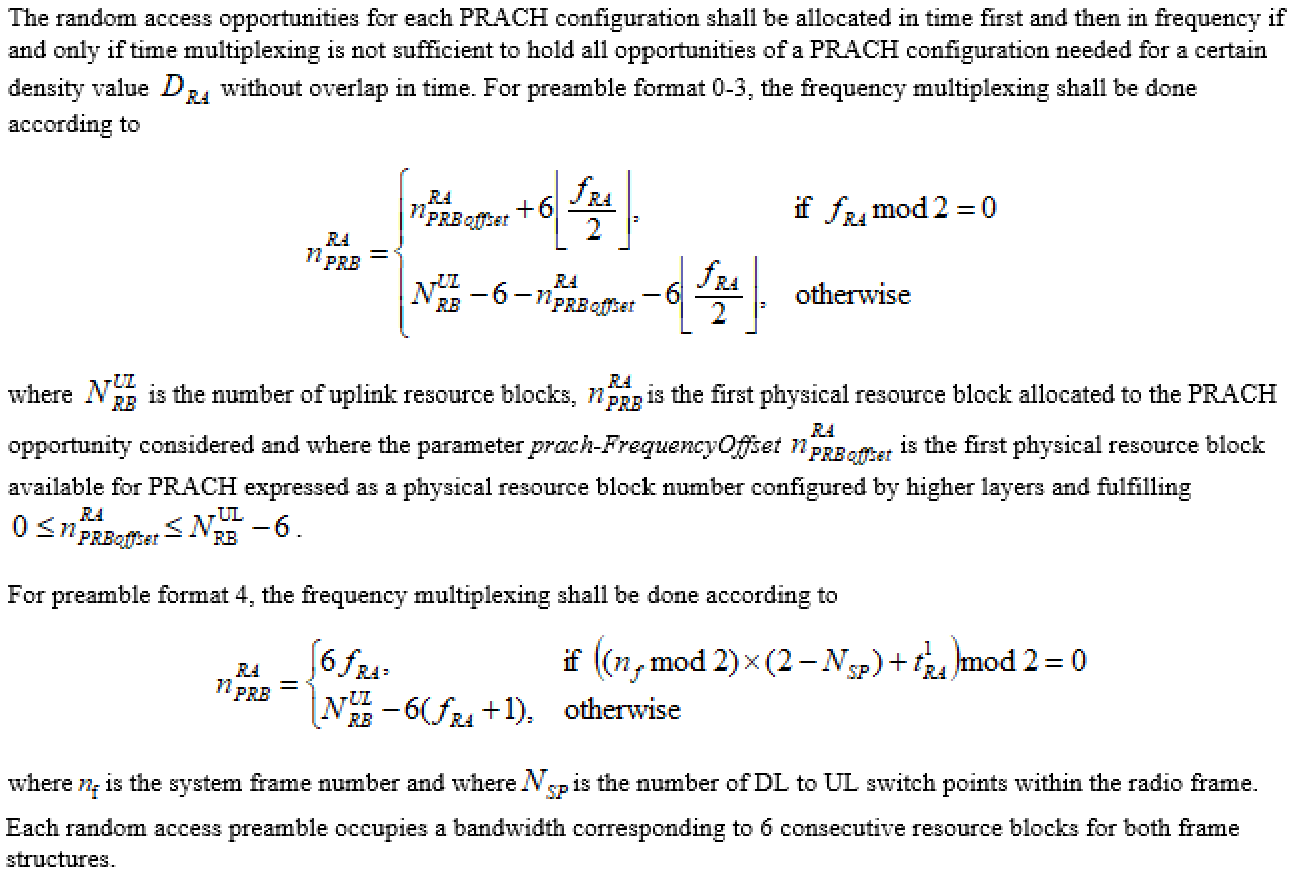


For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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.
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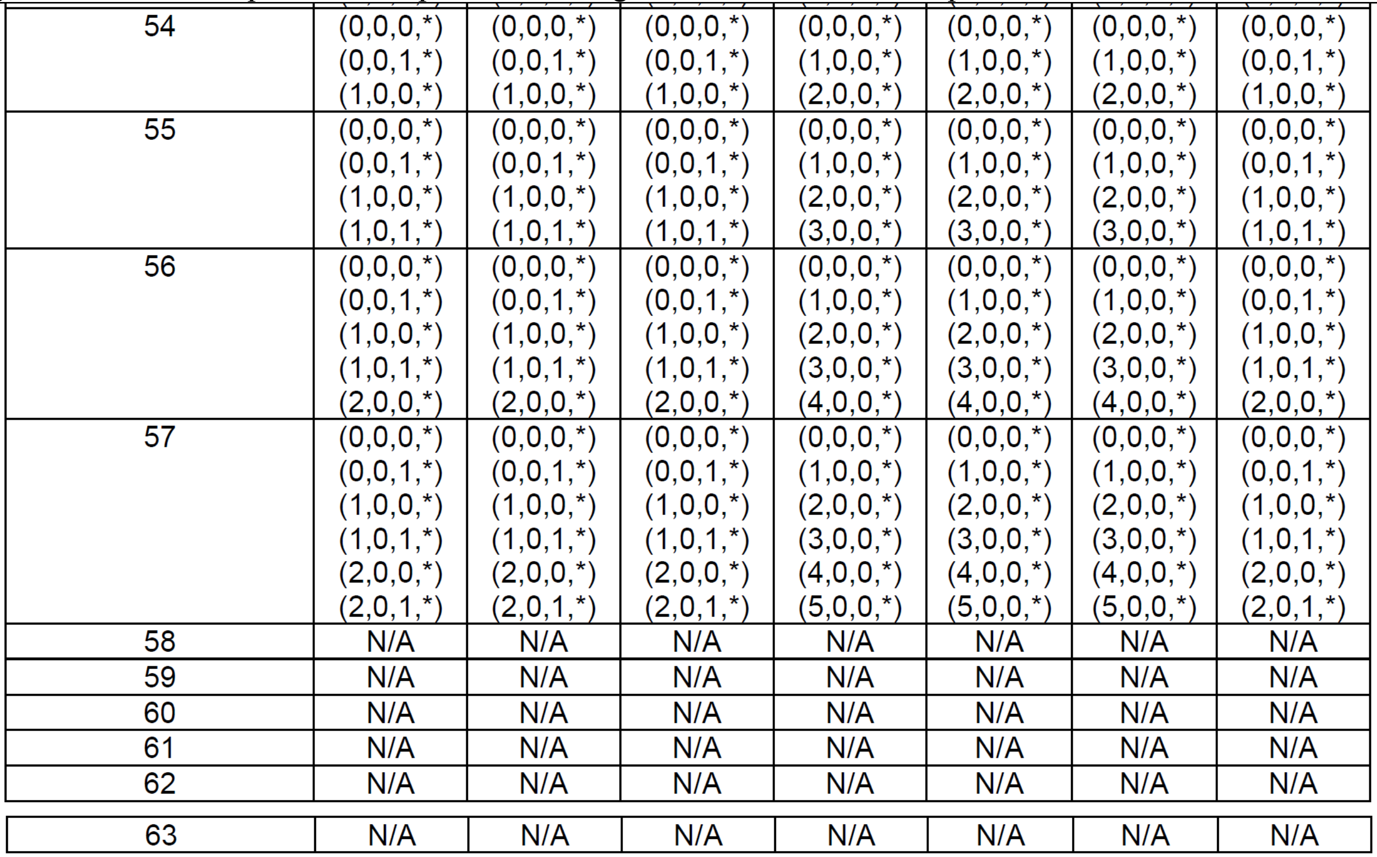
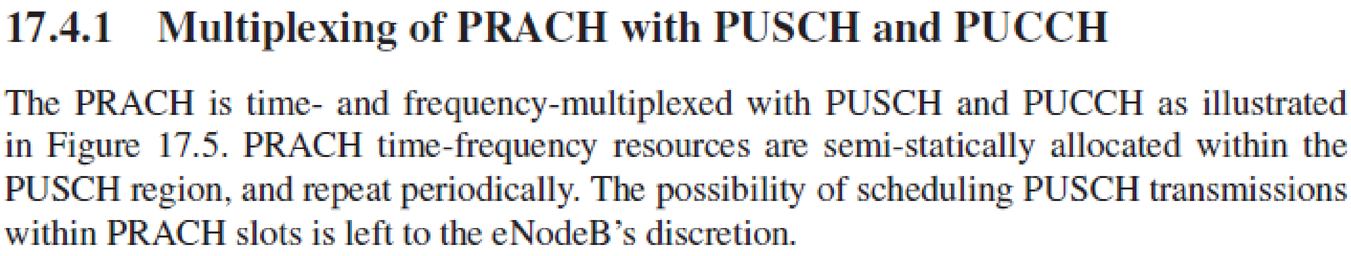
US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

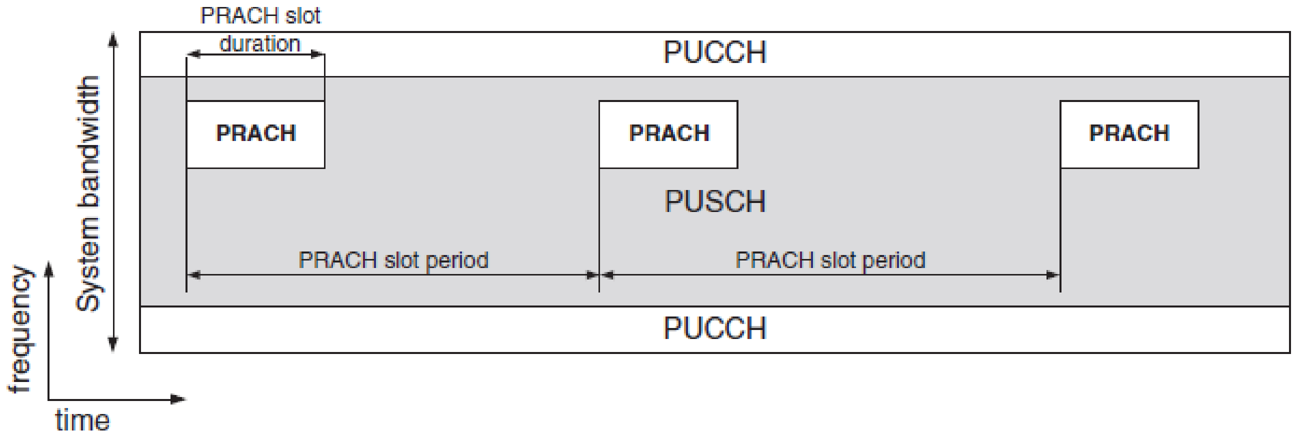
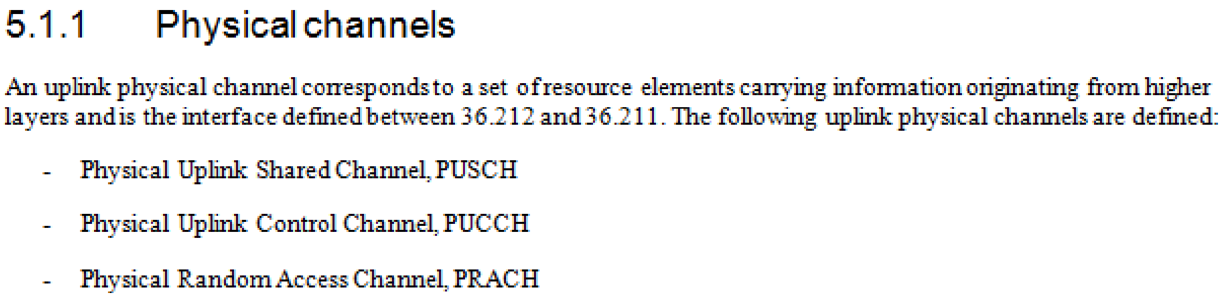


Figure 17.5: PRACH multiplexing with PUSCH and PUCCH.

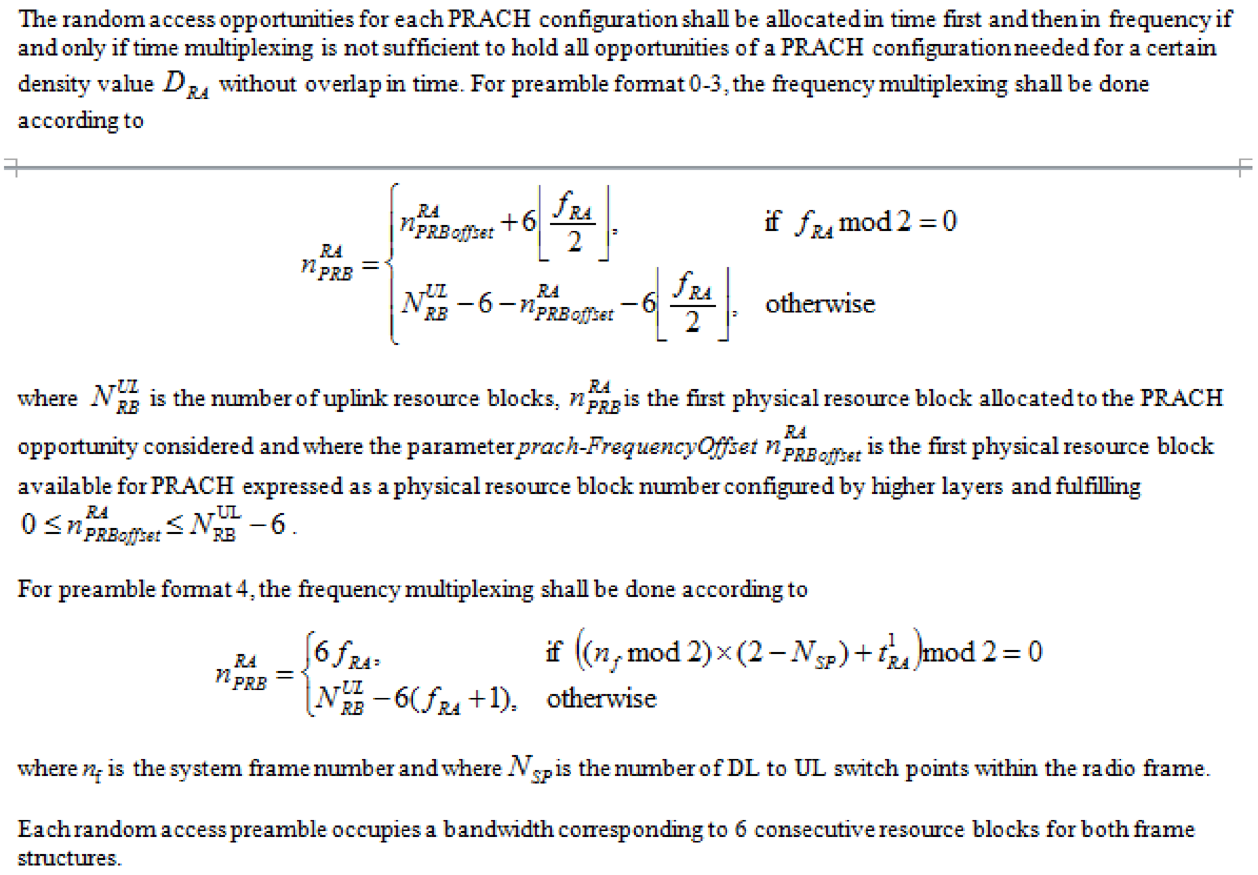
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

See also Claim 4.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Toyota’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1} \right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

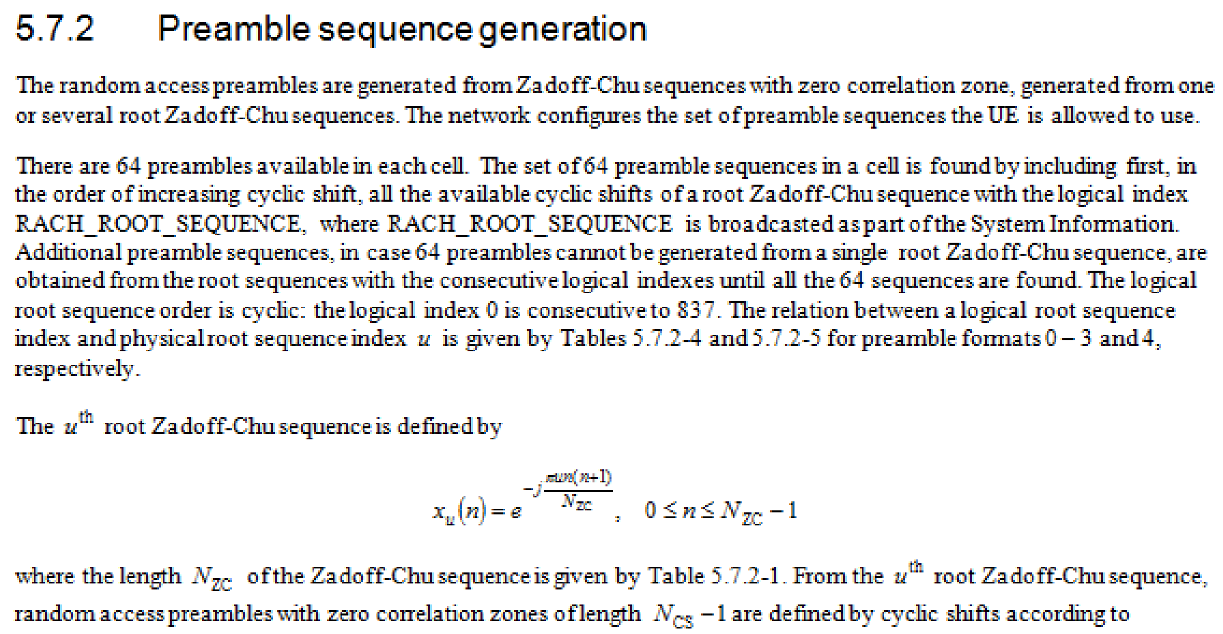
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

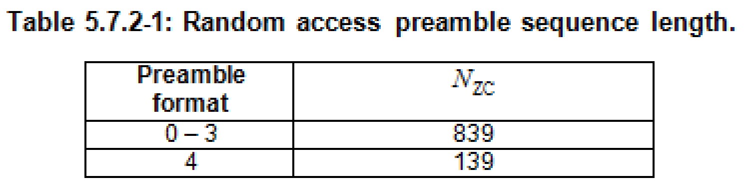
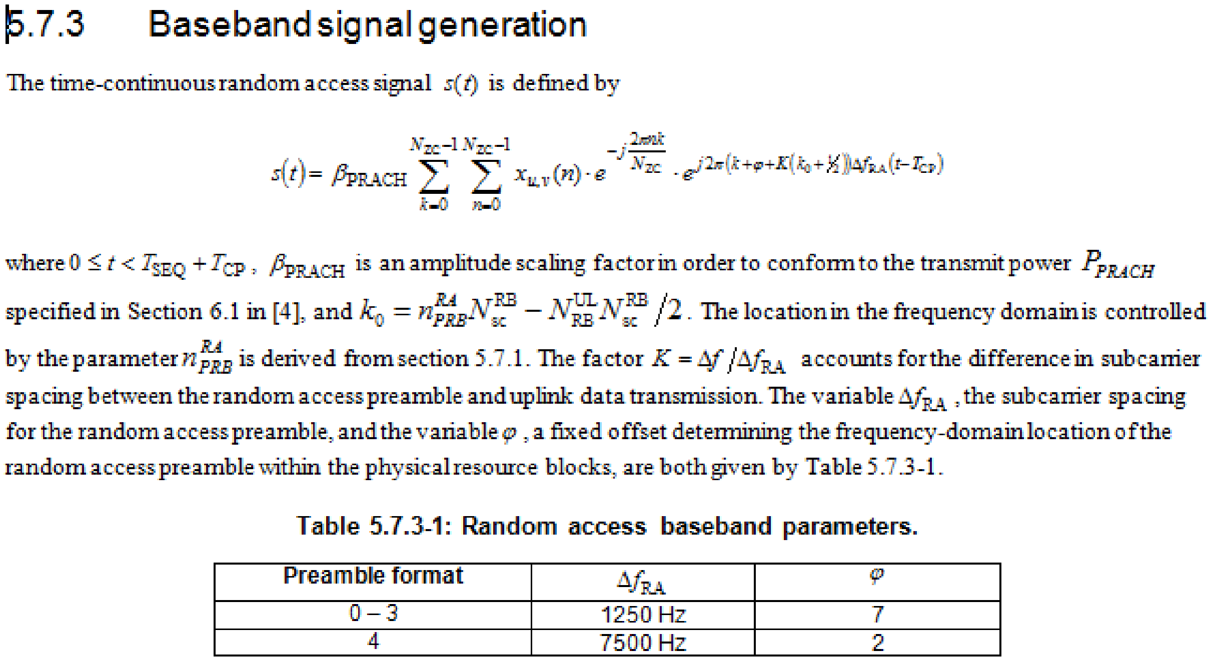


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

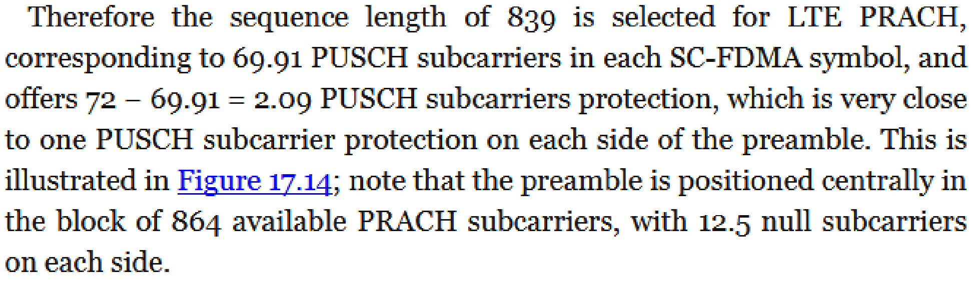
where $0 \le t < T_{\text{SEQ}} + T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\text{sc}}^{\text{RB}} - N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

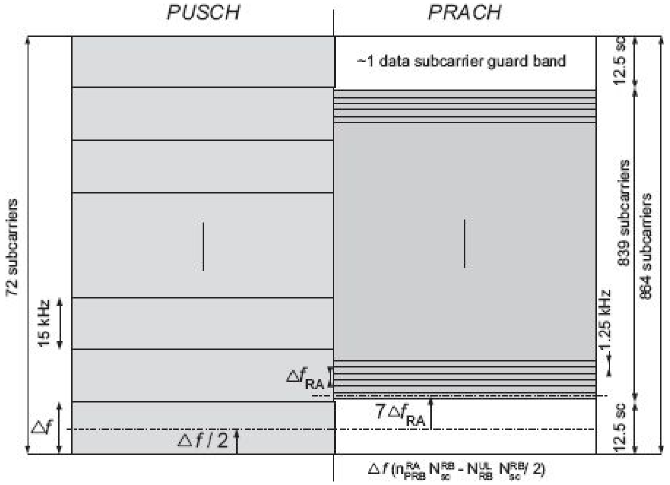
See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”



Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

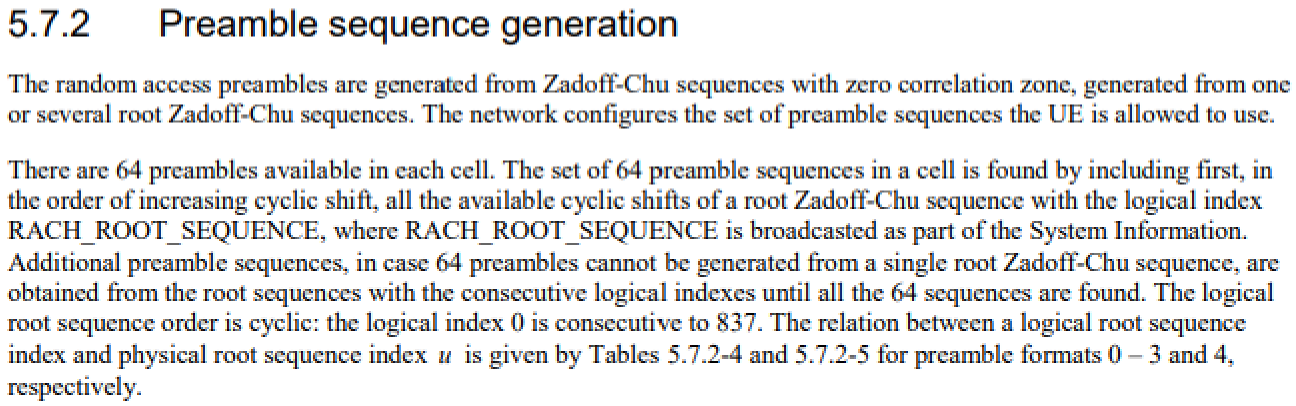
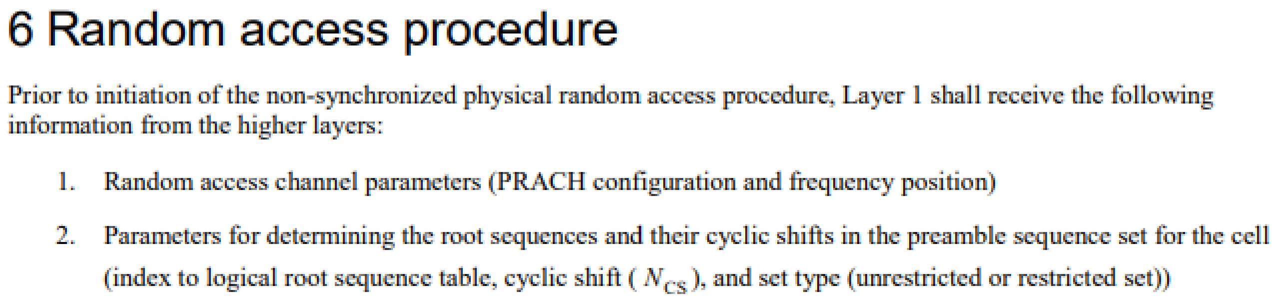
Figure 17.14: PRACH preamble mapping onto allocated subcarriers.



See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Toyota's Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

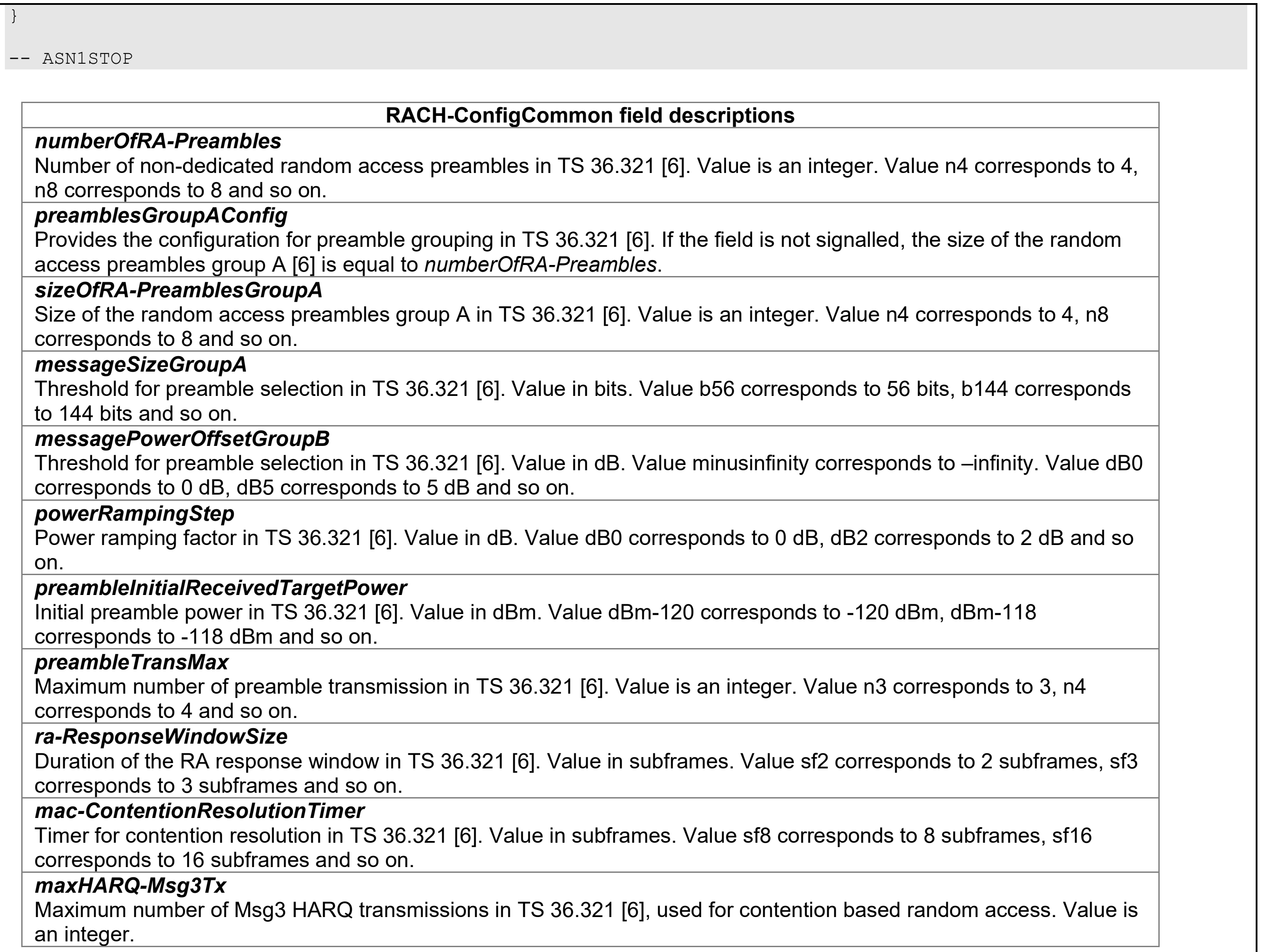
***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."



```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

US Patent No. 10,833,908: Claim 10

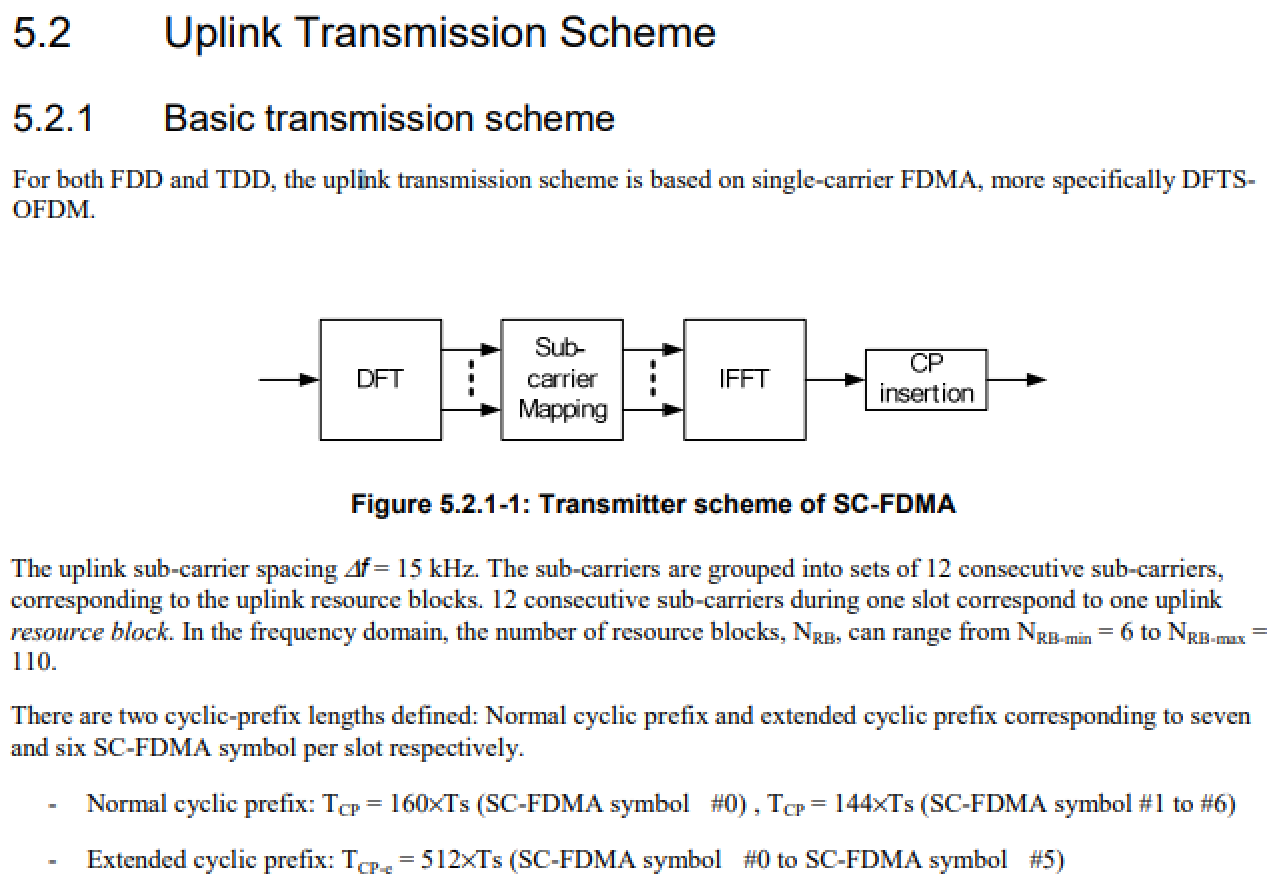
"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

<table>
<tr>
<td>10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.</td>
<td>

See Claim 1.

Toyota's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,*

Toyota's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:



5.2 Uplink Transmission Scheme

5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

</td>
</tr>
</table>

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

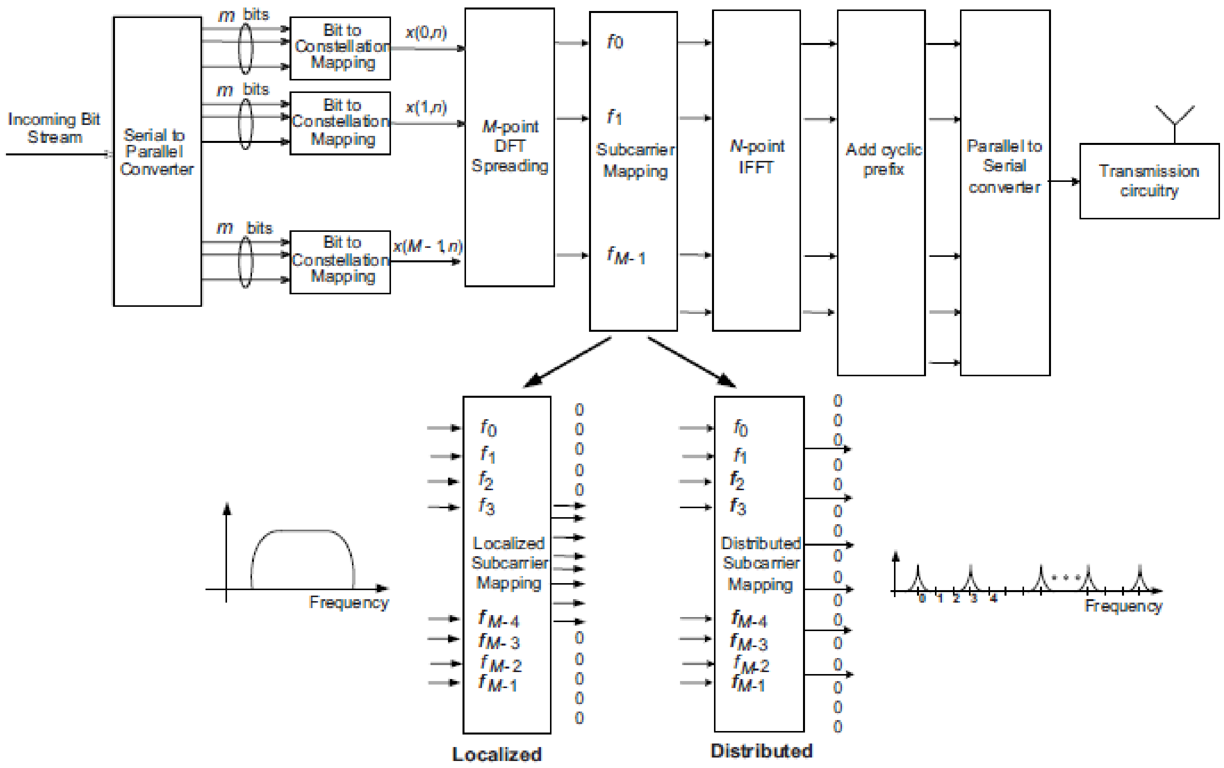
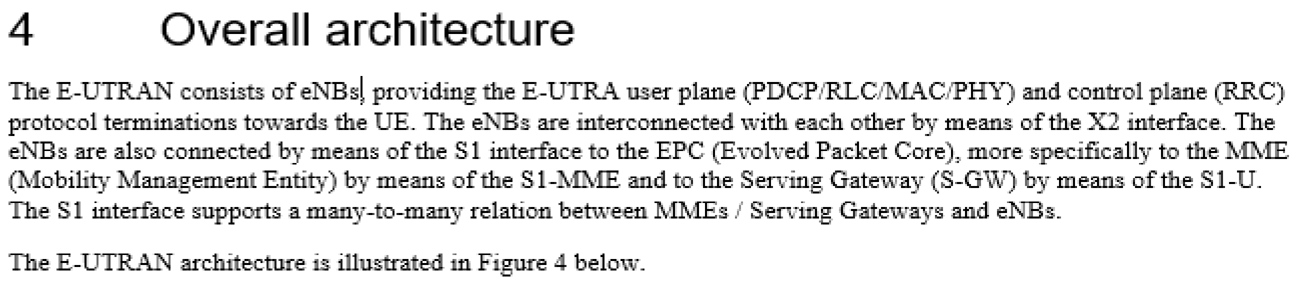


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, Toyota's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* Toyota's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Toyota offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

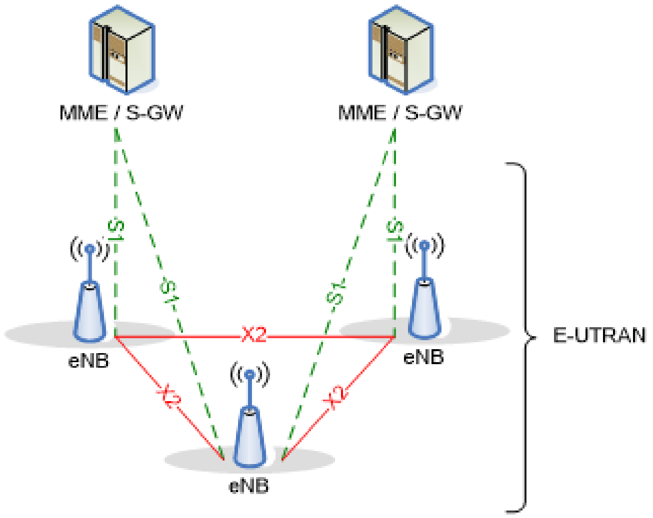


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

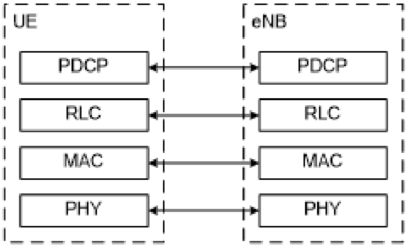


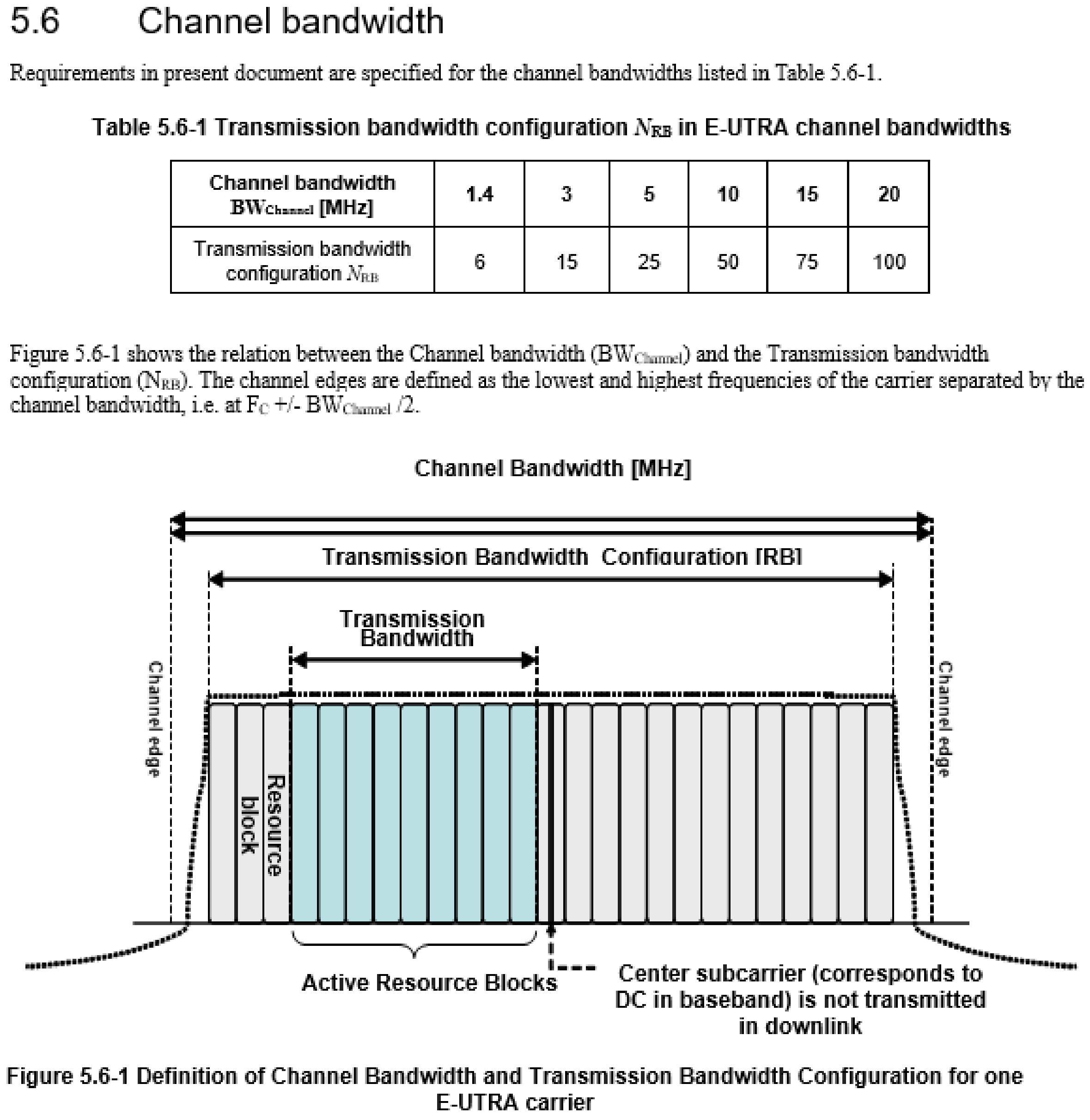
Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Toyota's Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

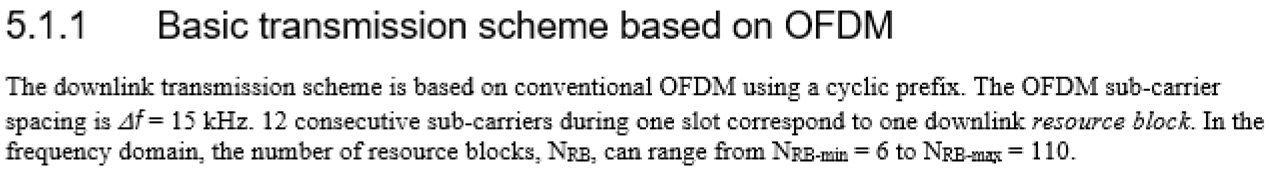
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

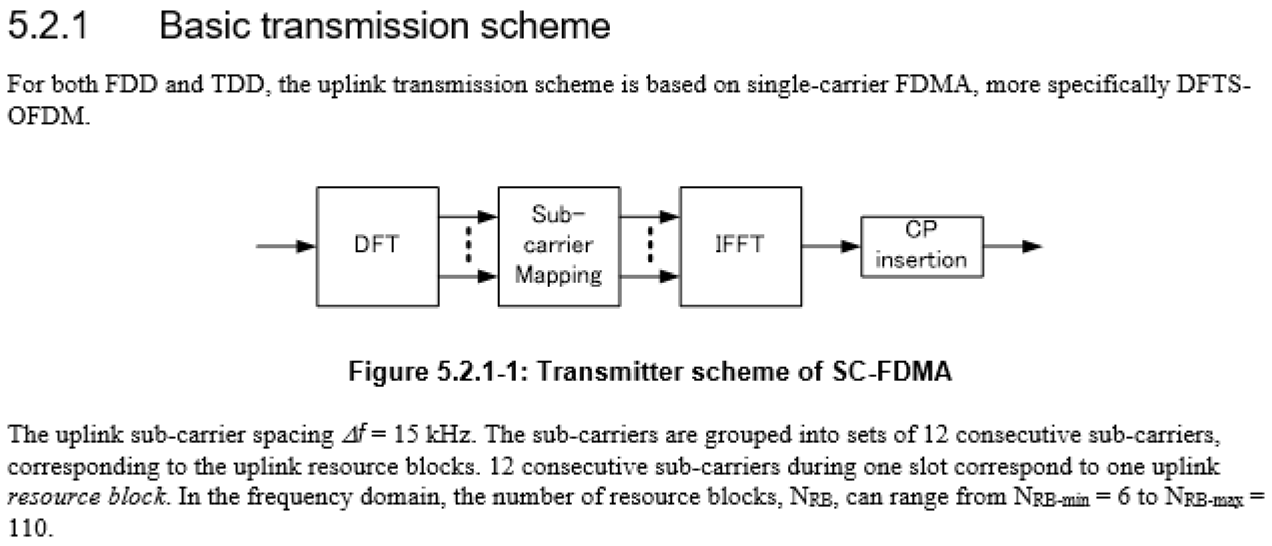
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

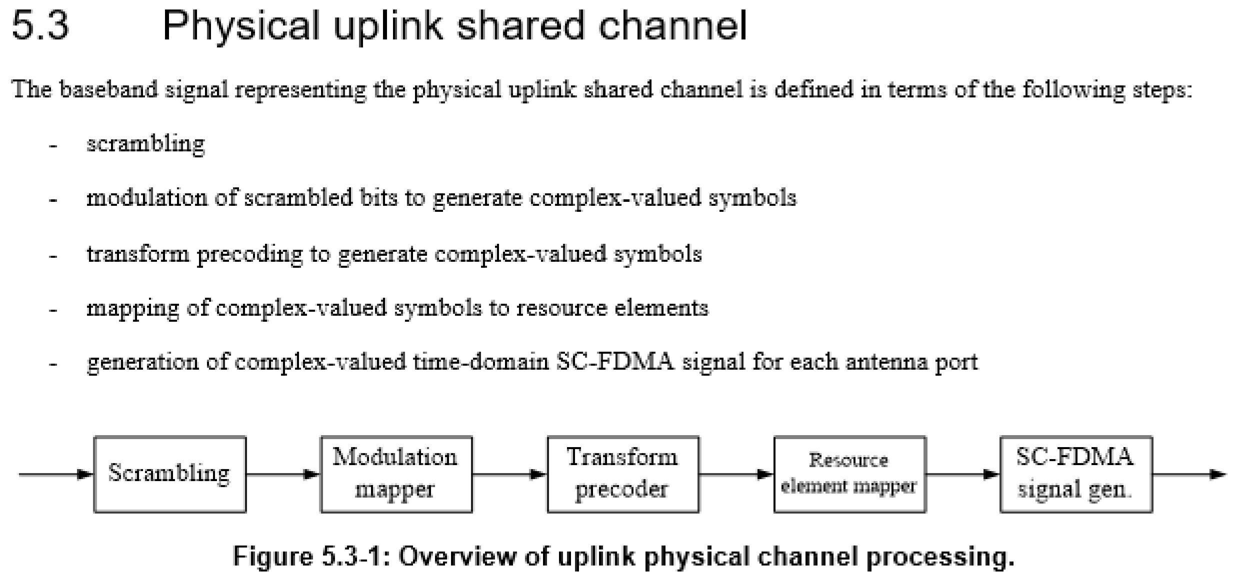
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

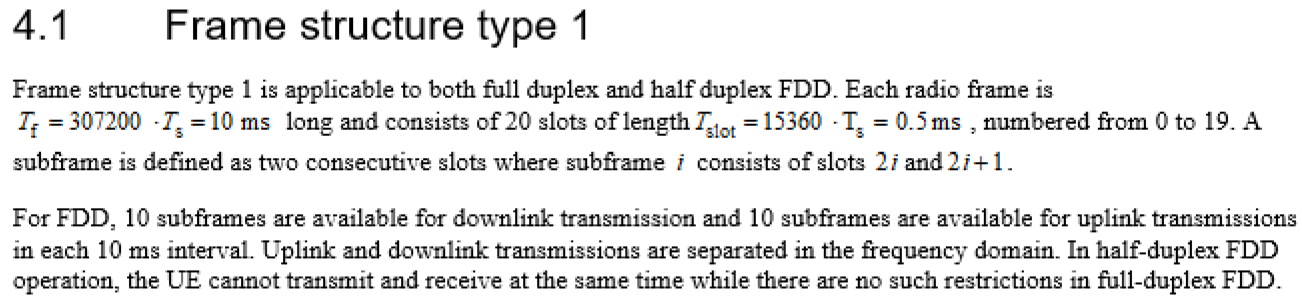
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\text{ ms}$ long and consists of 20 slots of length $T_{\text{slot}} = 15360 \cdot T_s = 0.5\text{ ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

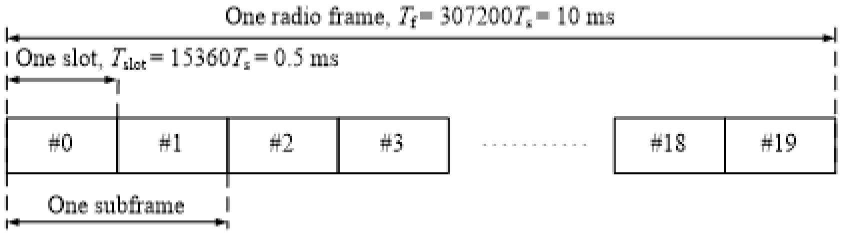
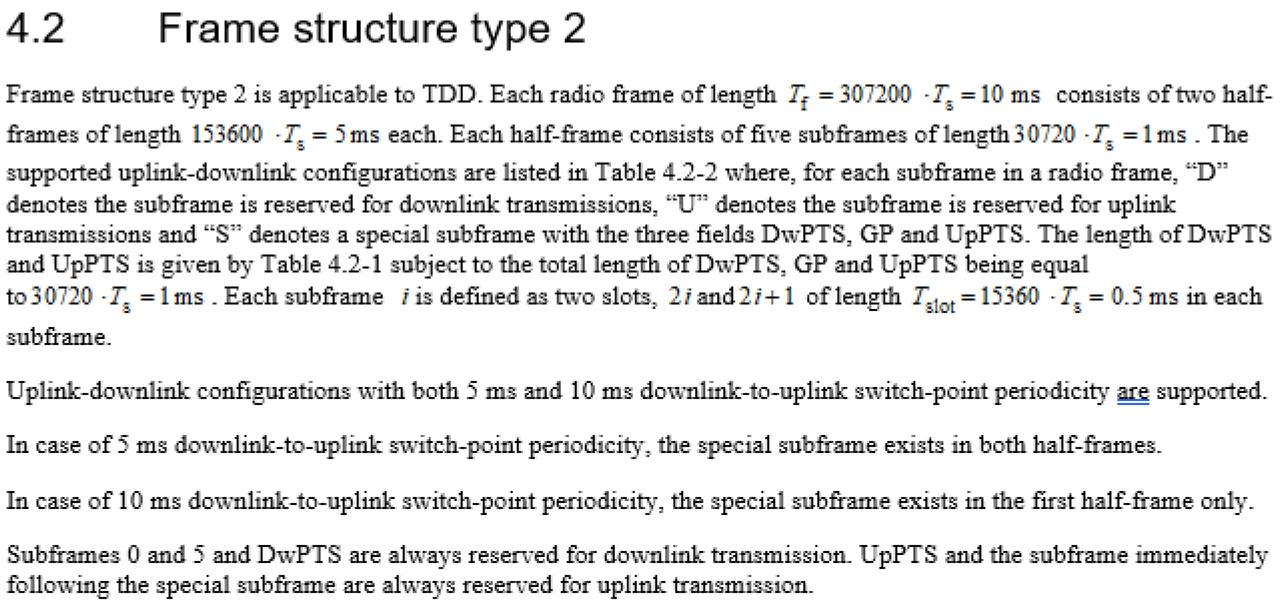


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_\mathrm{f} = 307200 \cdot T_\mathrm{s} = 10$ ms consists of two half-frames of length $153600 \cdot T_\mathrm{s} = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_\mathrm{s} = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_\mathrm{s} = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_\mathrm{slot} = 15360 \cdot T_\mathrm{s} = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

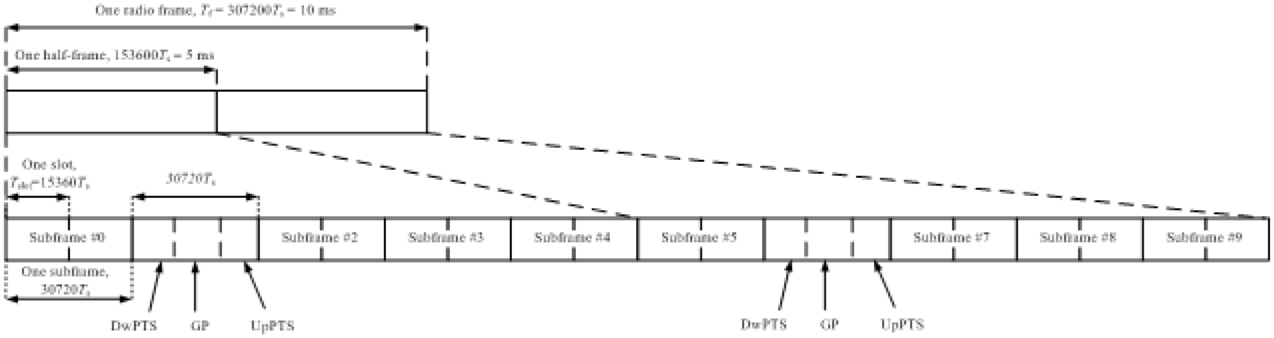


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).

5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\min,\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$$

where $N_{\mathrm{RB}}^{\min,\mathrm{UL}} = 6$ and $N_{\mathrm{RB}}^{\max,\mathrm{UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

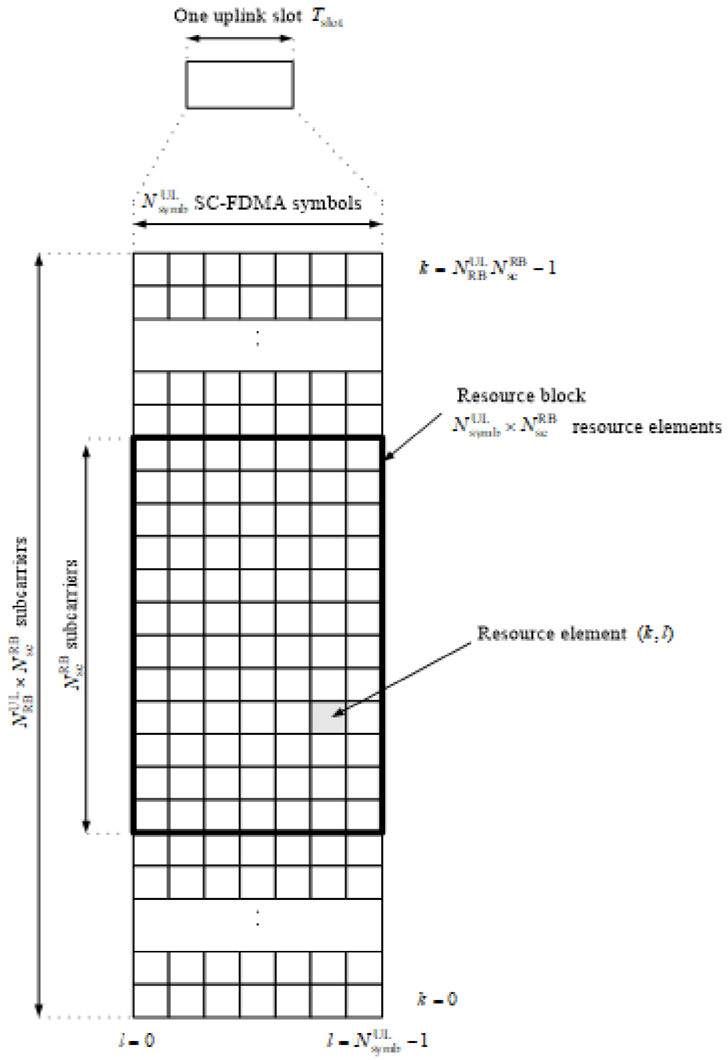
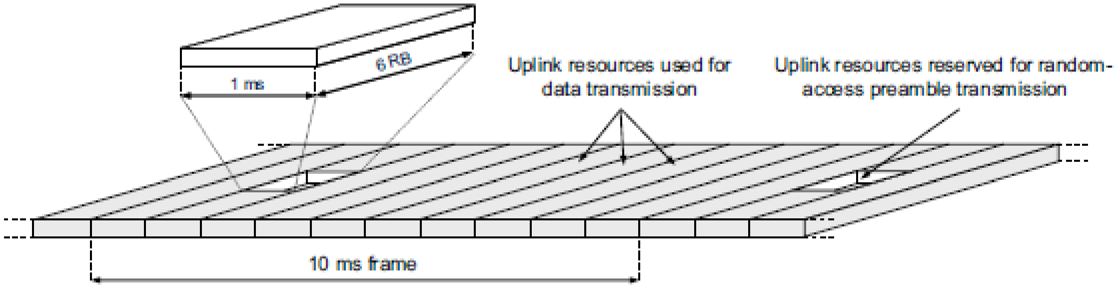


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 11(b)

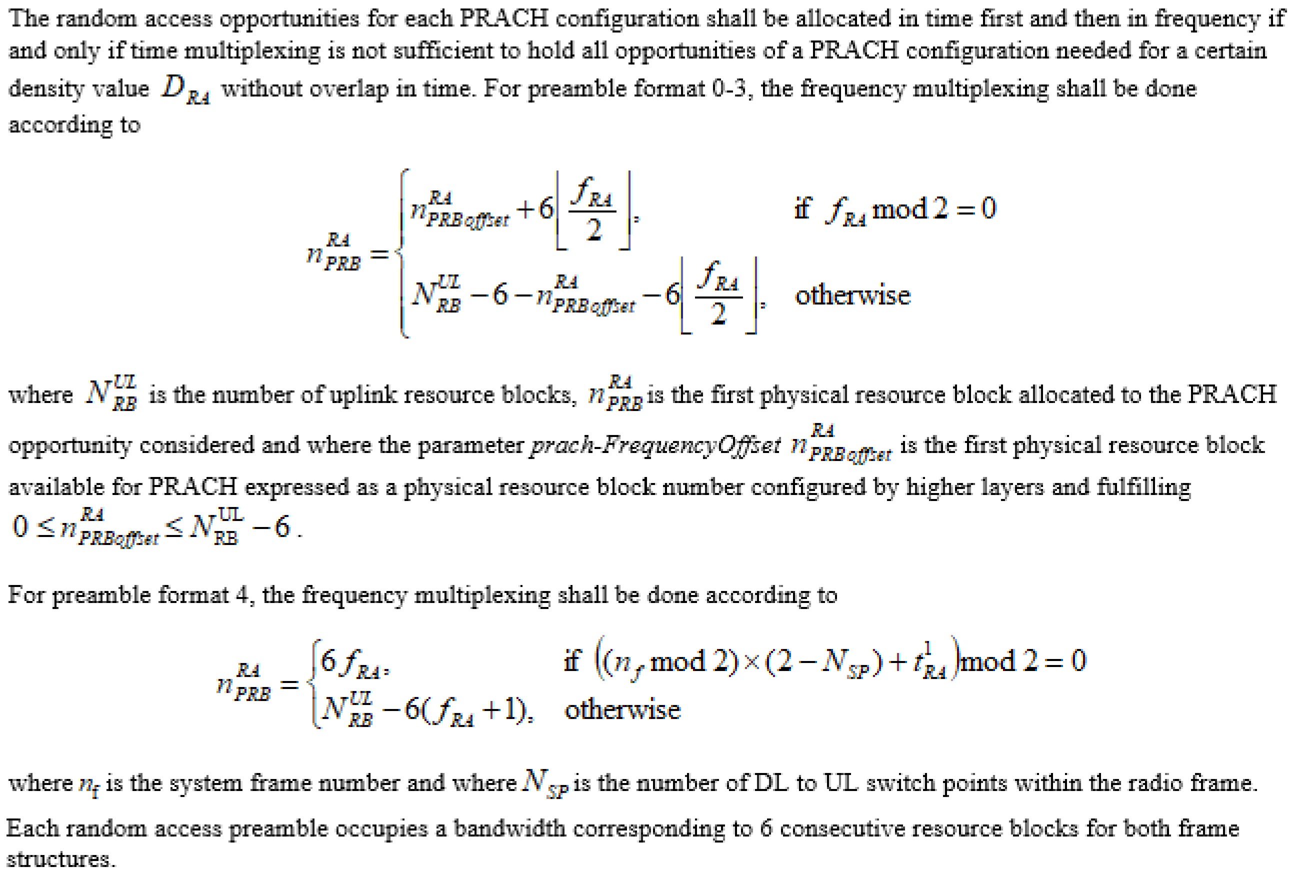
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	Toyota’s Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

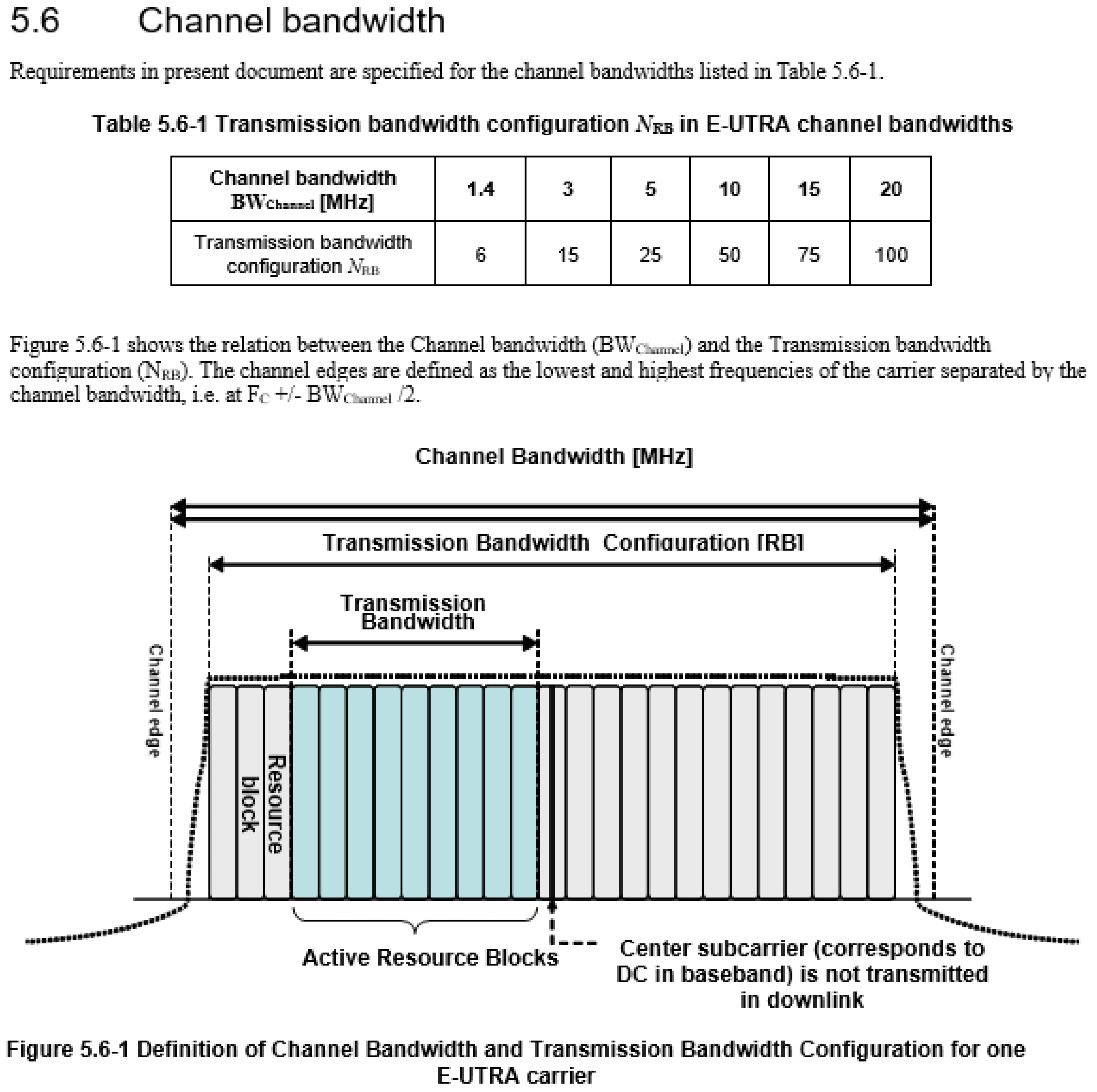
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

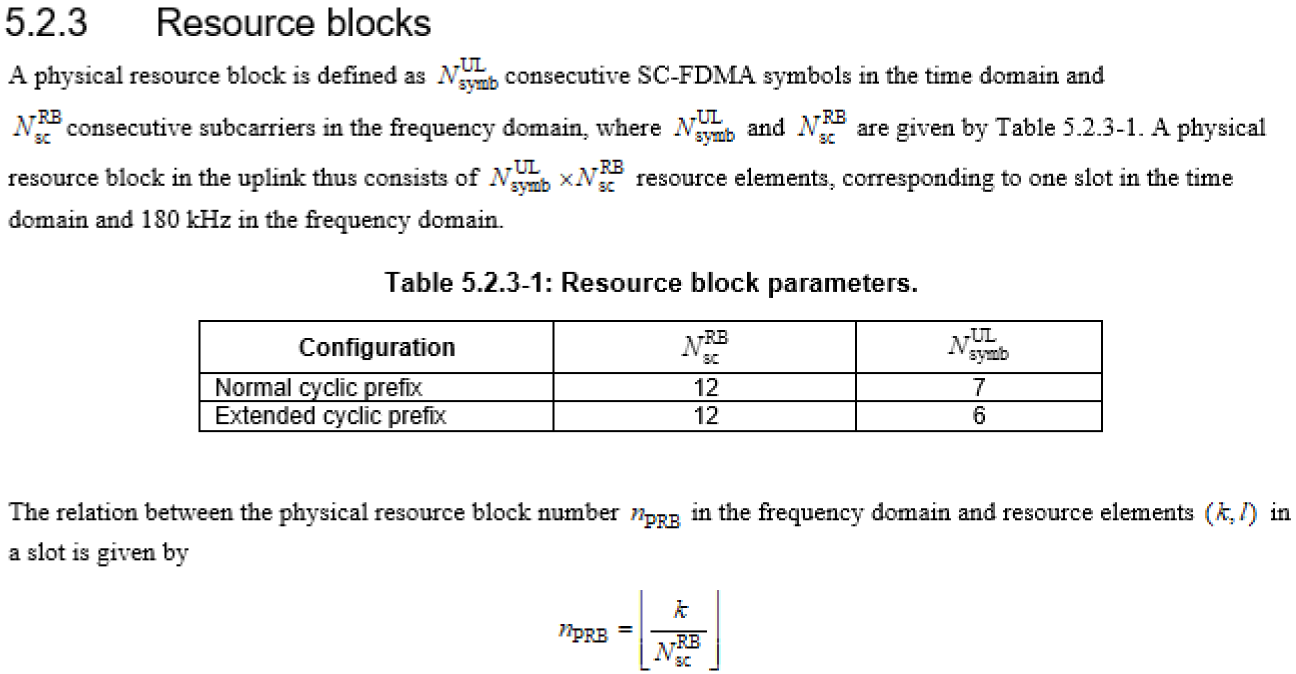
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

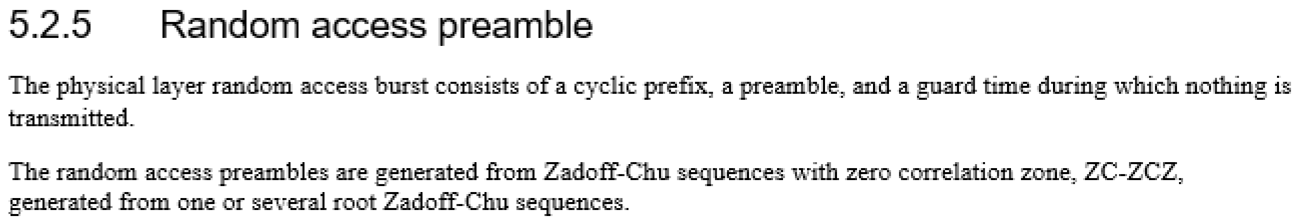
Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\mathrm{PRB}} = \left\lfloor \frac{k}{N_{\mathrm{sc}}^{\mathrm{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

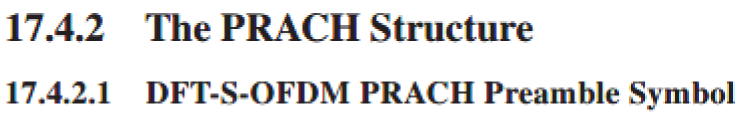


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

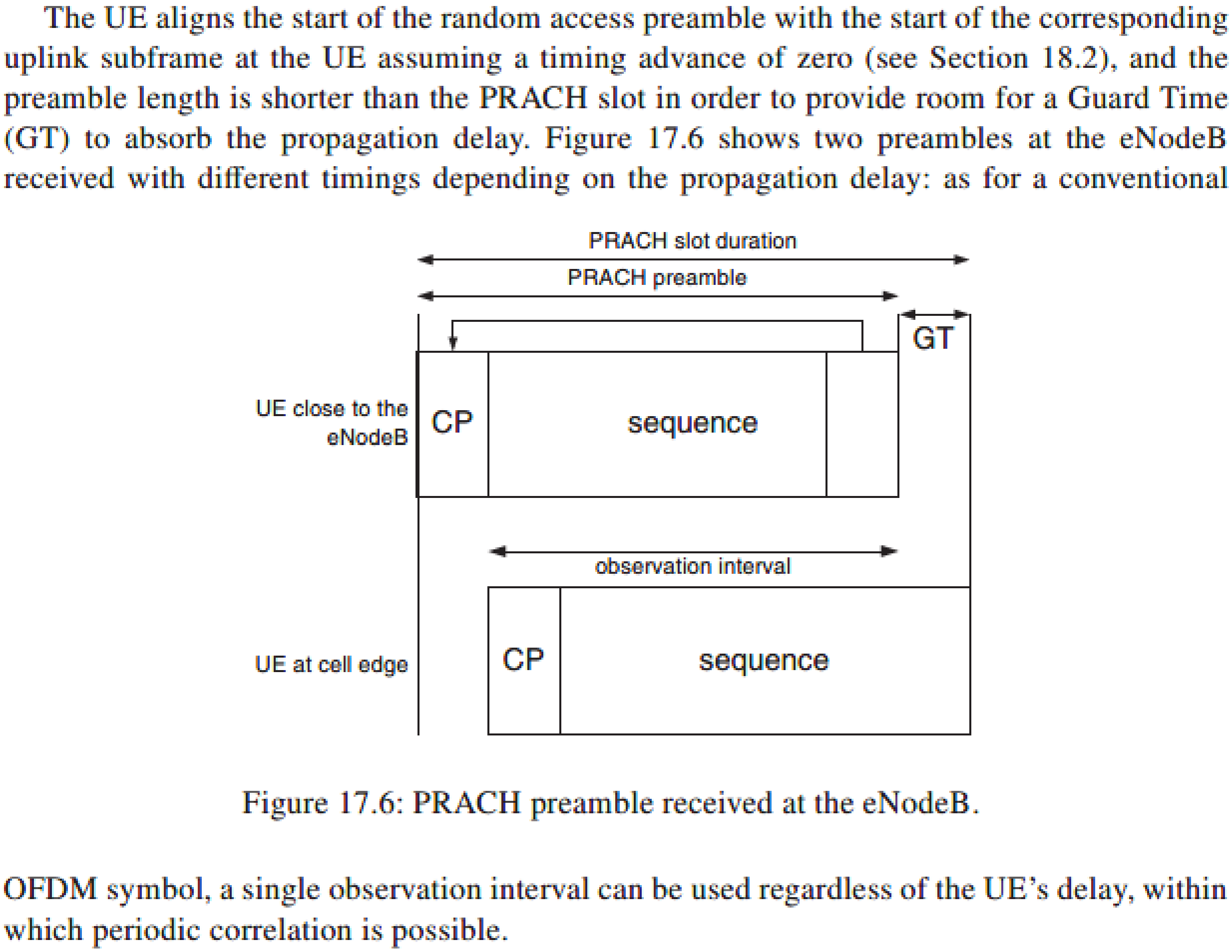


17.4.2 The PRACH Structure

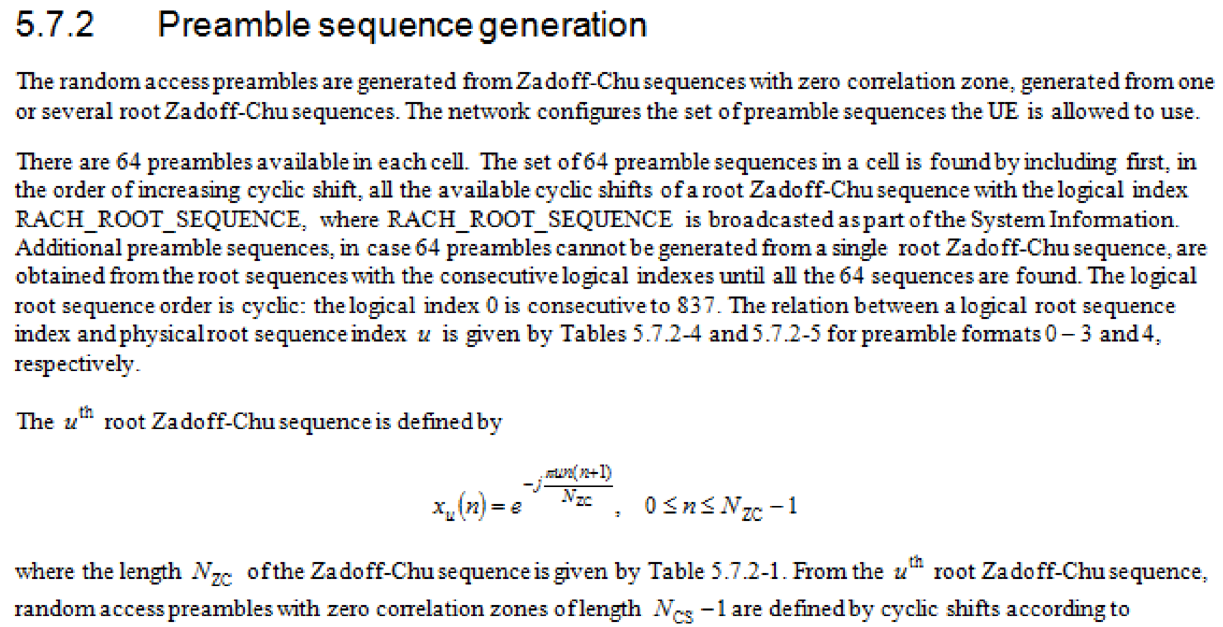
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE's delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

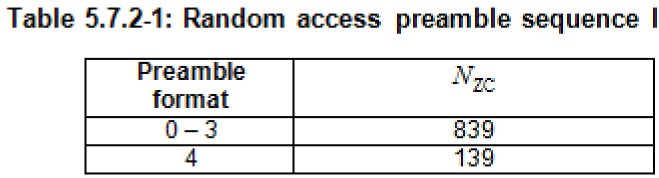
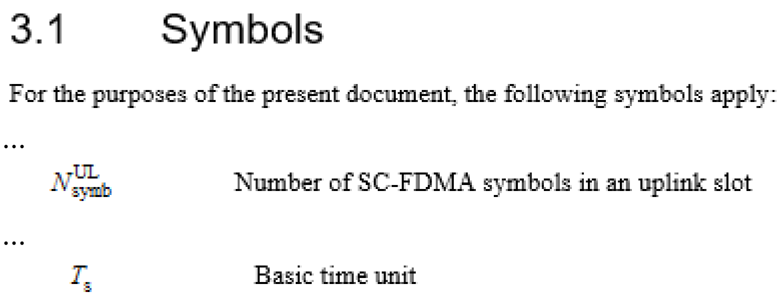
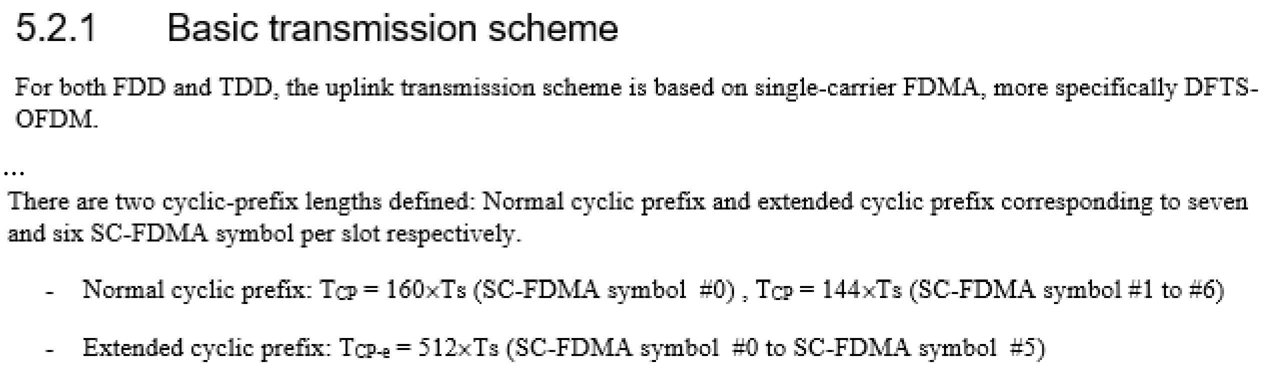


Table 5.7.2-1: Random access preamble sequence length.

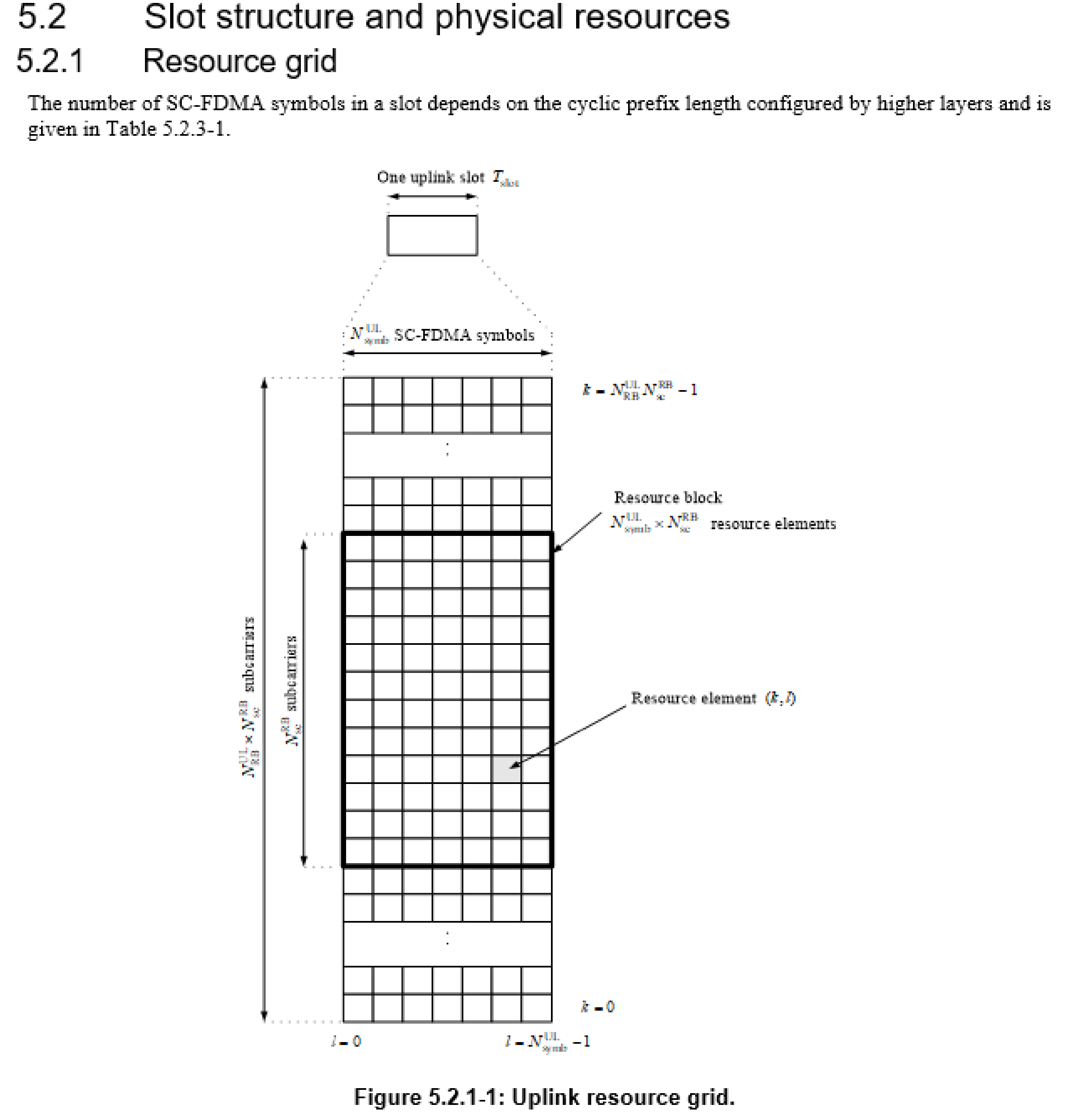
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Toyota's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”



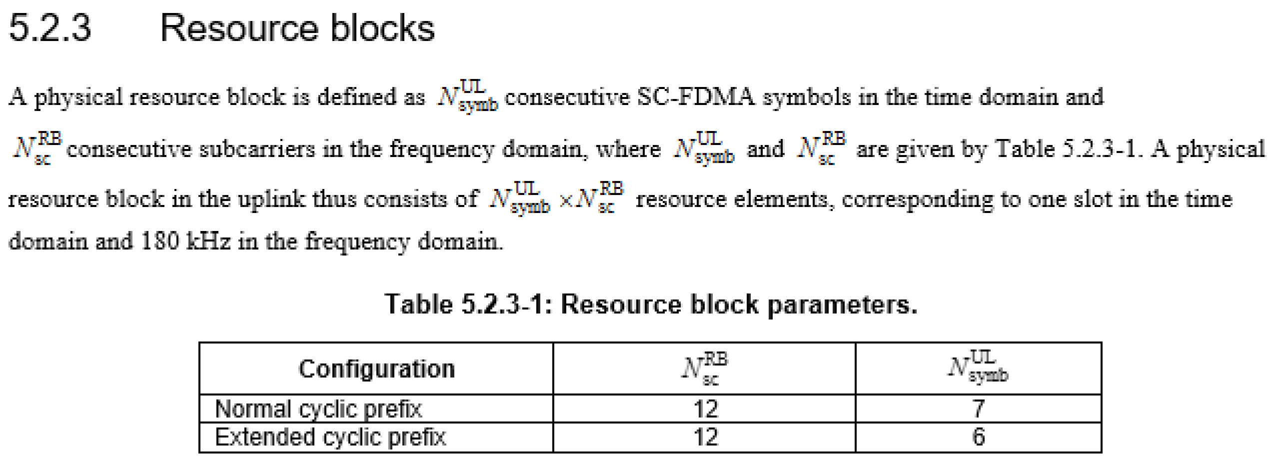
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

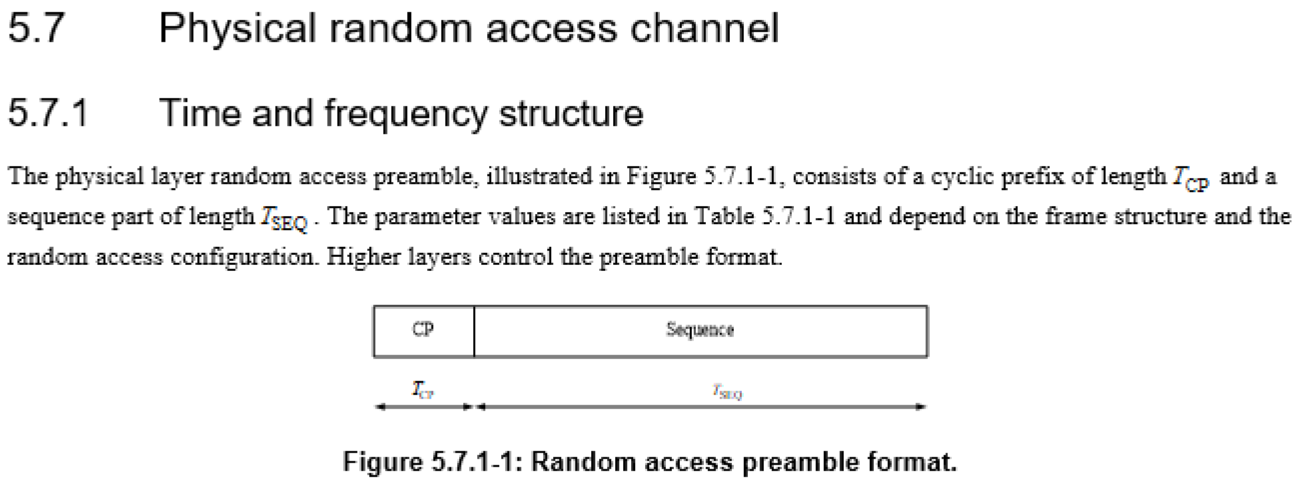
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

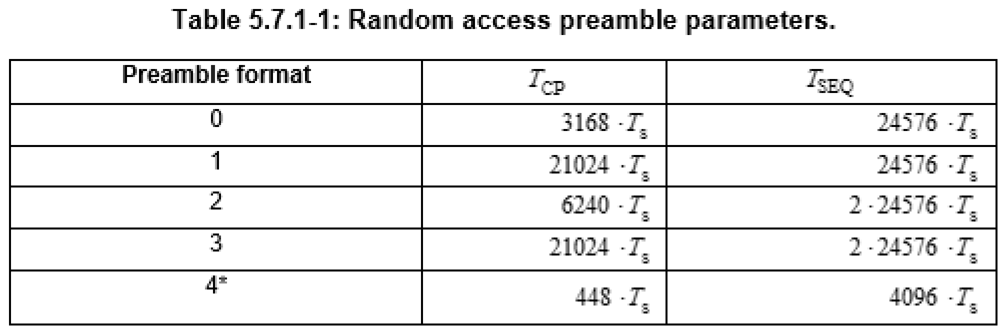
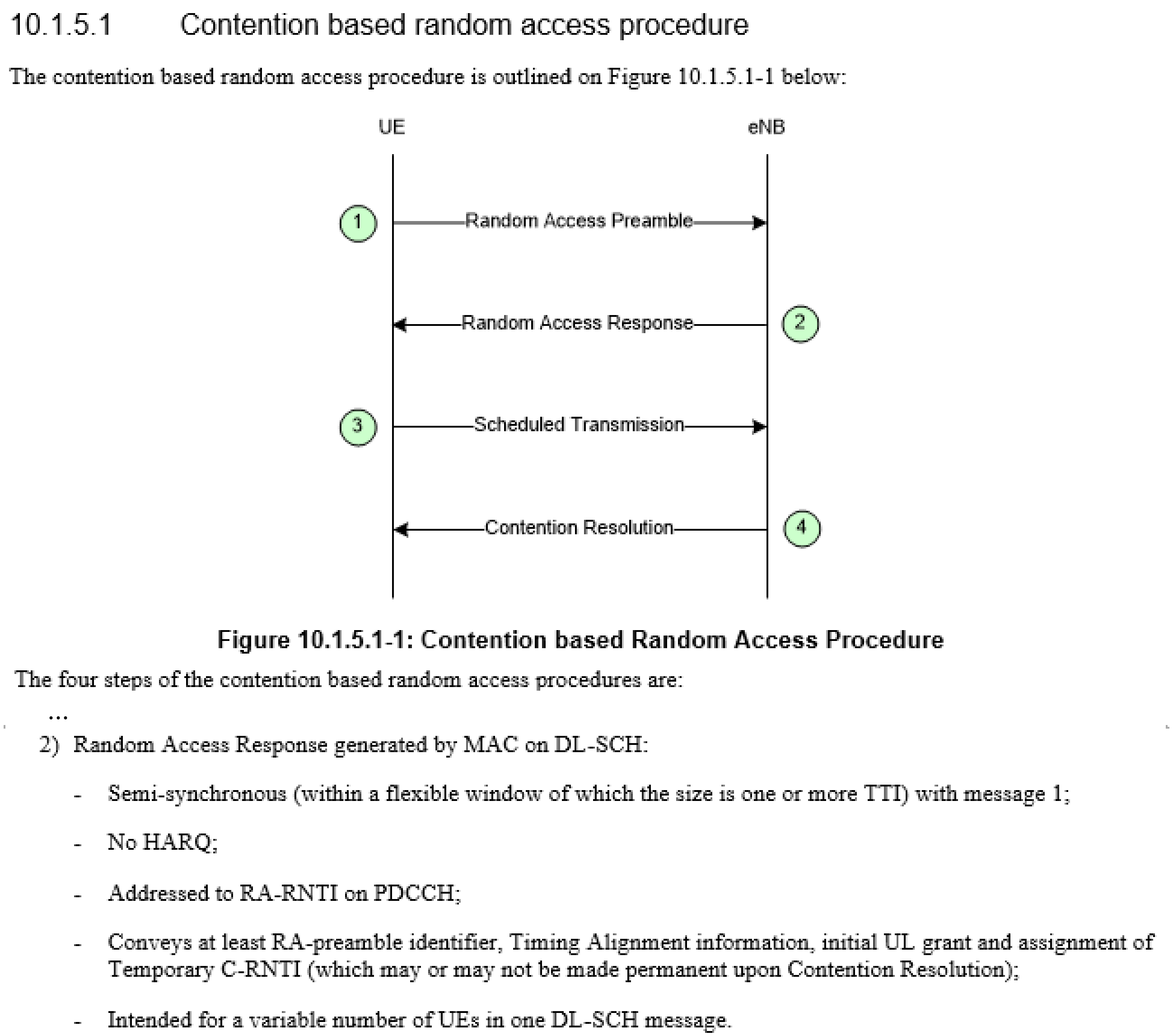


Table 5.7.1-1: Random access preamble parameters.

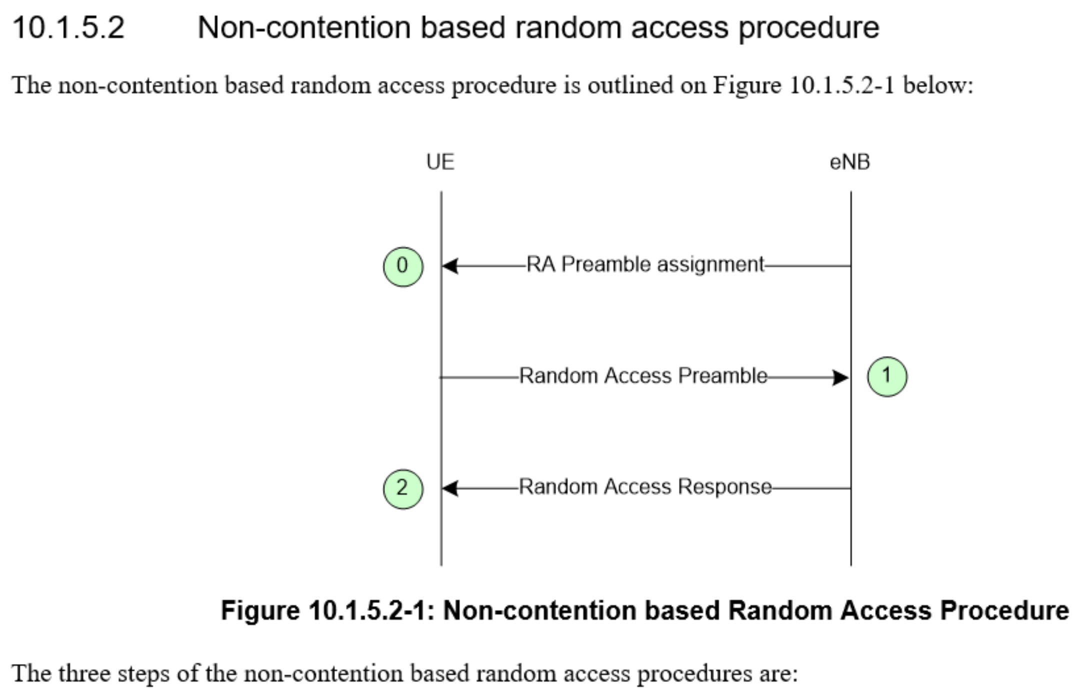
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

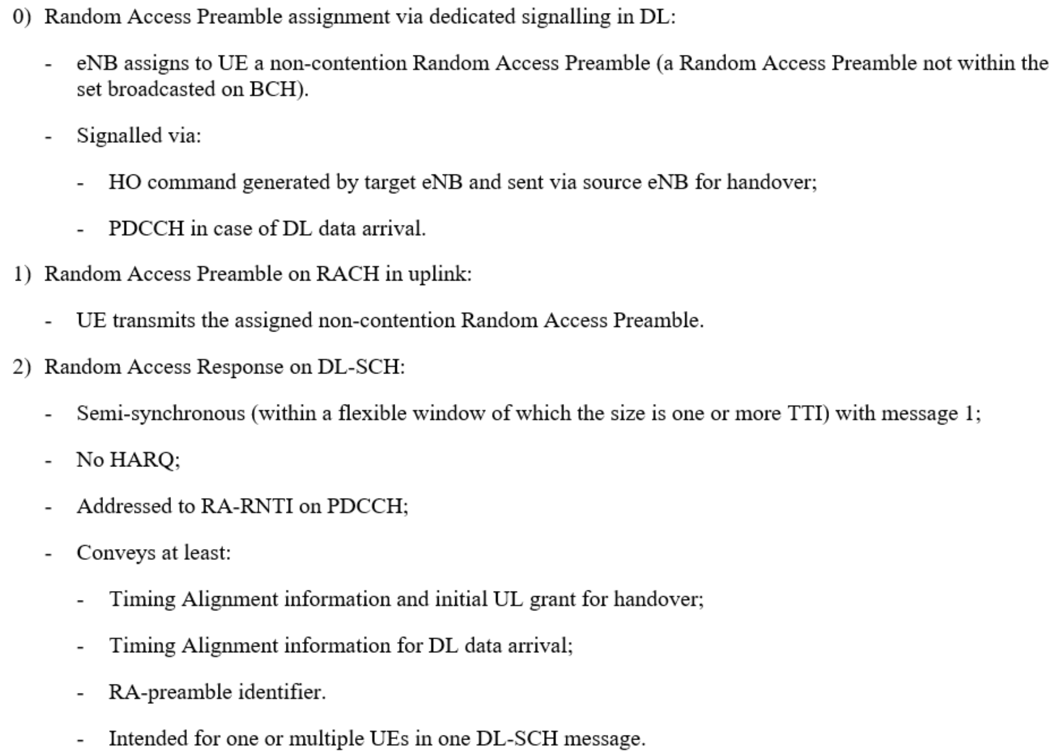
US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

receiving, from the base station, a response message. ;	Toyota's Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

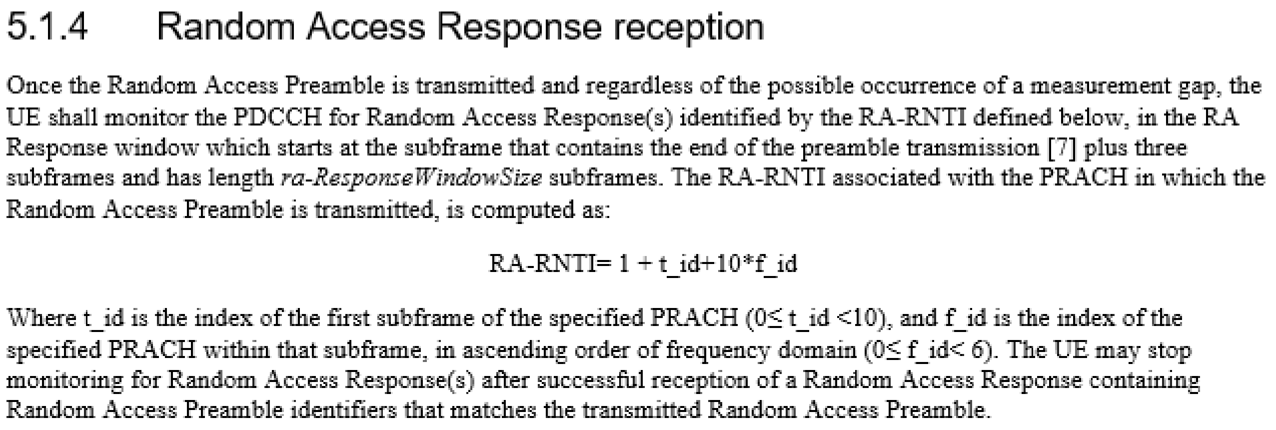
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

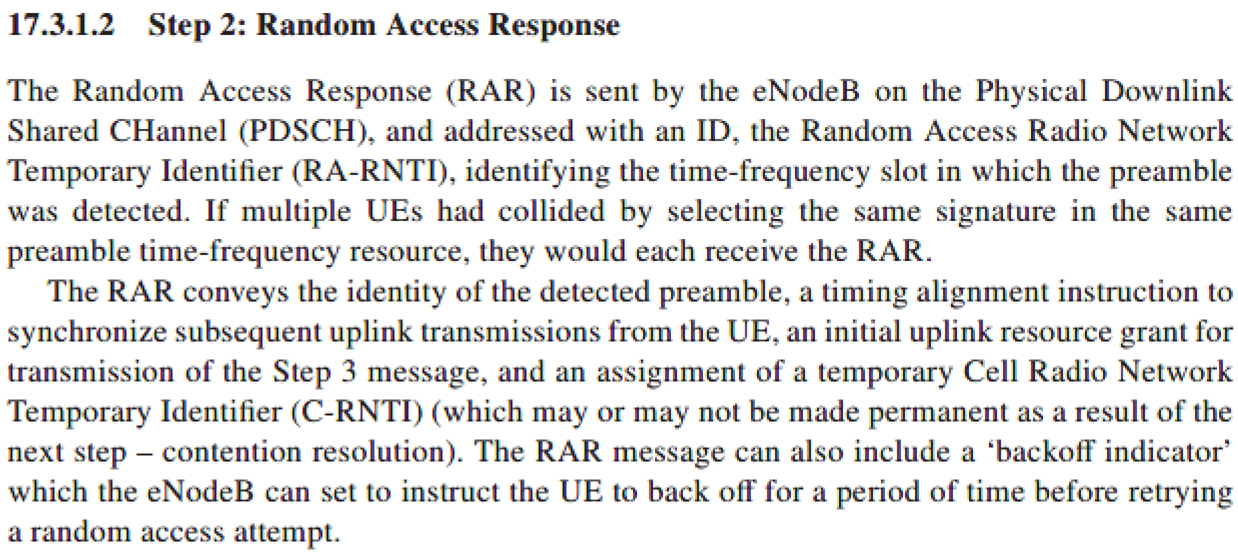
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”



17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

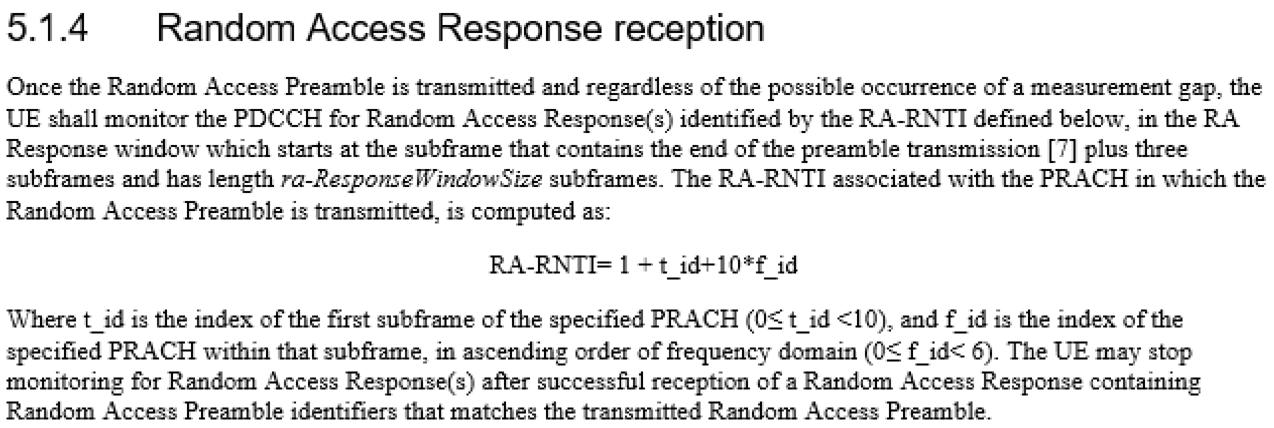
The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

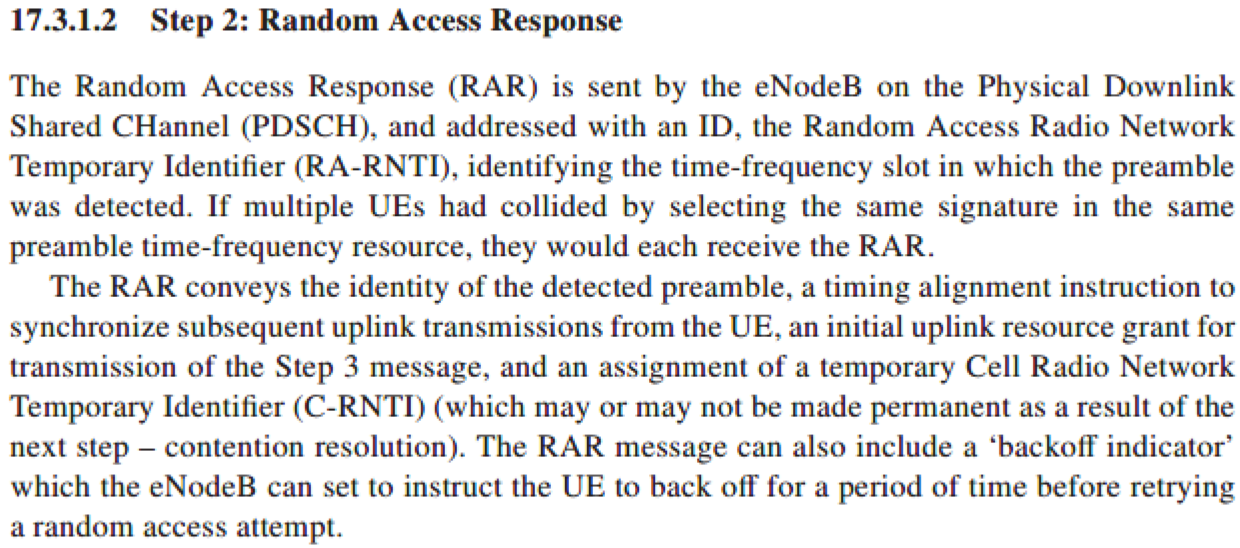
US Patent No. 10,833,908: Claim 12(a)
“The method claim 11, further comprising:”

12. The method claim 11, further comprising:	*See* Claim 11.

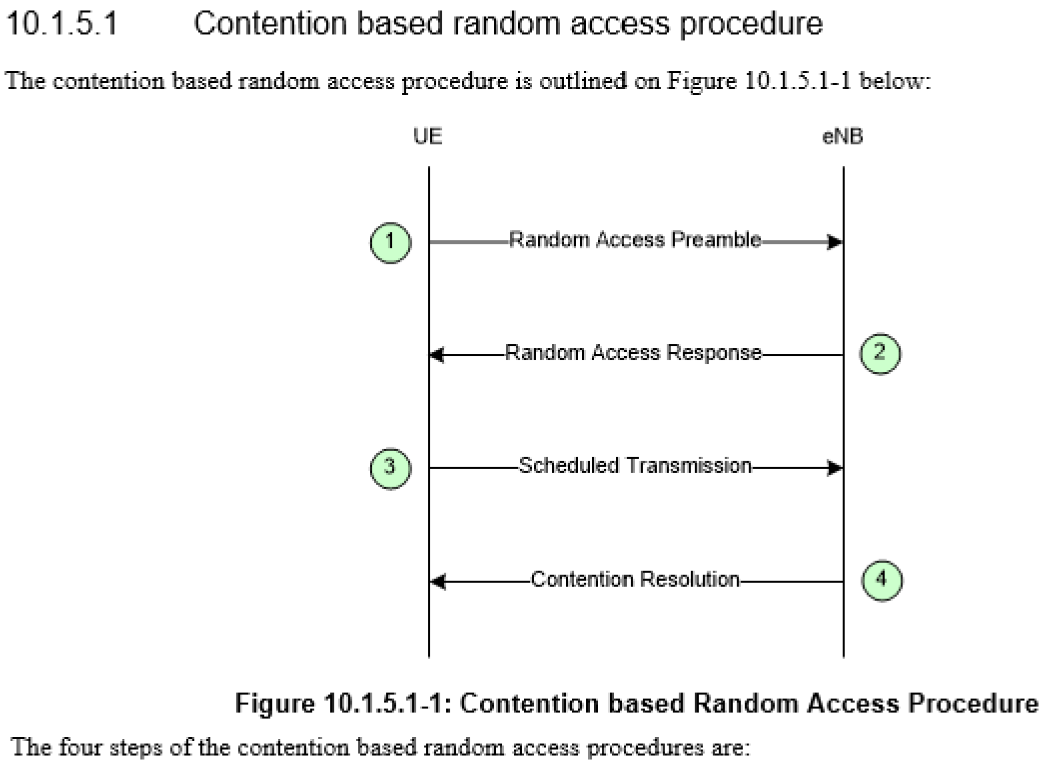
US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

determining if the response message identifies the sequence associated with the base station in the random access signal; and	Toyota’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

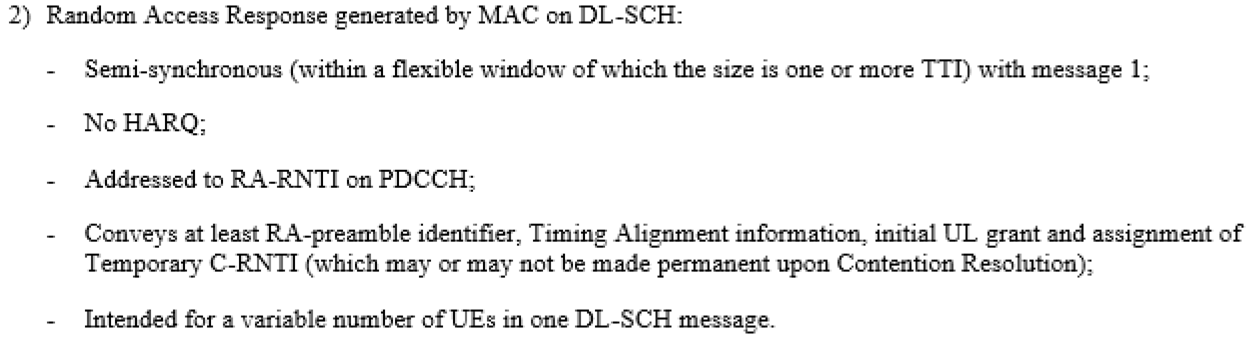
US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Toyota’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

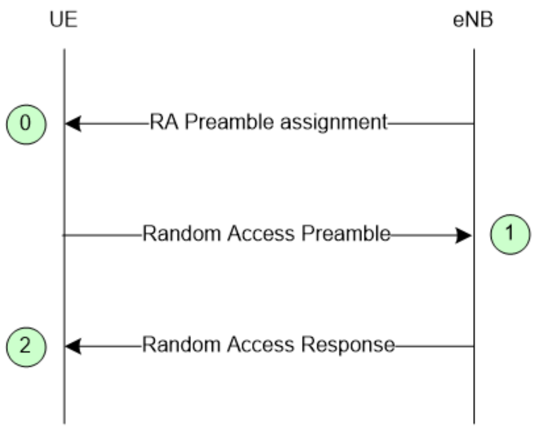
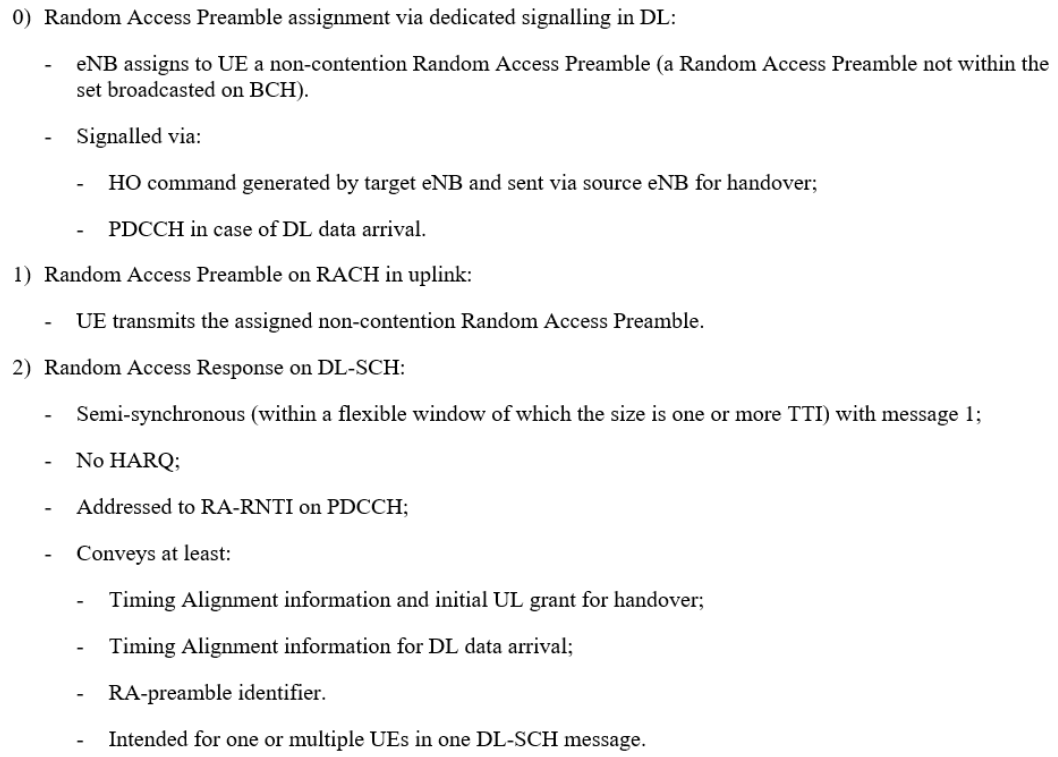


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

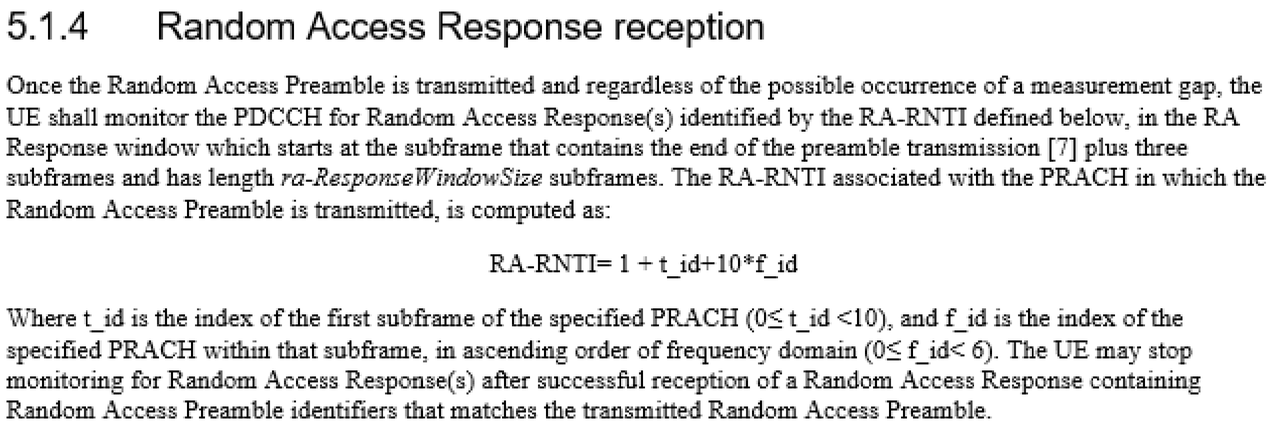


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

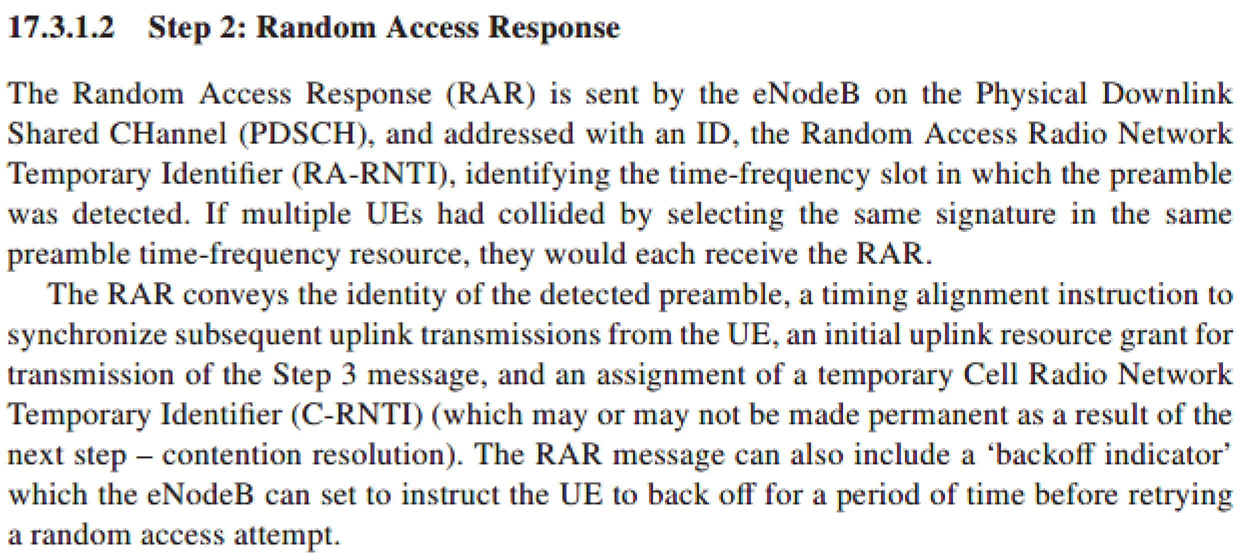
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10*f\_id$$

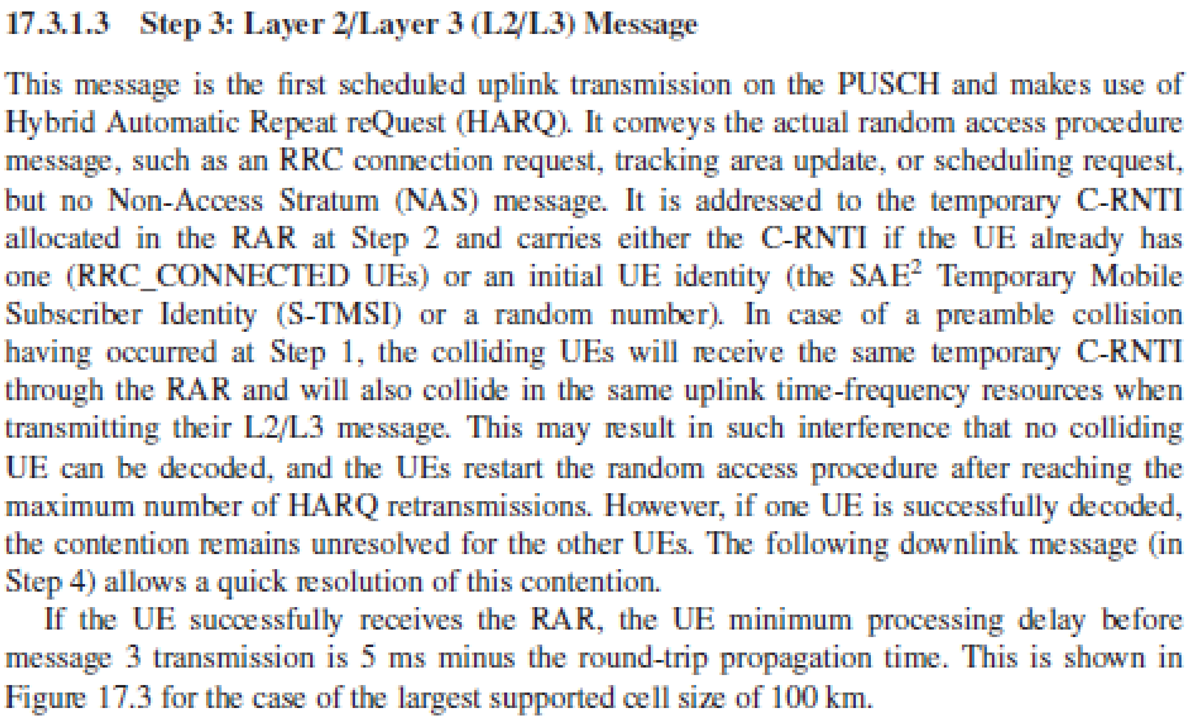
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

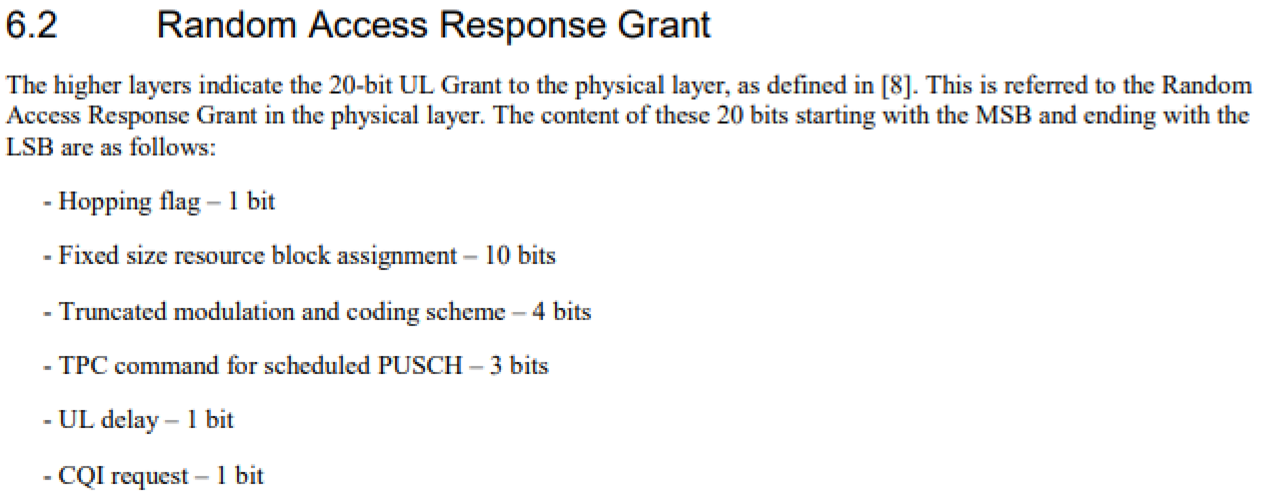
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

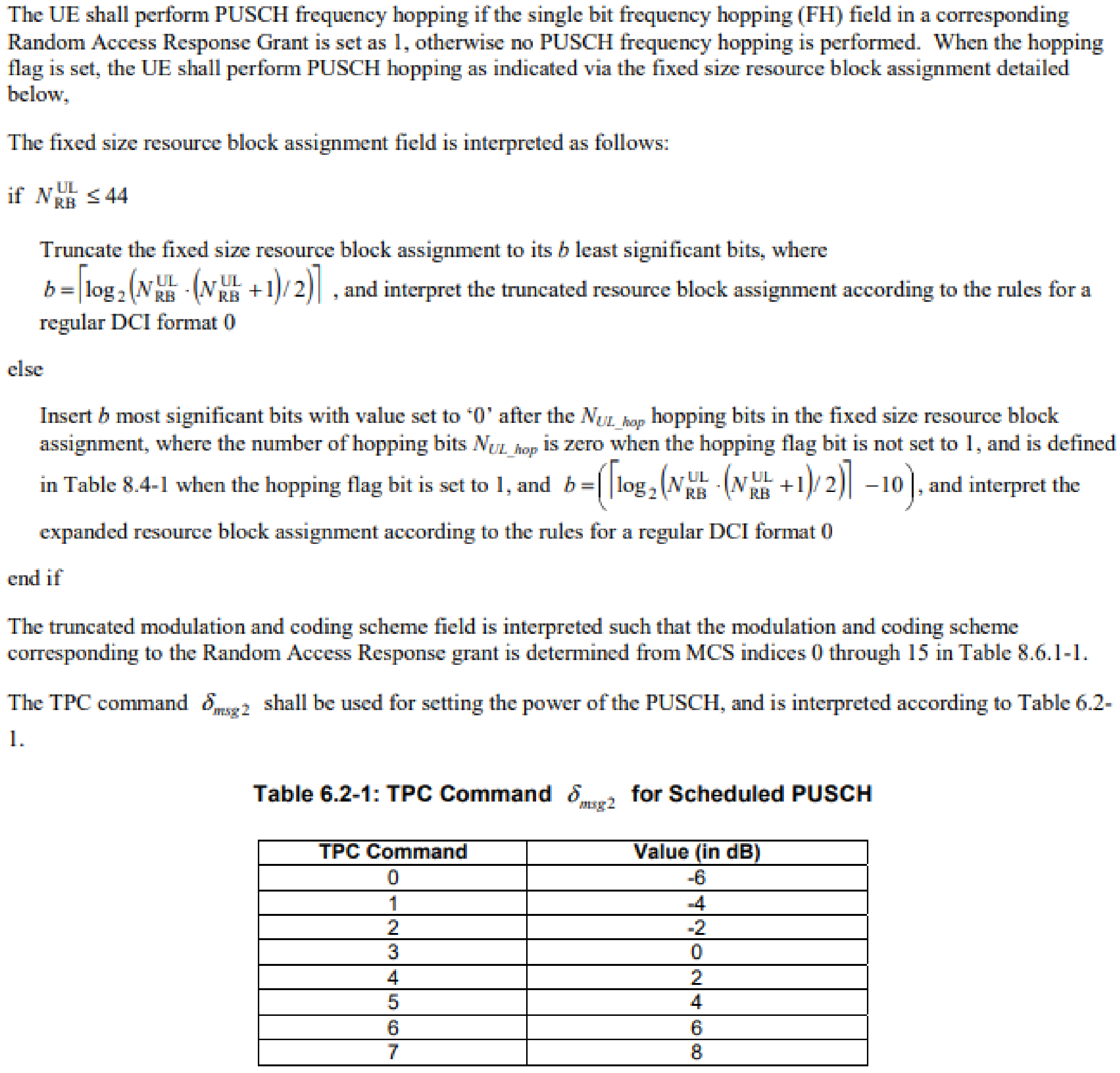
	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 13(a)
“The method of claim 12, wherein the response message includes power adjustment information and”

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by Toyota’s Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)

"The method of claim 12, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

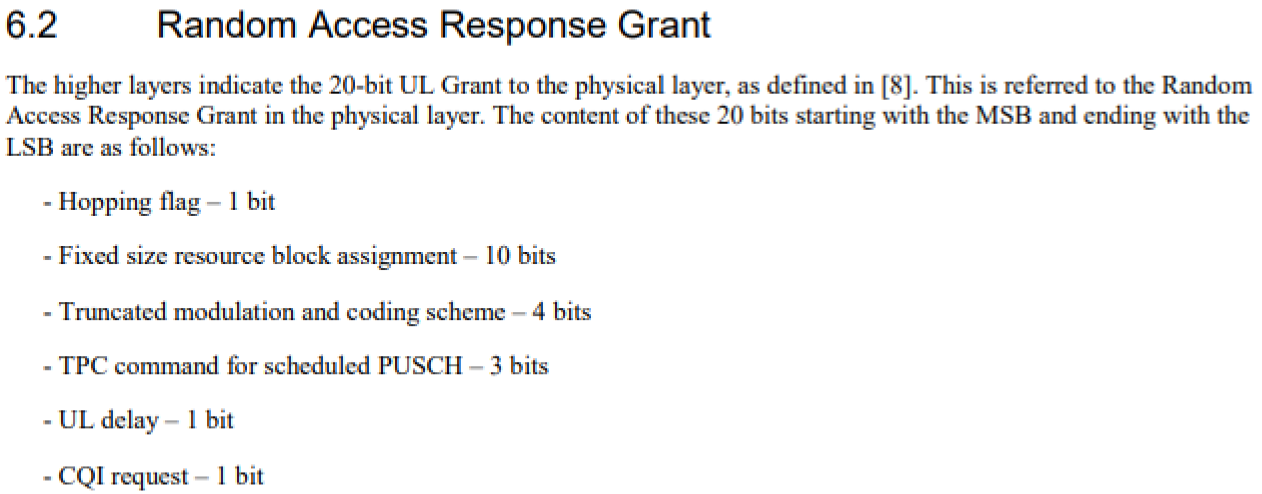
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

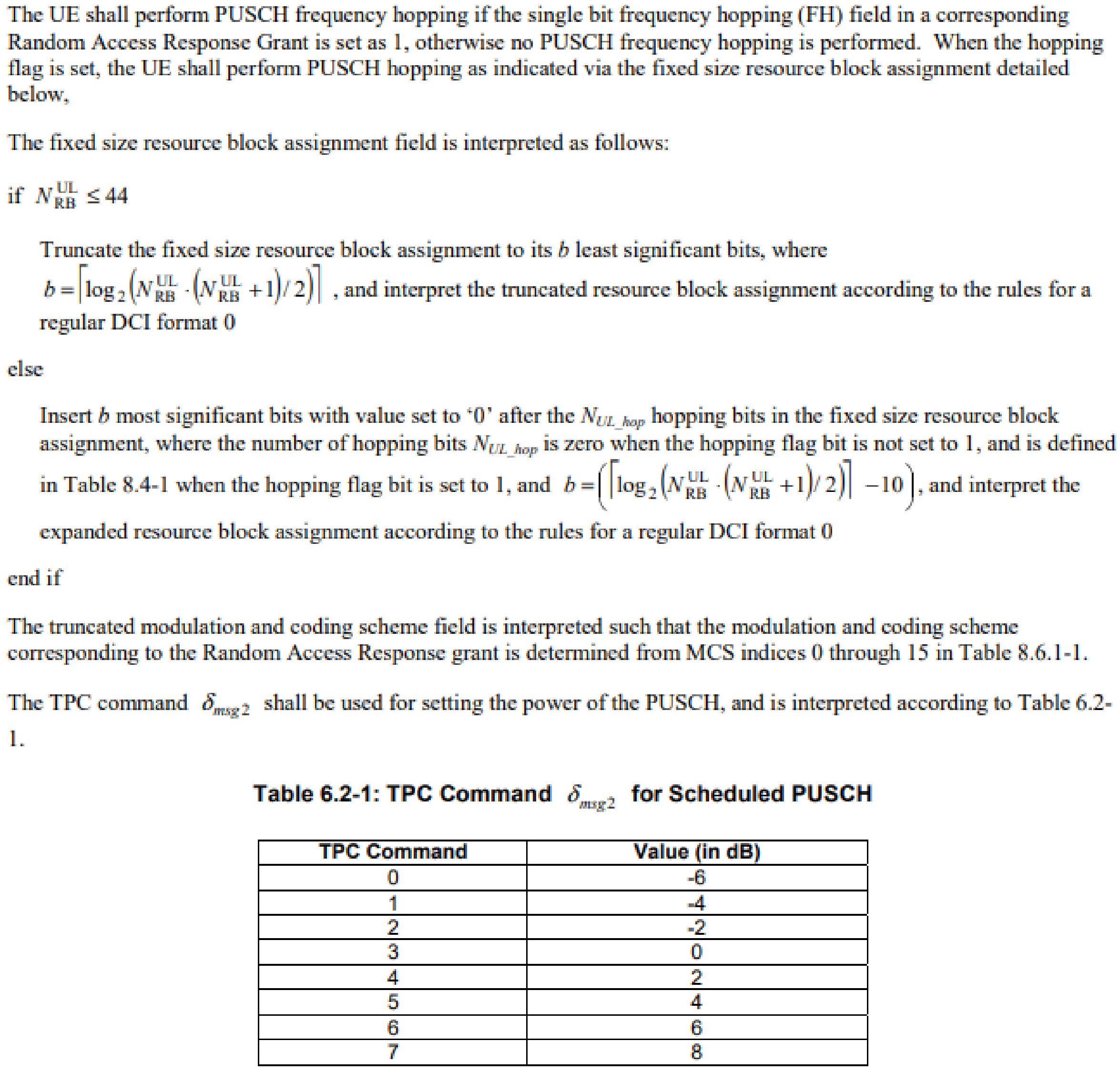
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

wherein the second uplink signal is transmitted according to the power adjustment information.	Toyota’s Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

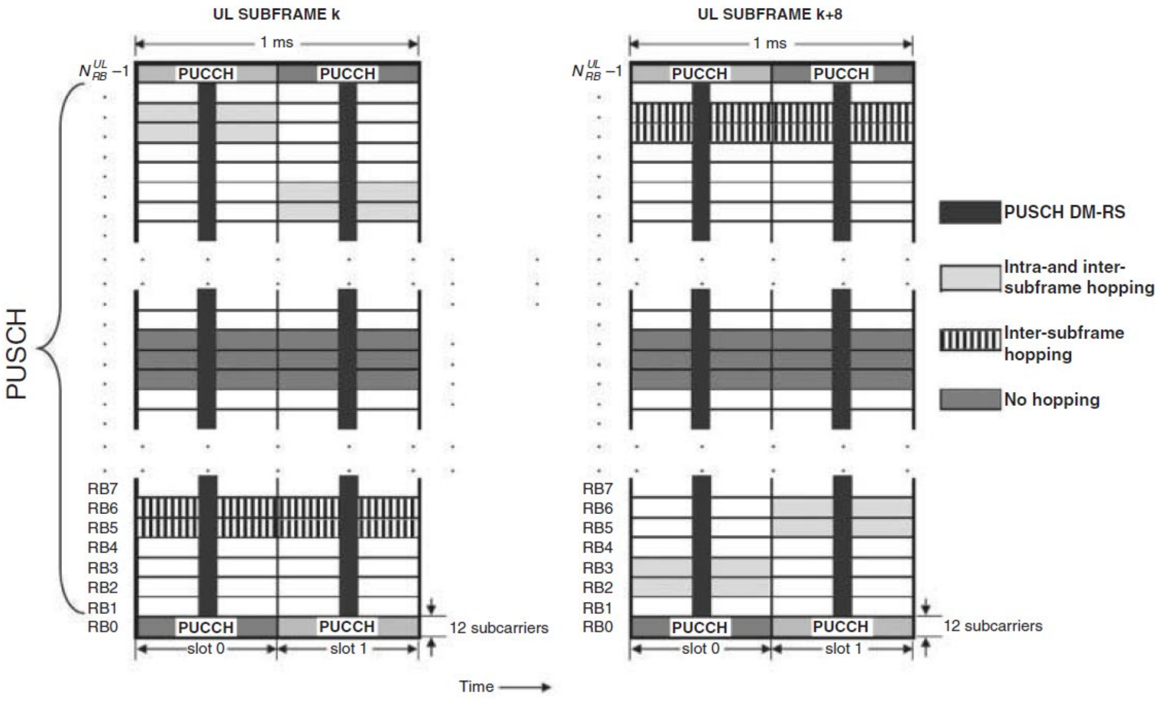
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 14

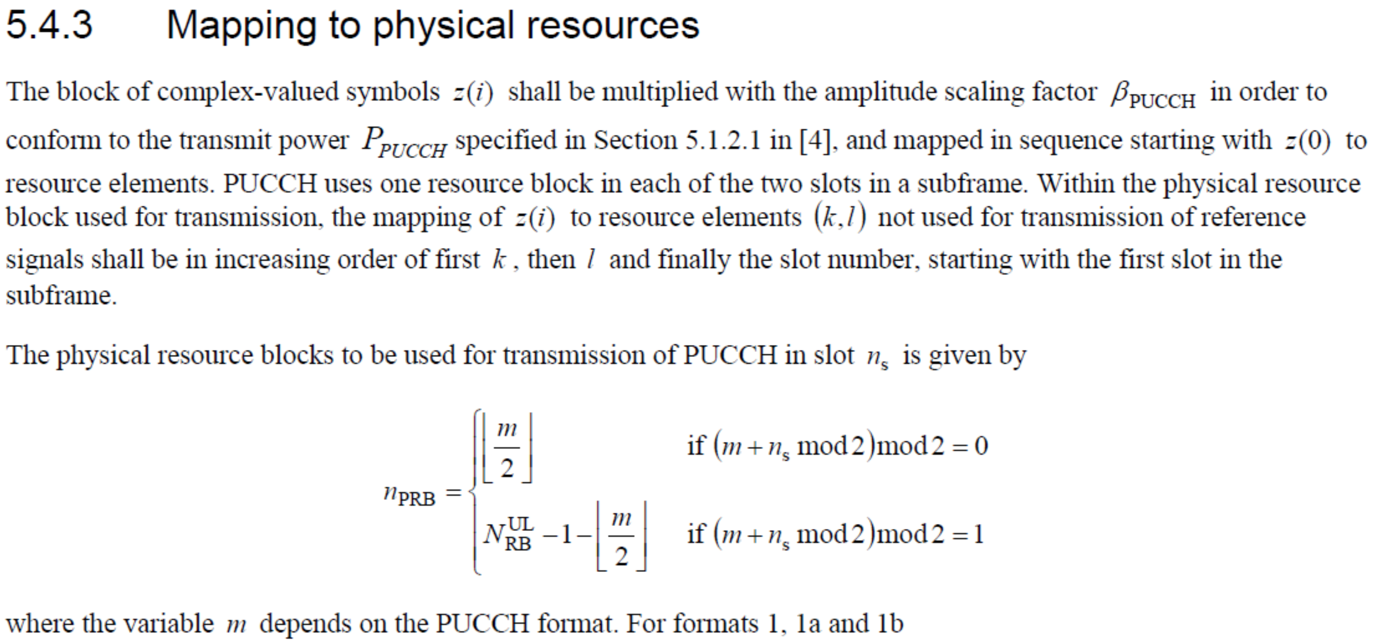
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Toyota's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 11. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

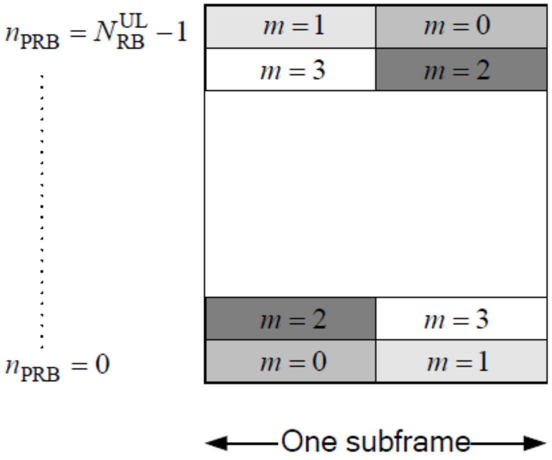
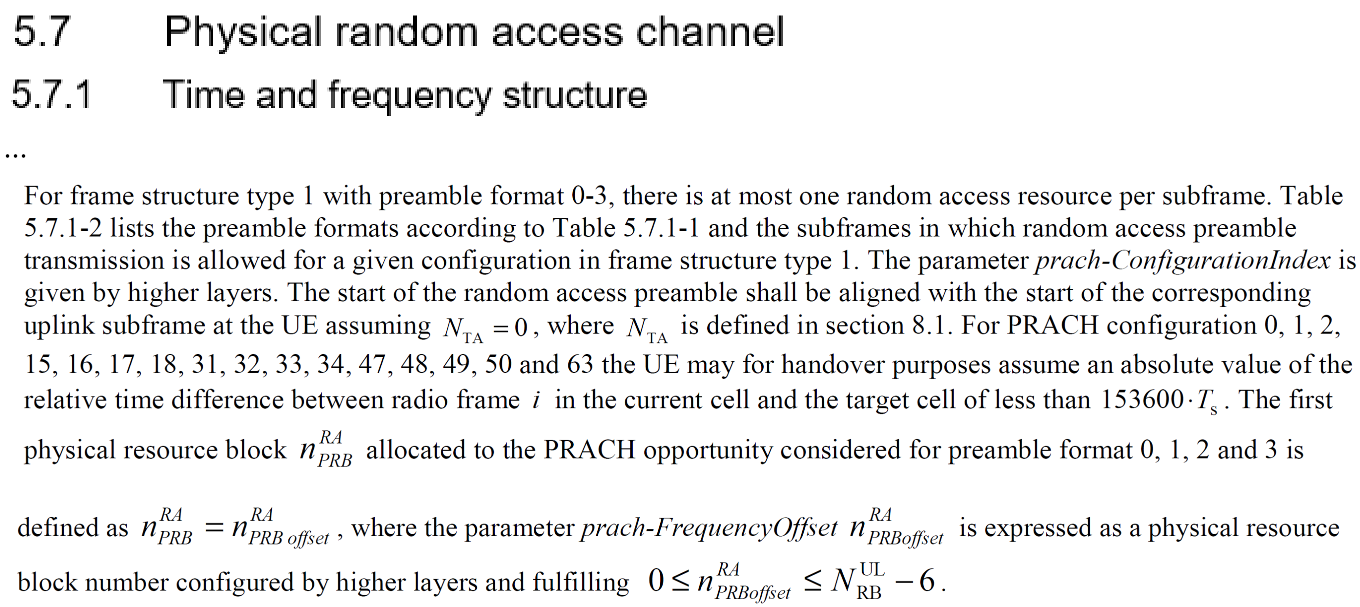


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\mathrm{RA}}_{\mathrm{PRBoffset}}$. For FDD, the parameter directly determines

the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

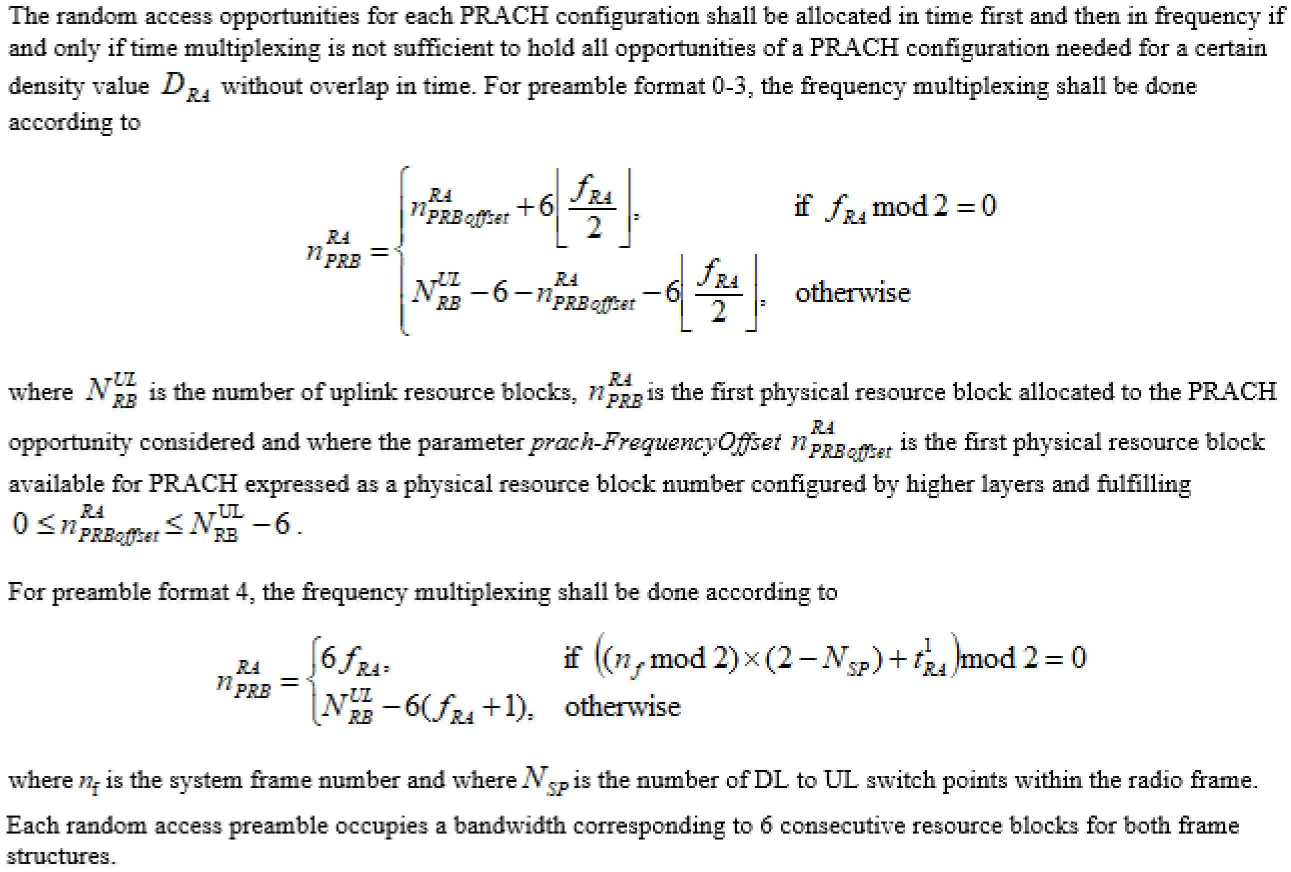
…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	**UL/DL configuration (See Table 4.2-2)**						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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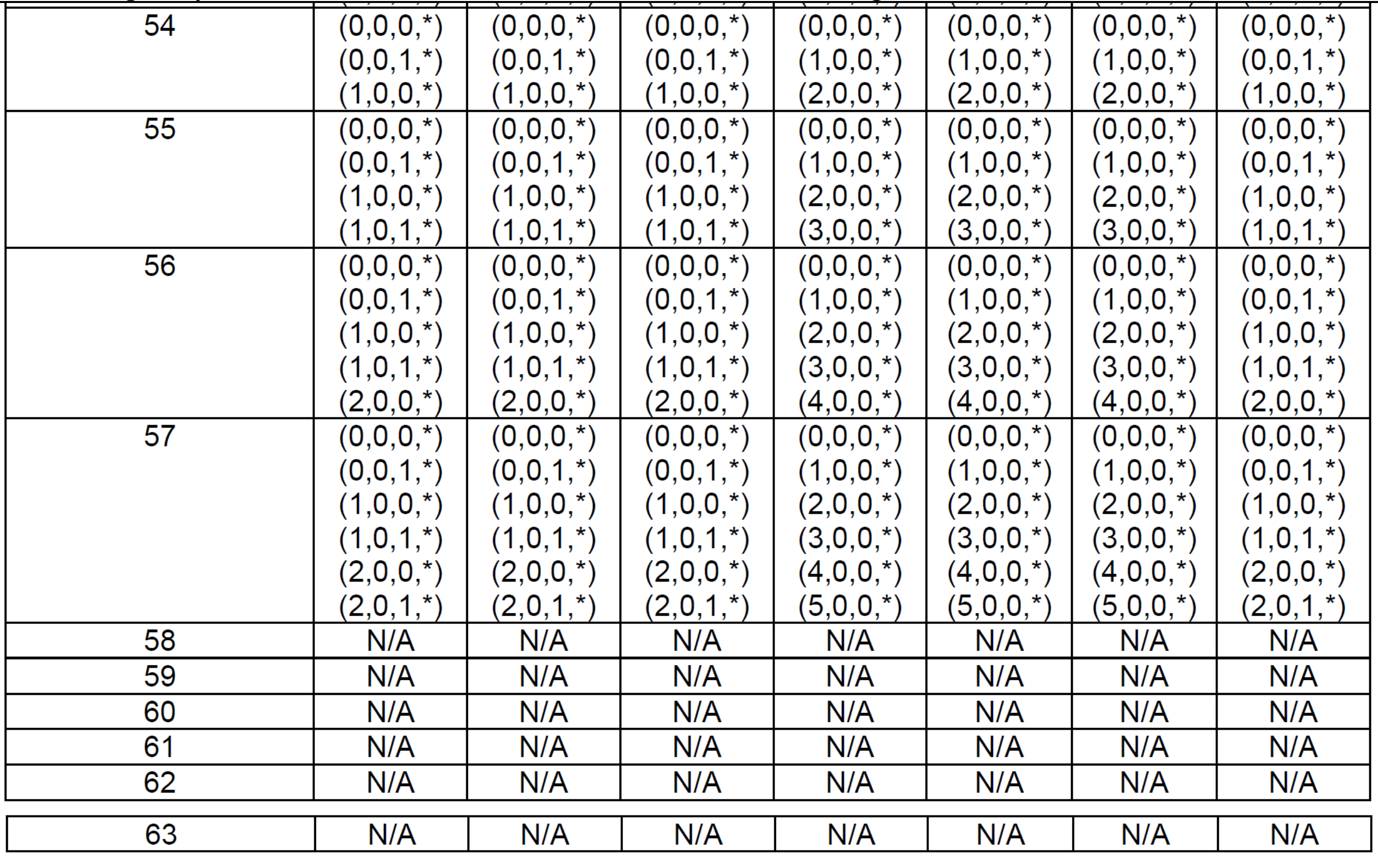
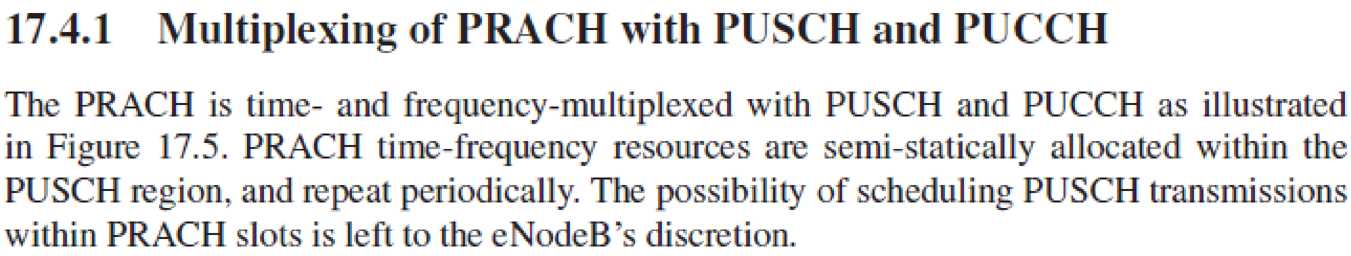
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

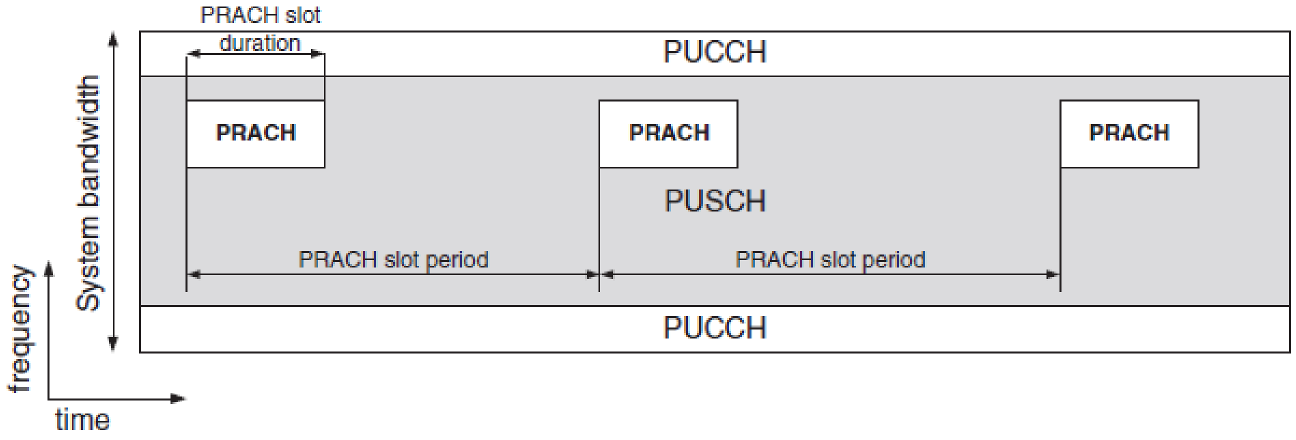
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



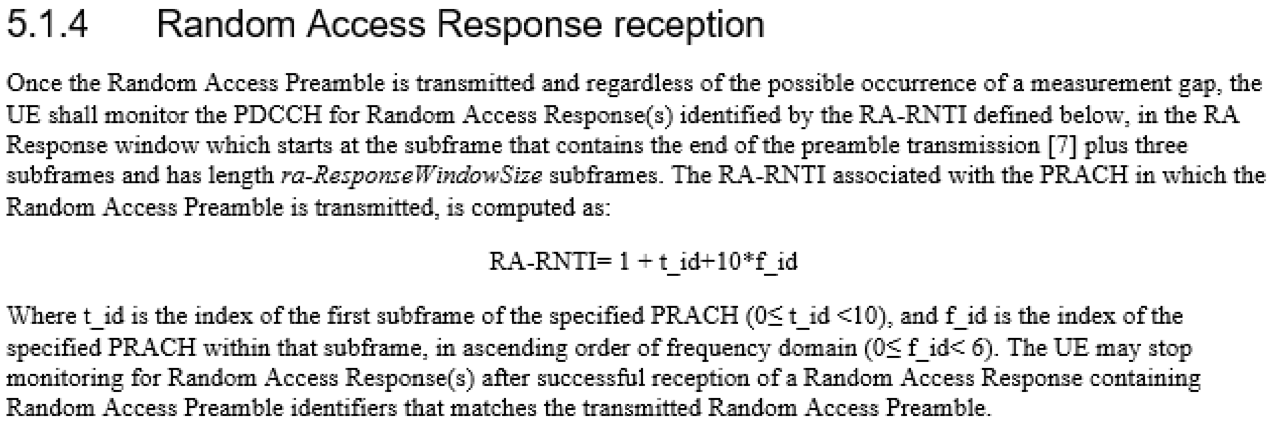
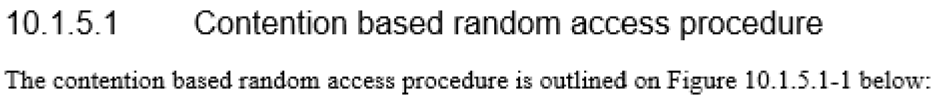
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 15
“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Toyota’s Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

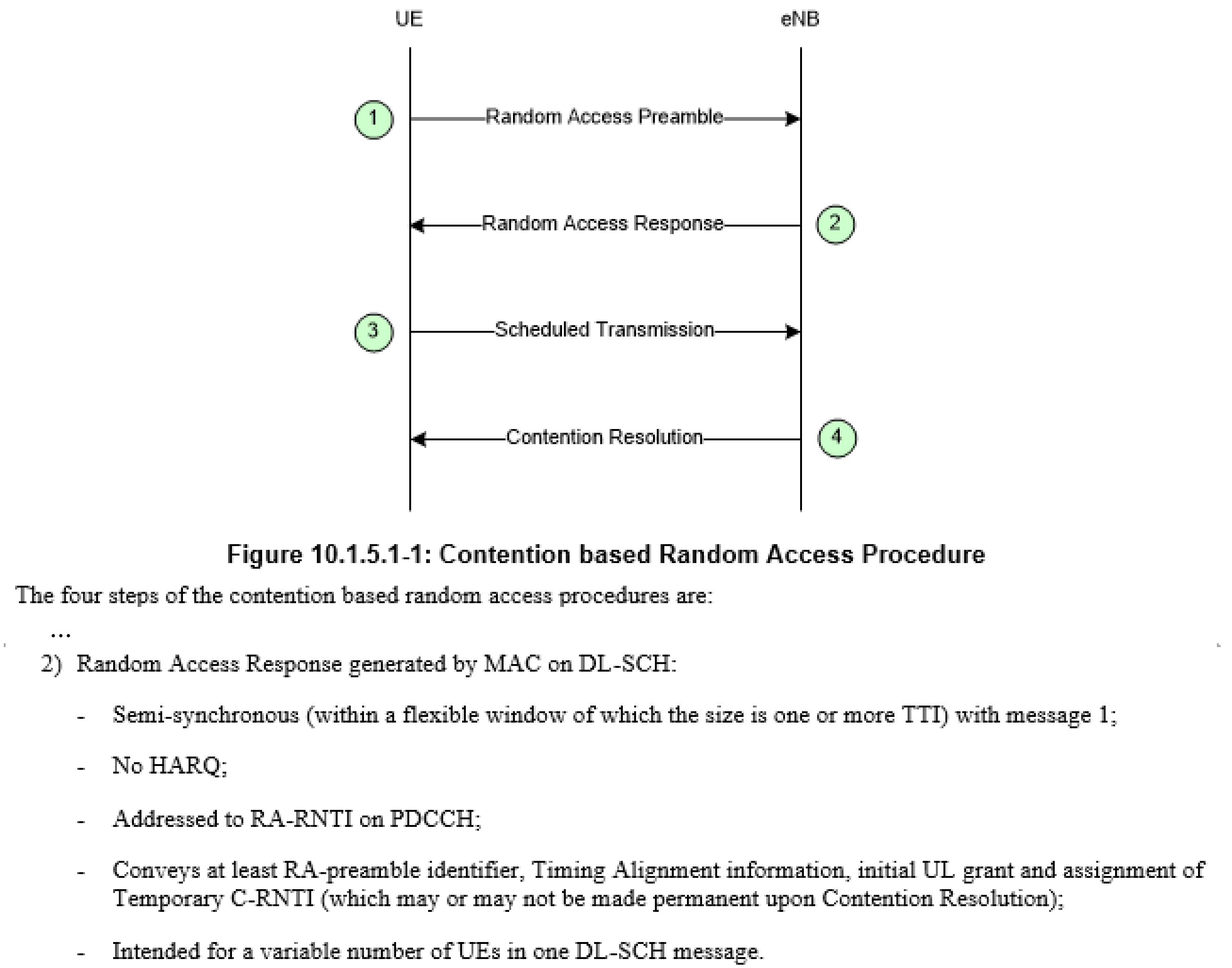


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

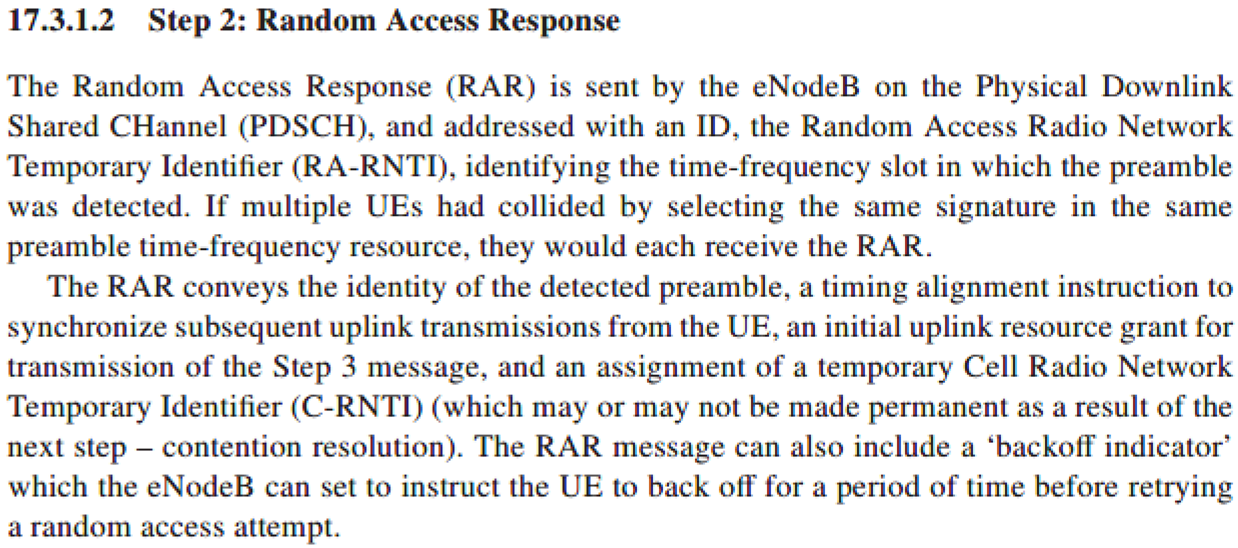
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

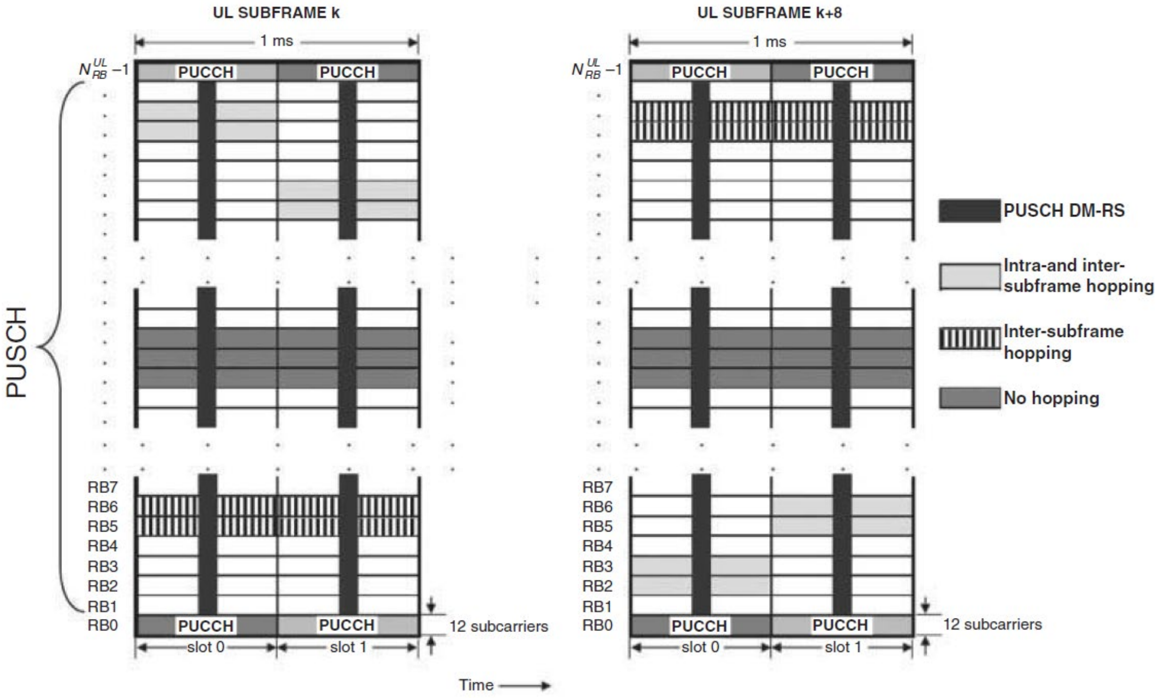
US Patent No. 10,833,908: Claim 15
“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

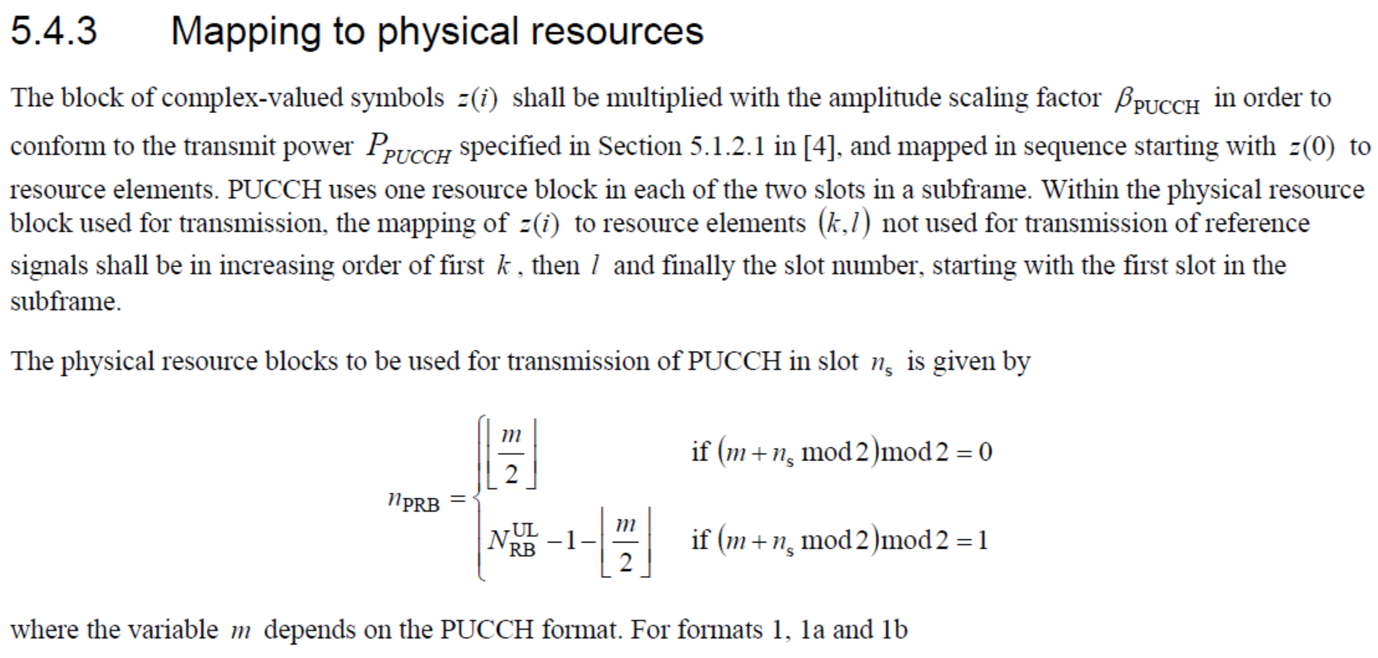
US Patent No. 10,833,908: Claim 16
"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Toyota's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

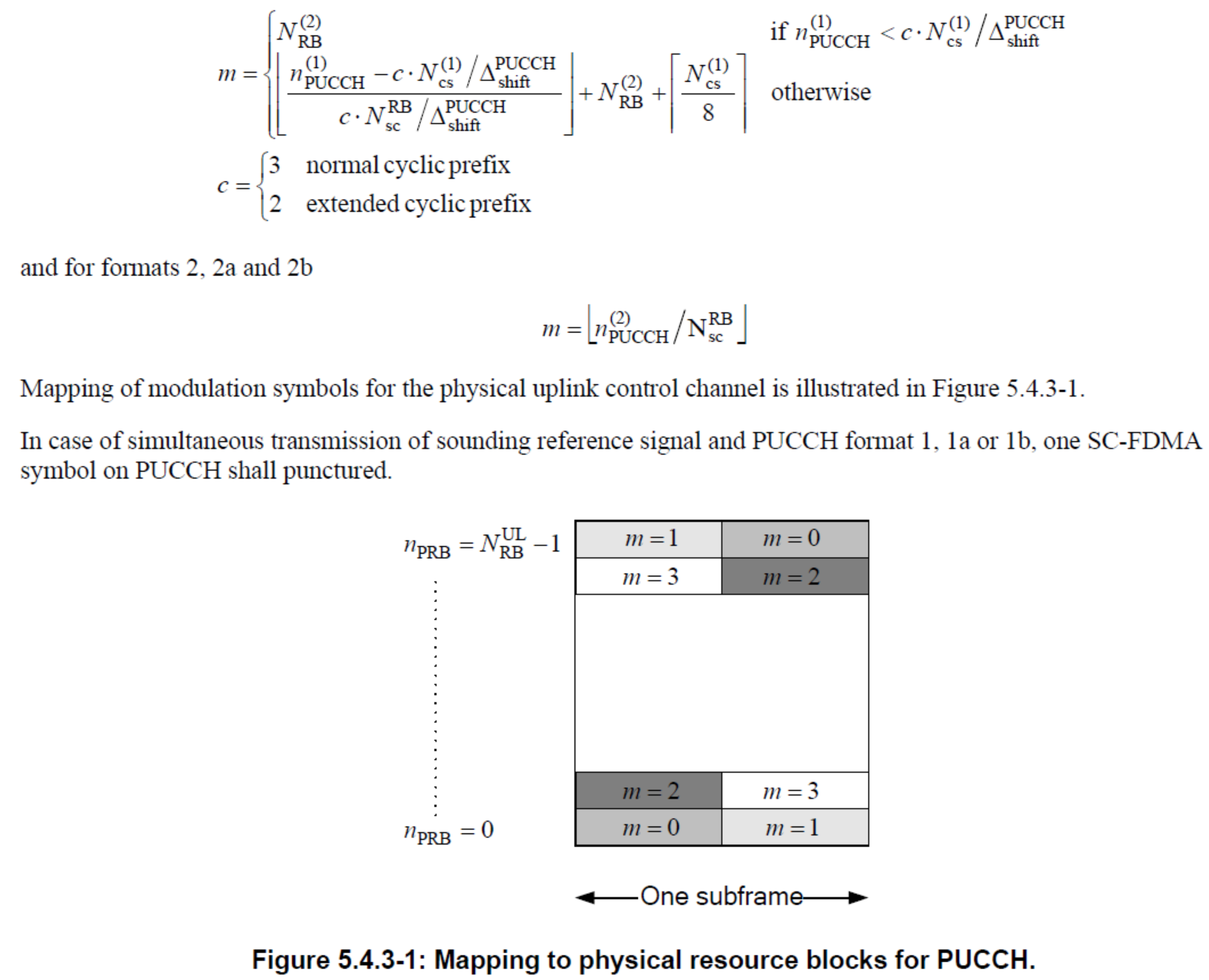
17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Toyota's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

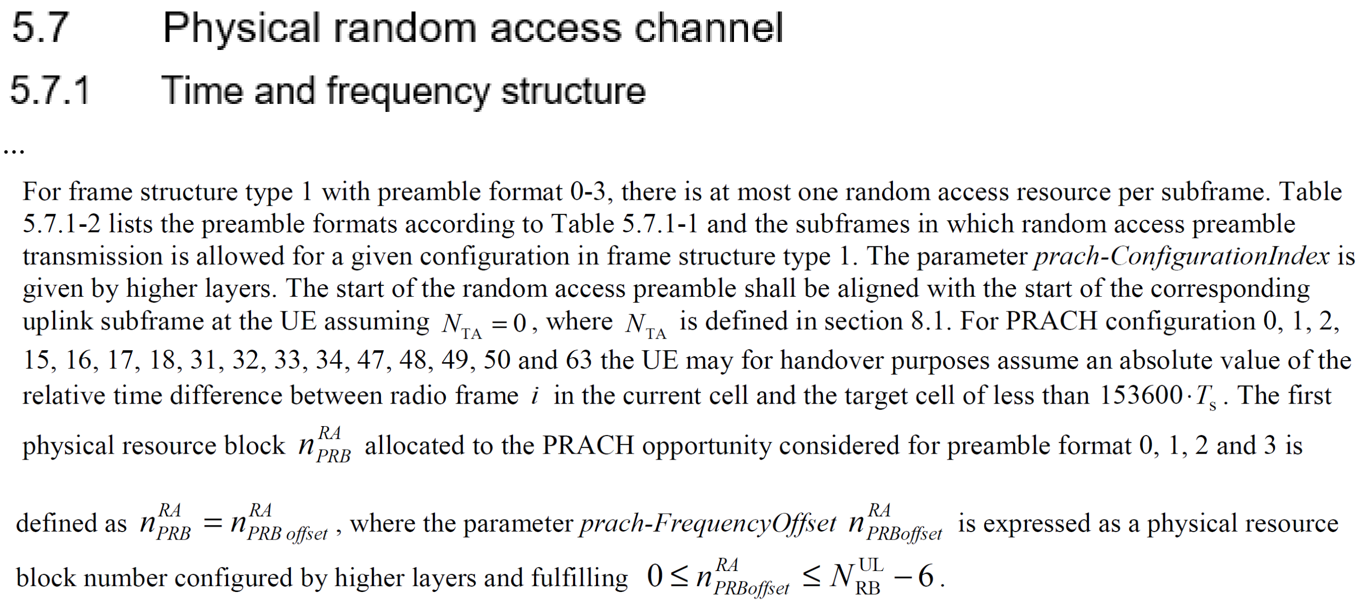
In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

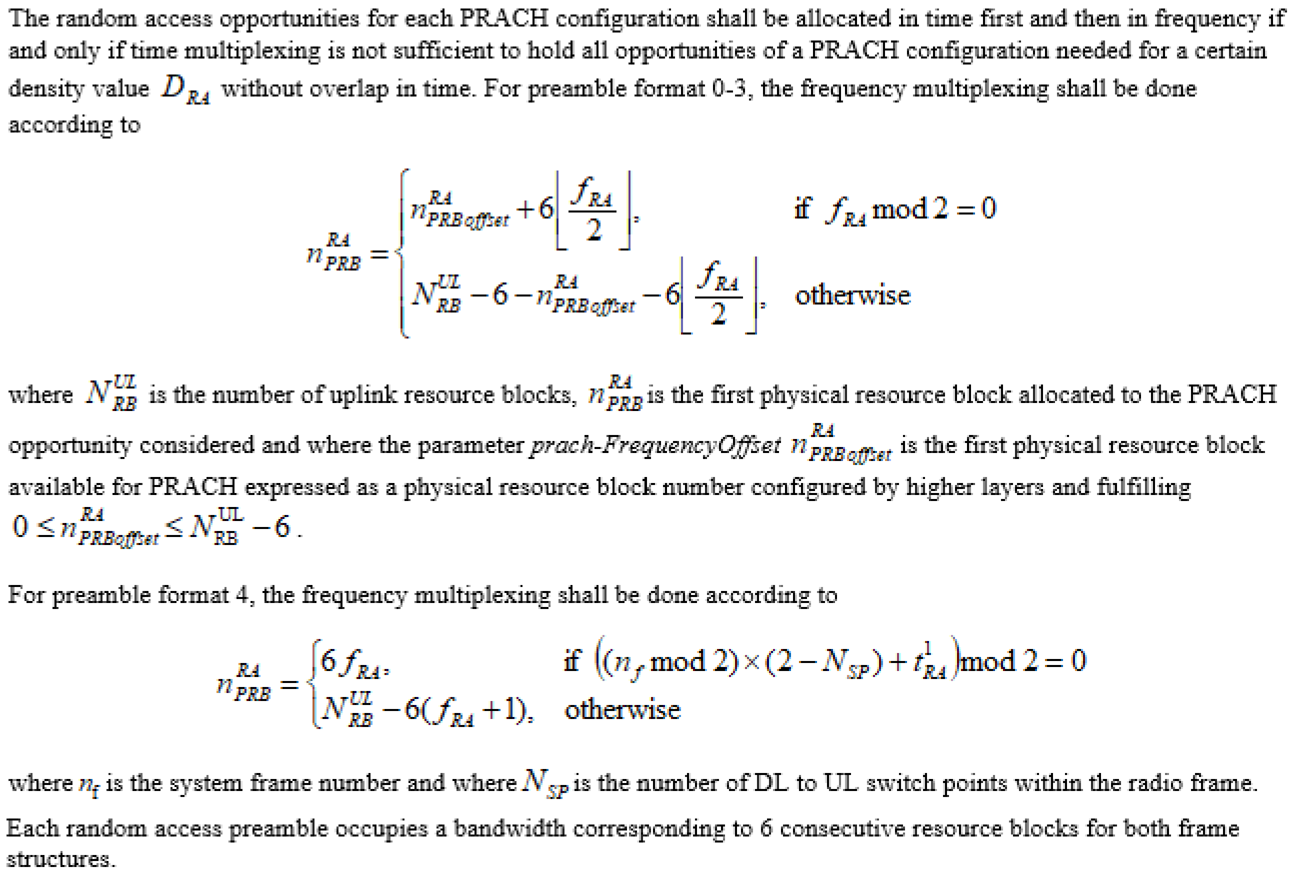
…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$ where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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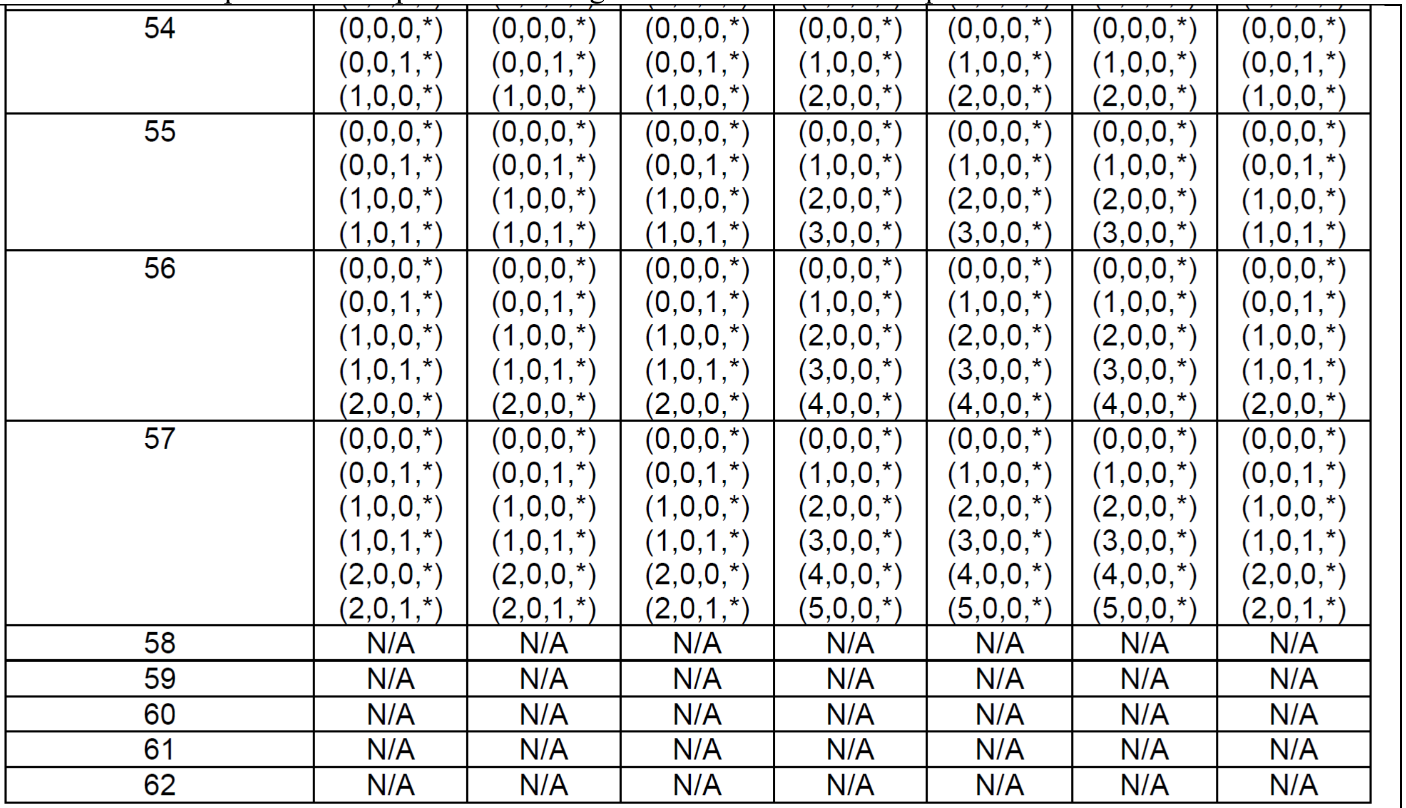
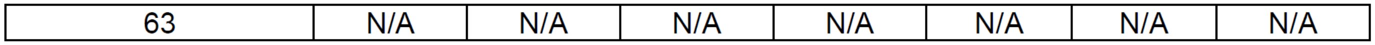
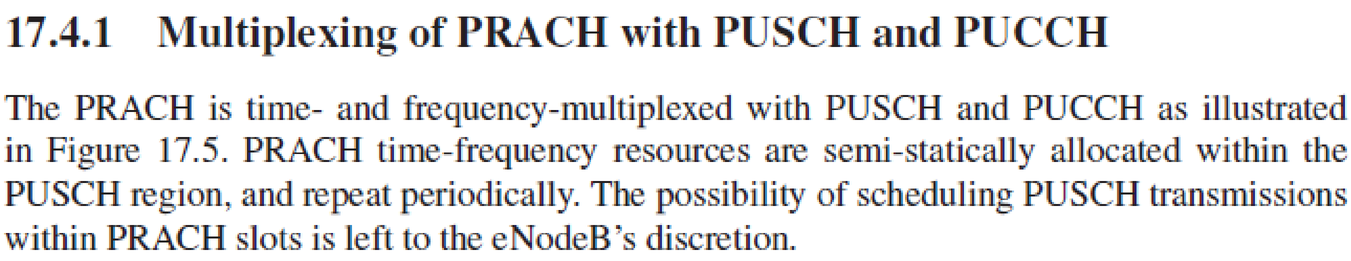


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A



63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

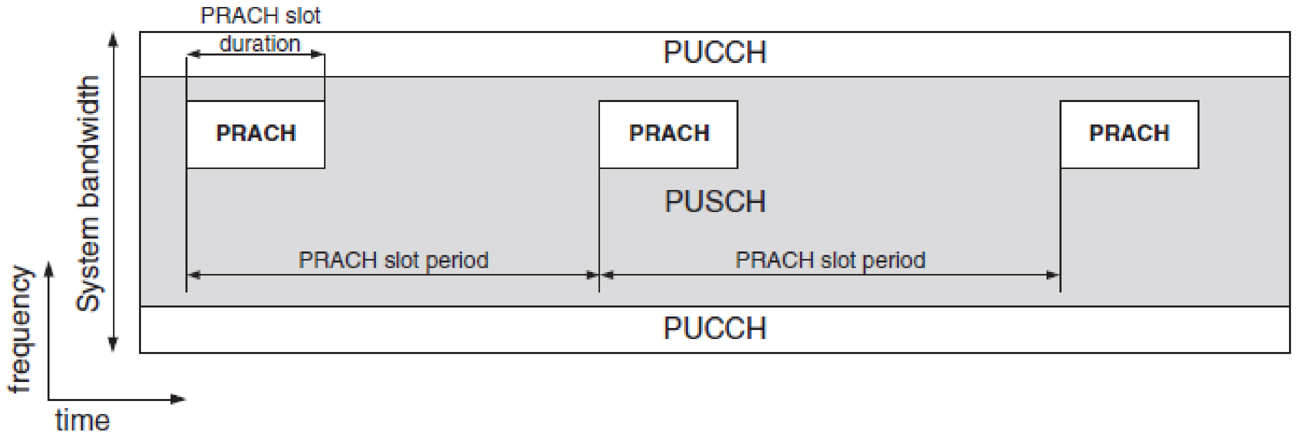


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

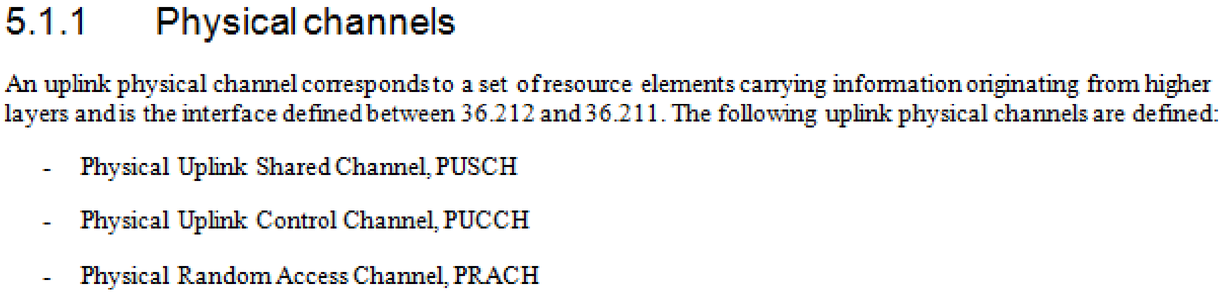
US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a centre portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

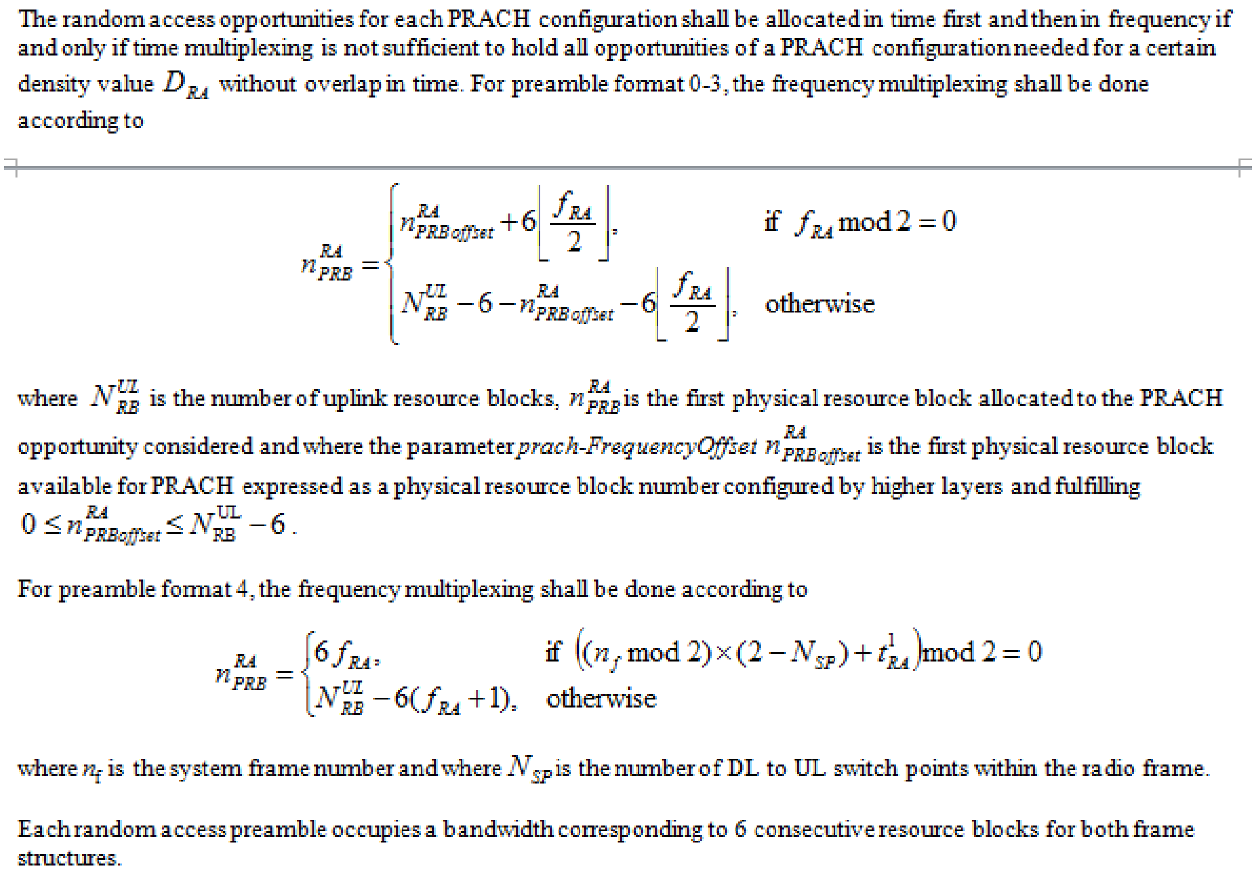
US Patent No. 10,833,908: Claim 18

"The method of claim 11, wherein the random access signal is a spread spectrum signal."

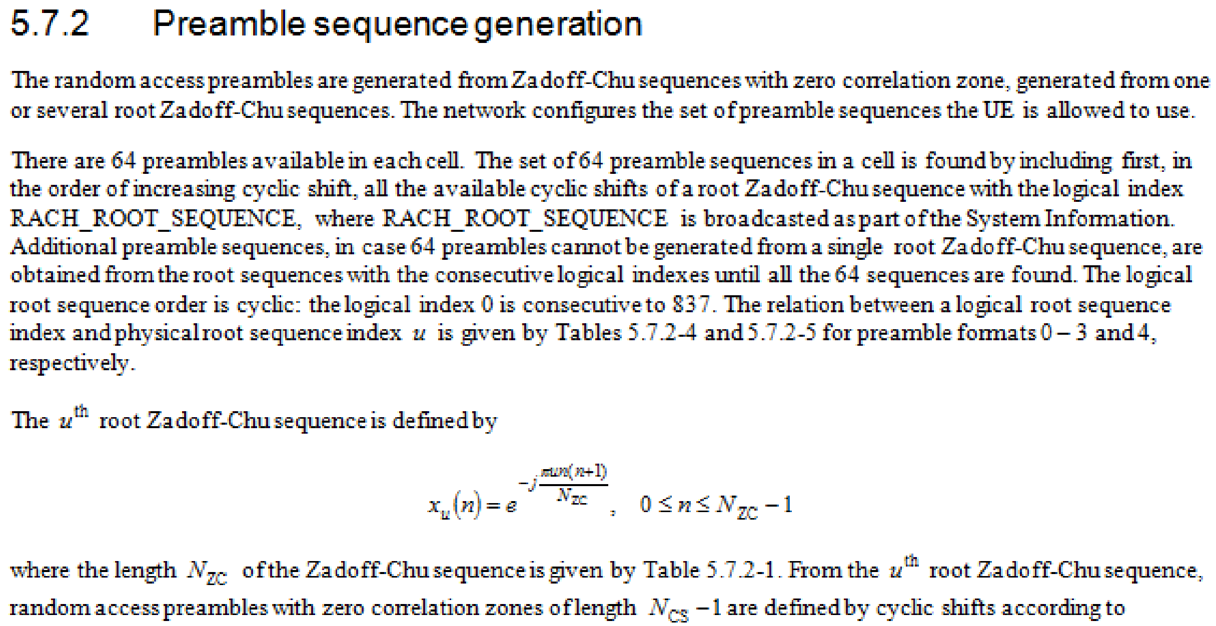
18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Toyota's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18

"The method of claim 11, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

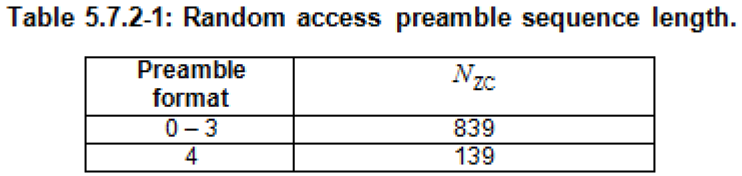
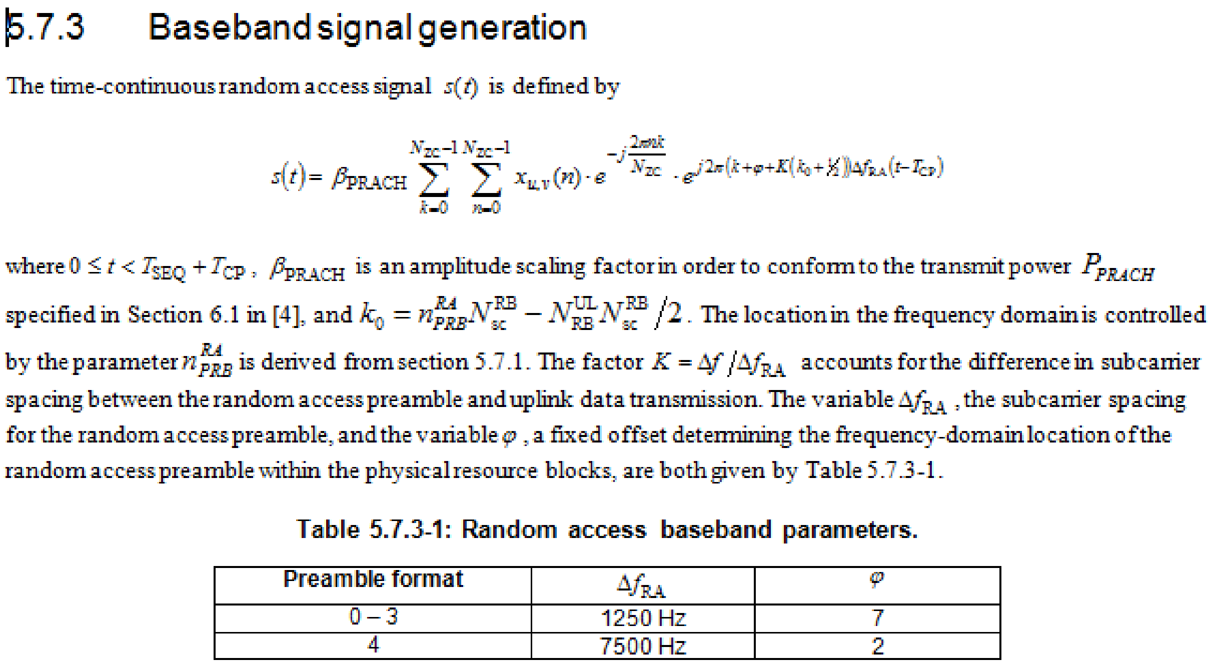


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

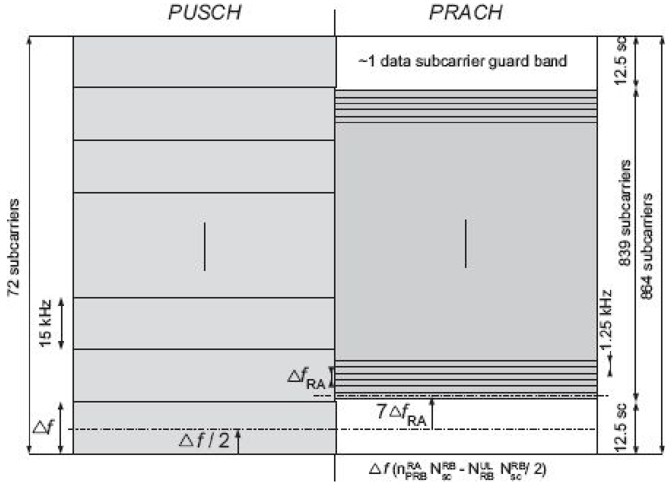
where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

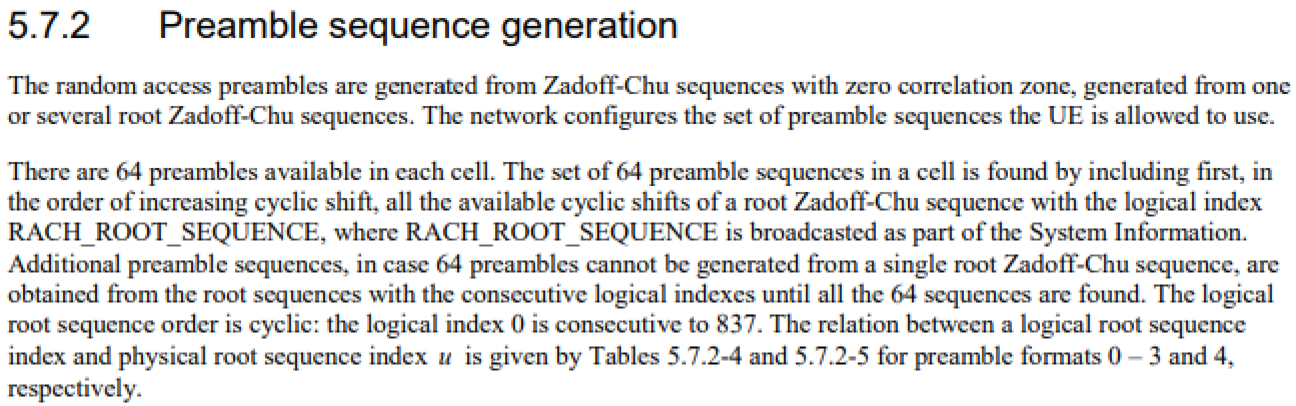
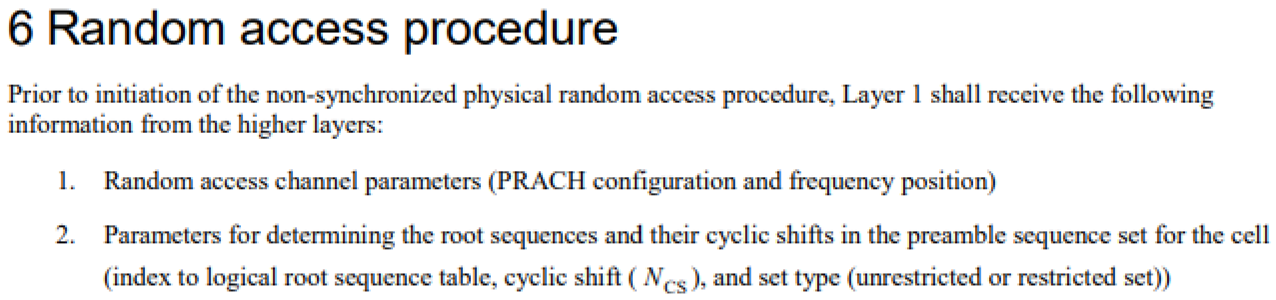
See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Toyota's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19
“The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

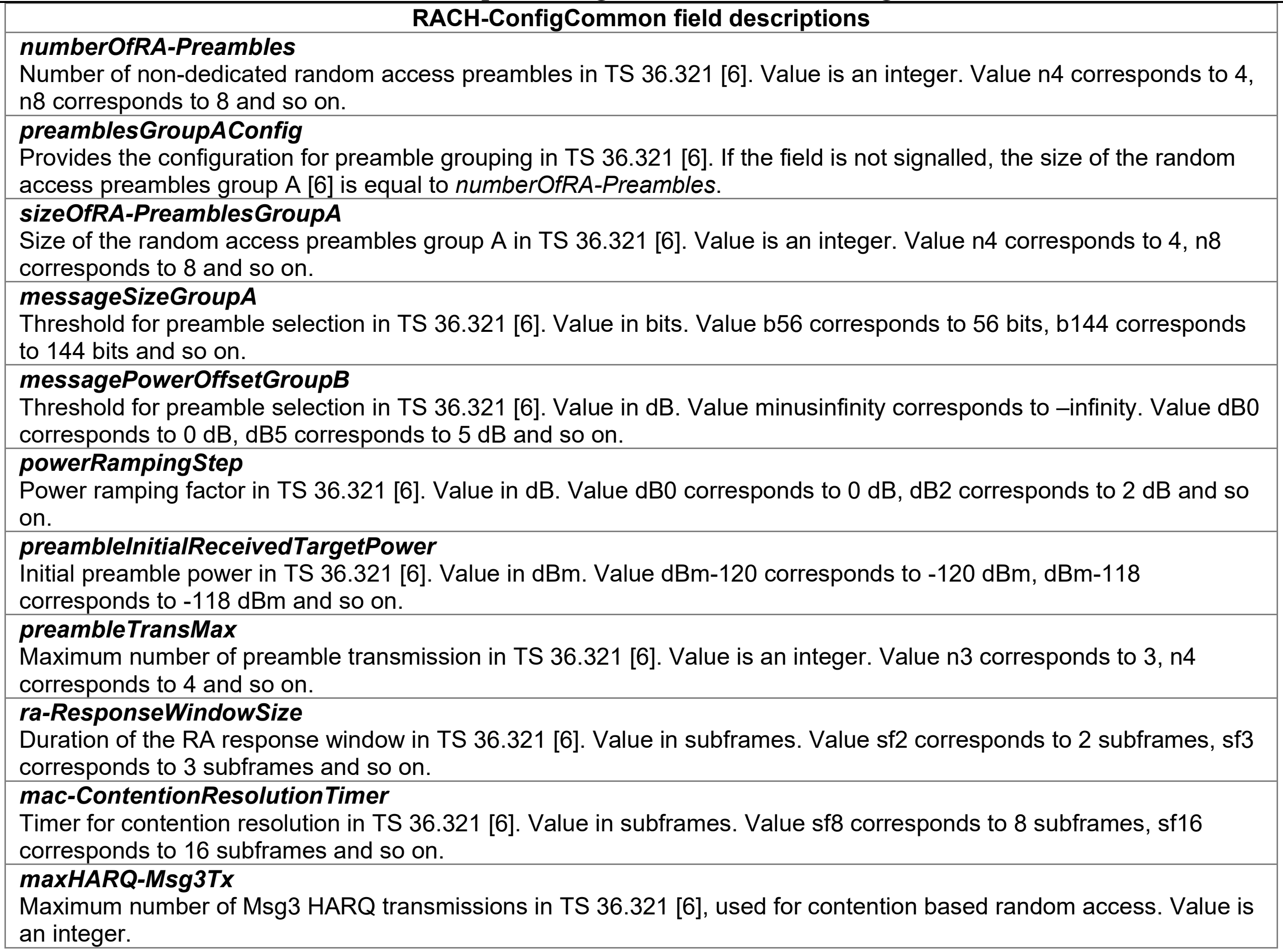
```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

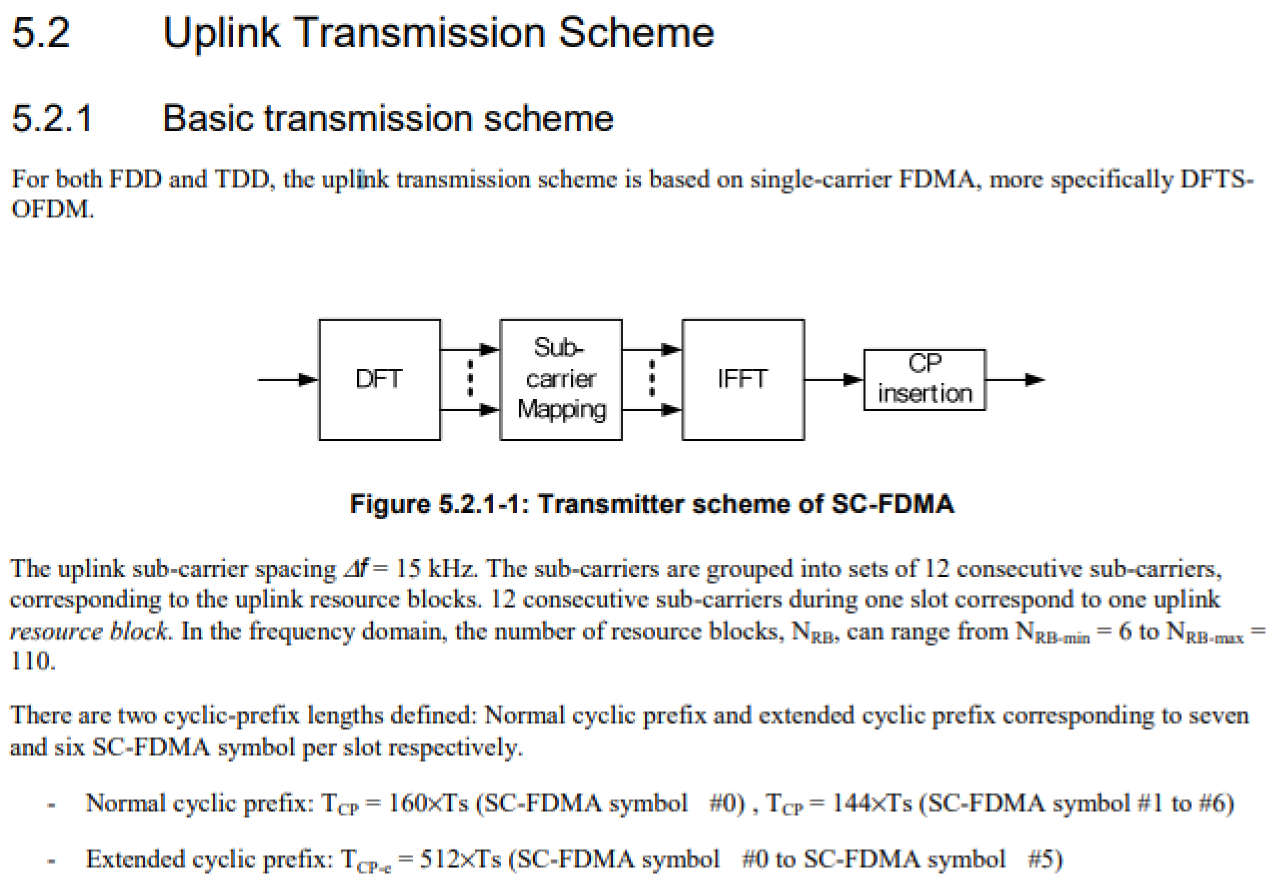


RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

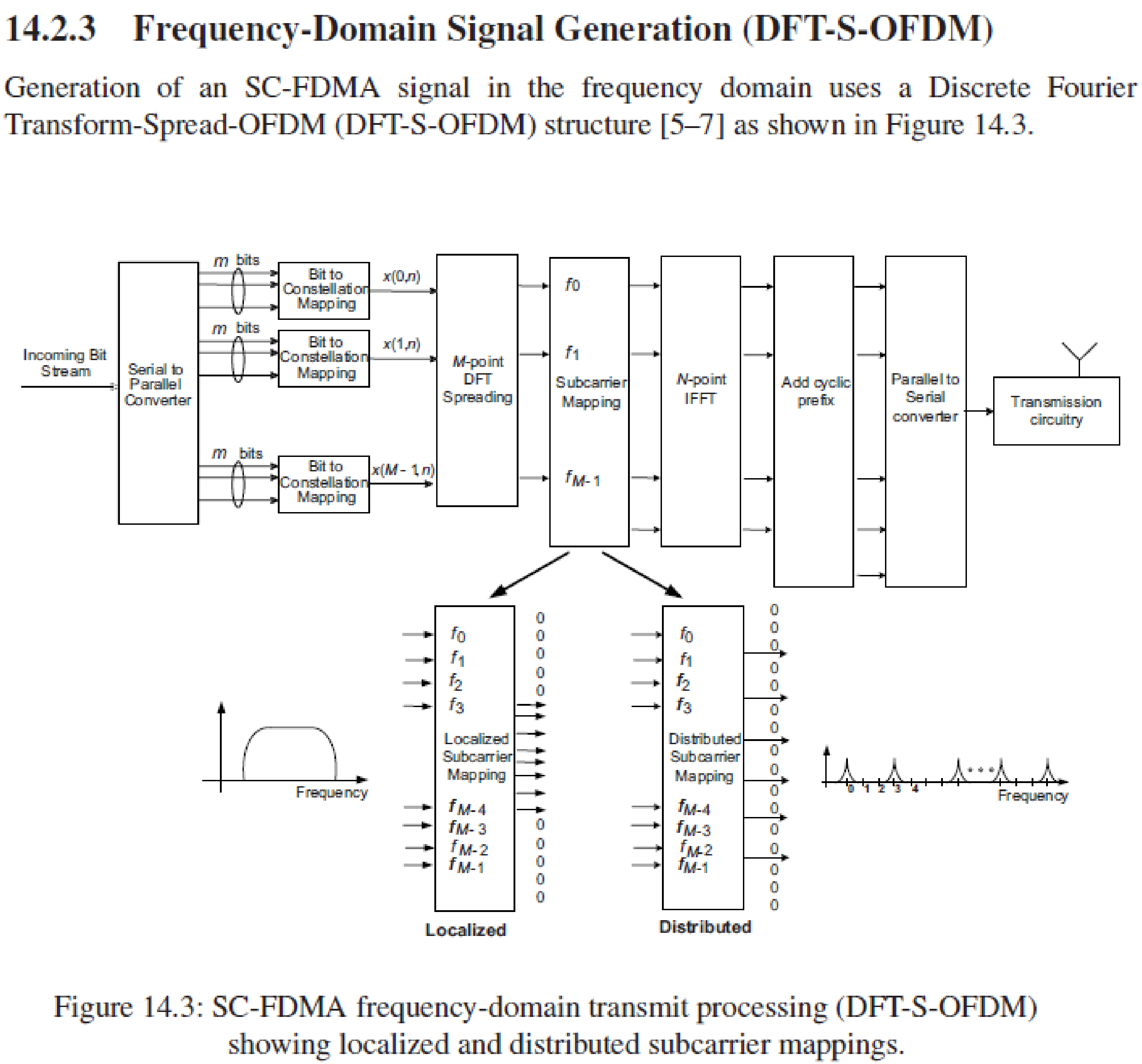
US Patent No. 10,833,908: Claim 20
“The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.”

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. Toyota’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.*, Toyota’s Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160{\times}Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144{\times}Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512{\times}Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

US Patent No. 10,833,908: Claim 20

"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

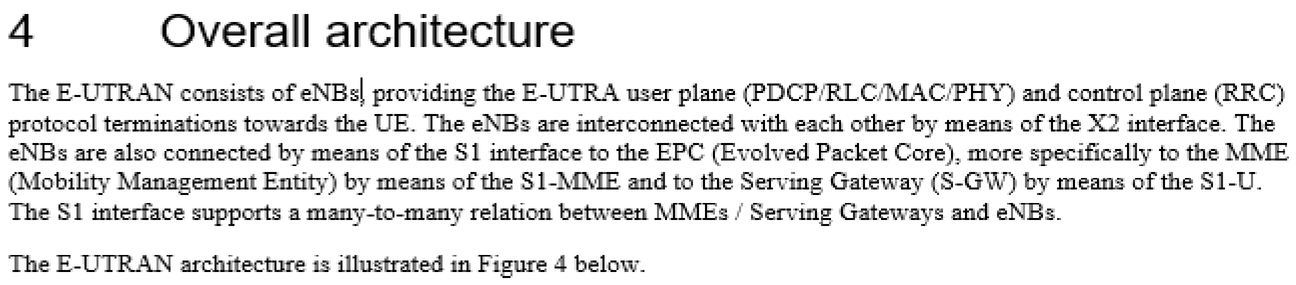
Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

21. A mobile station comprising:	To the extent the preamble is considered a limitation, Toyota's Accused Instrumentalities meet the preamble of claim 21 of the '908 patent. *E.g.,* Toyota's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Toyota offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:”

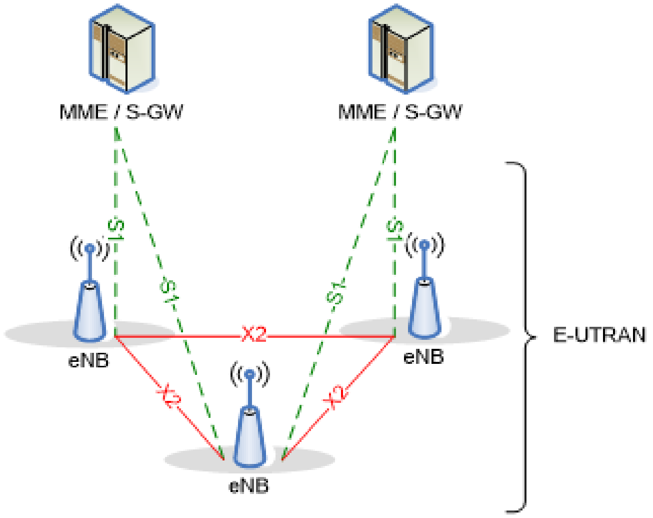
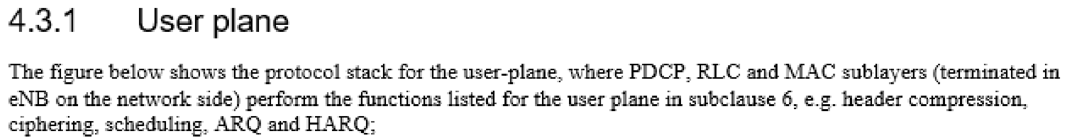


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

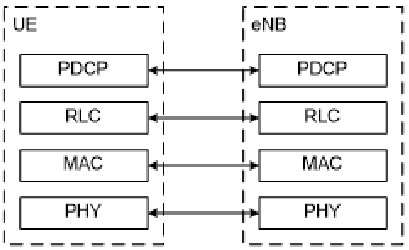


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	Toyota’s Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The Toyota Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

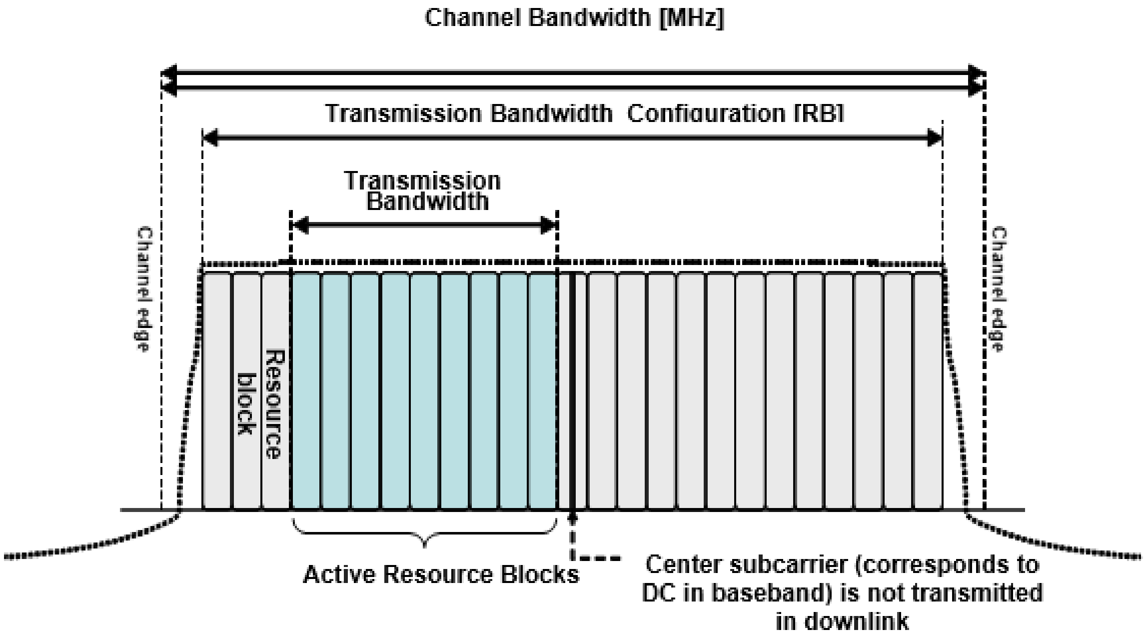
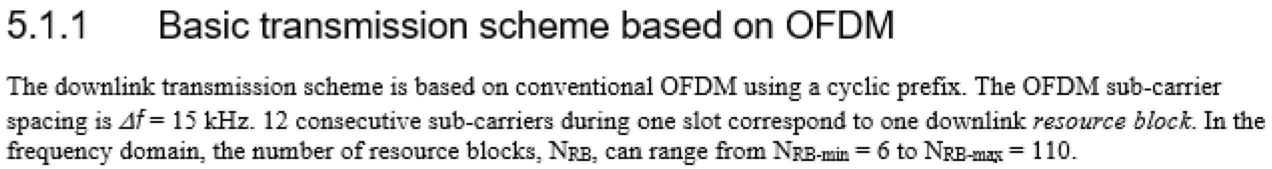


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

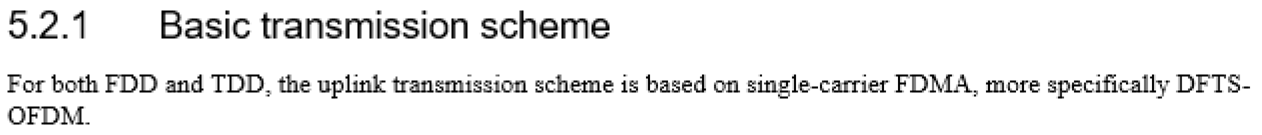
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

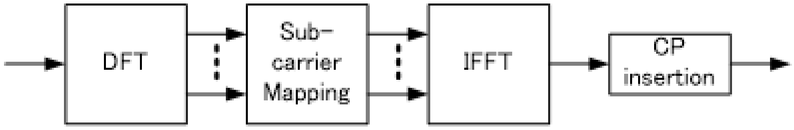
The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.



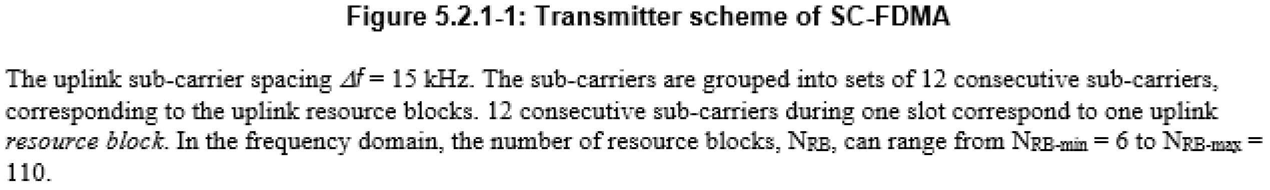


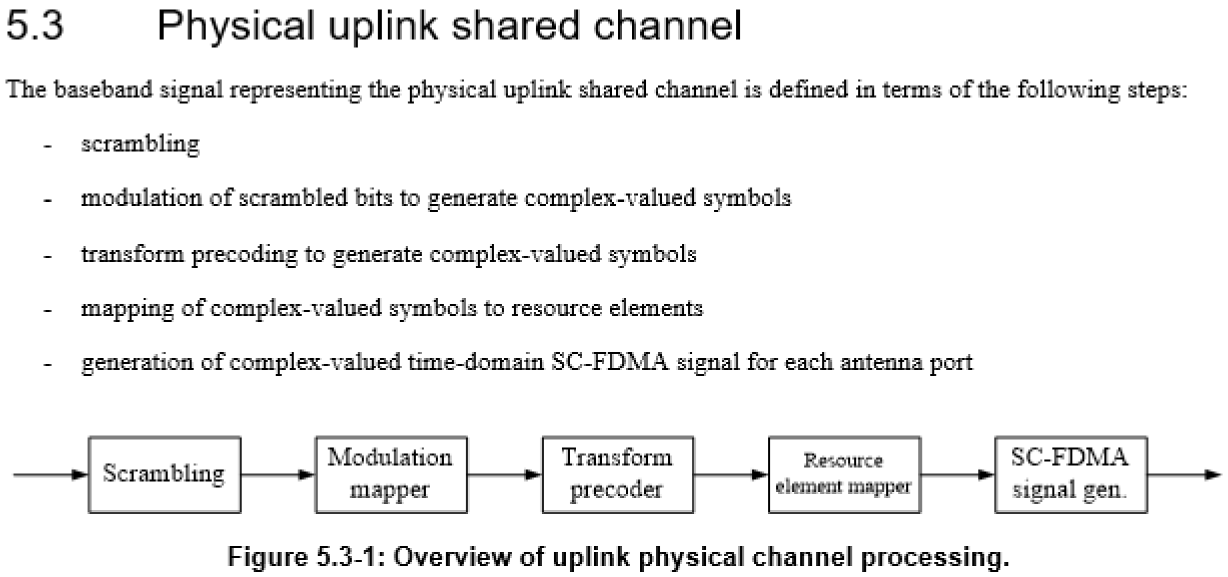
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

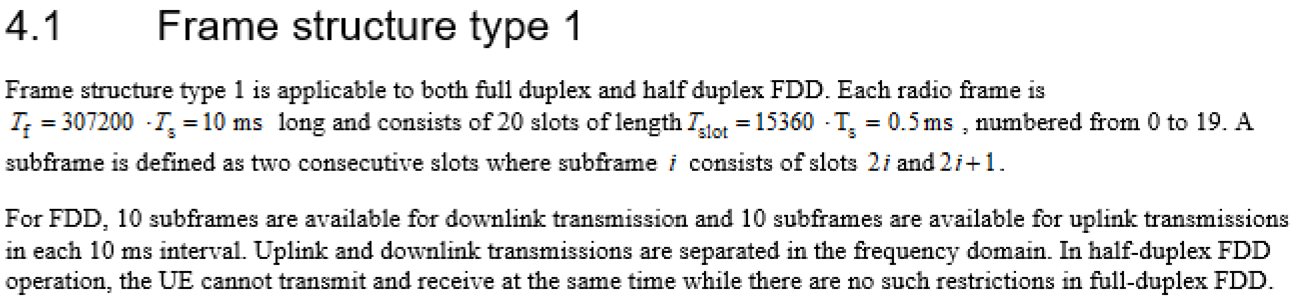
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\text{ ms}$ long and consists of 20 slots of length $T_{\text{slot}} = 15360 \cdot T_s = 0.5\text{ ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

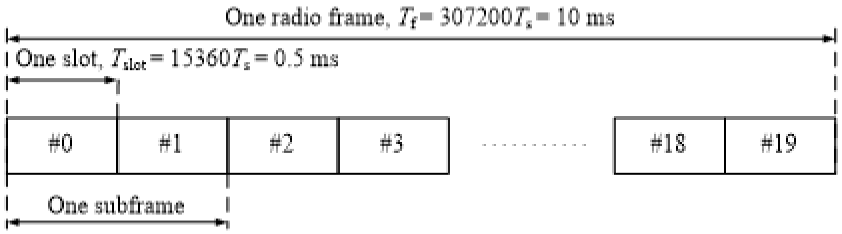
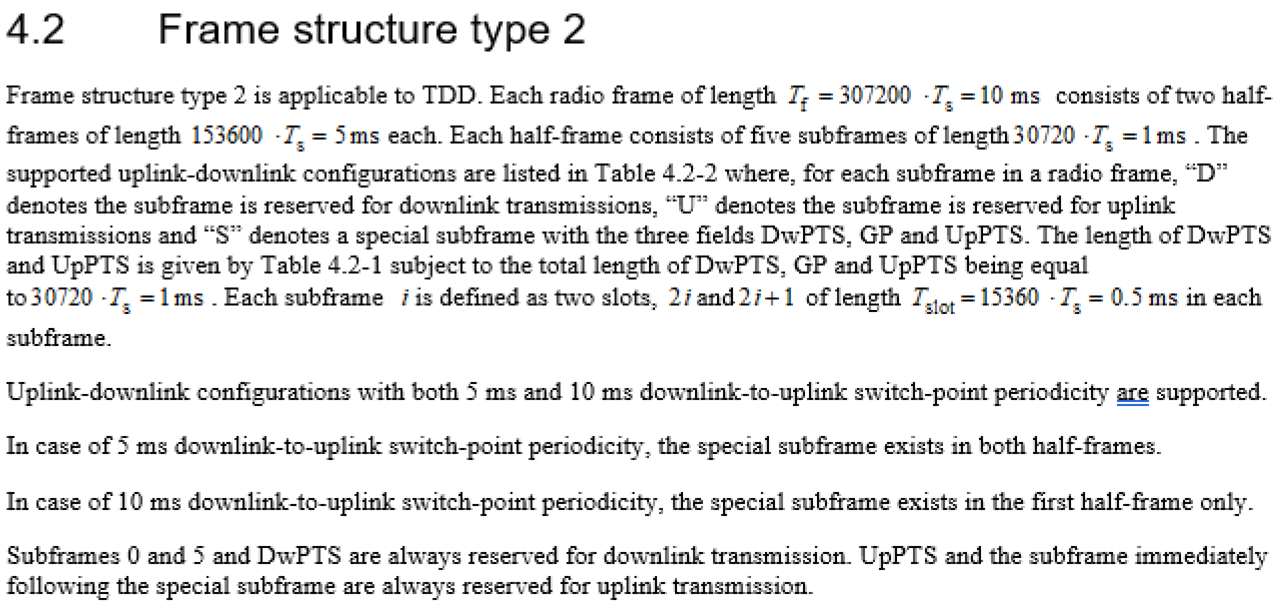


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

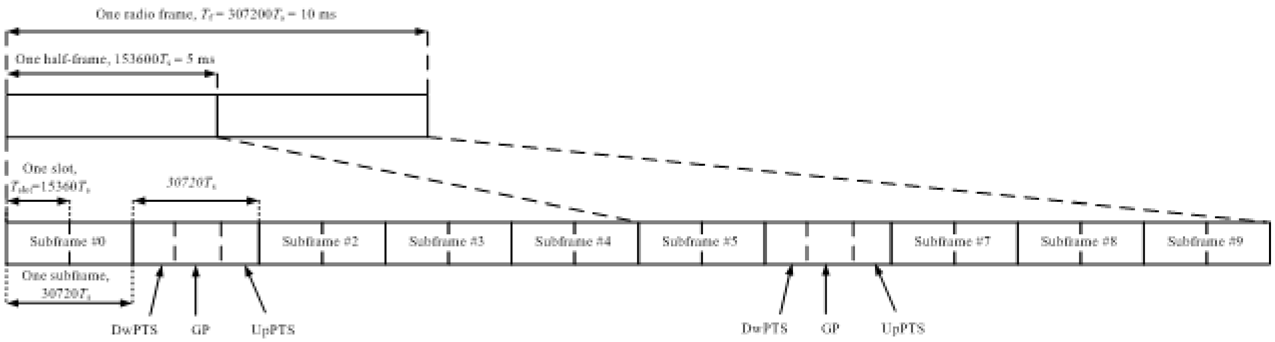


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).

5.2 Slot structure and physical resources

5.2.1 Resource grid

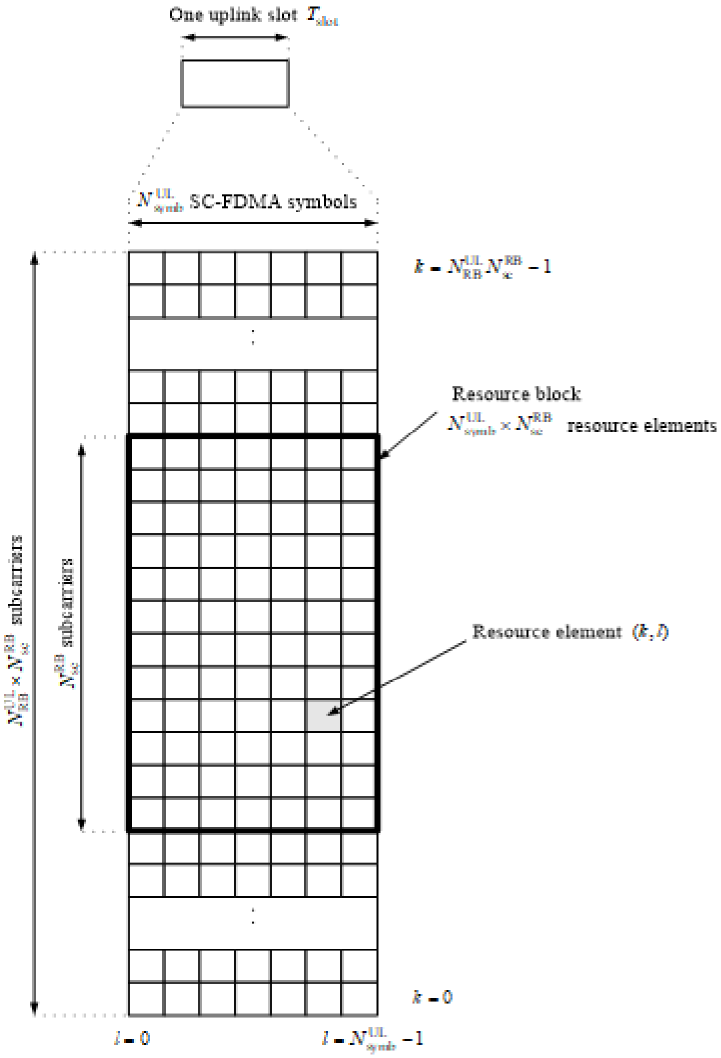
The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

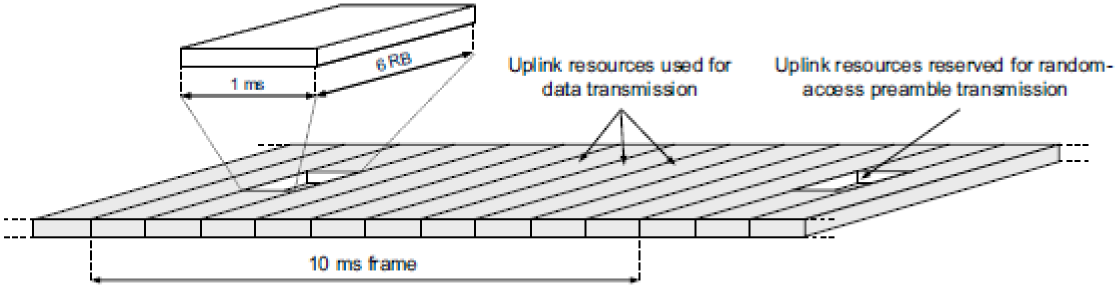
US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

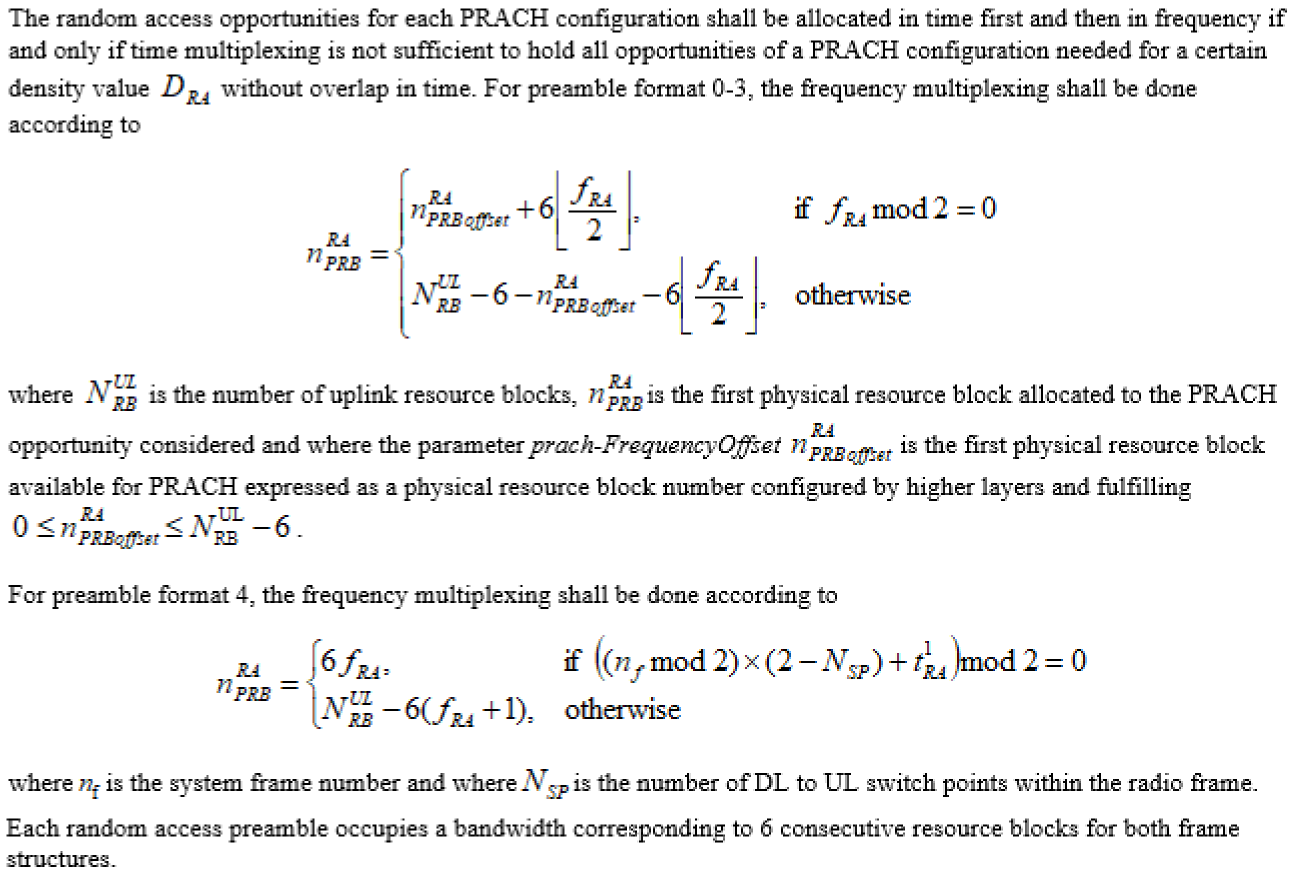
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	Toyota’s Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

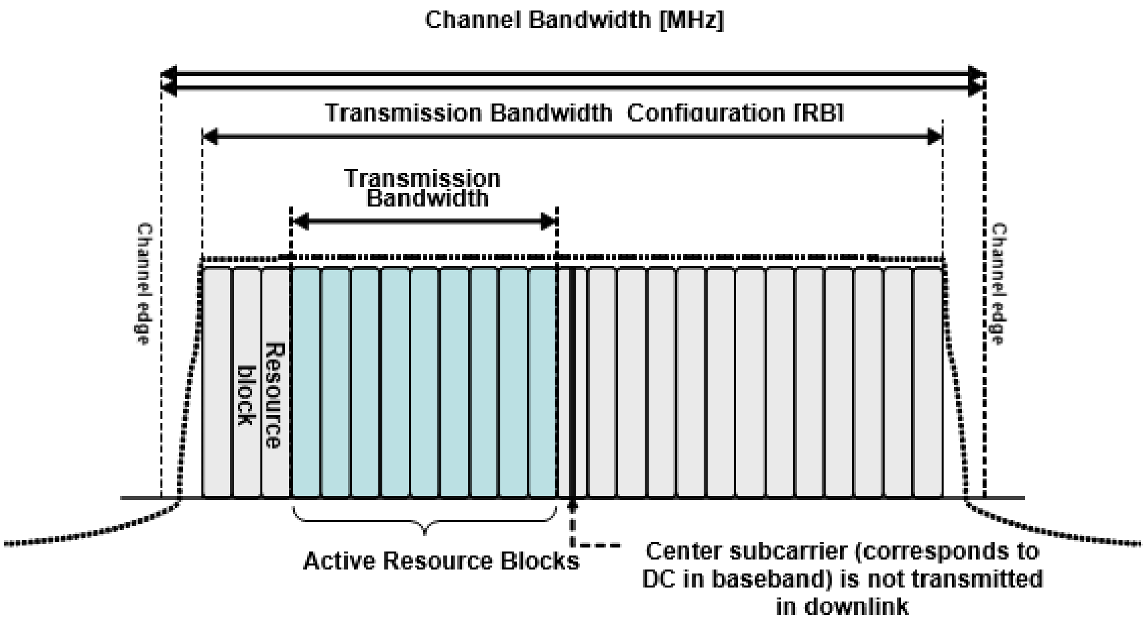
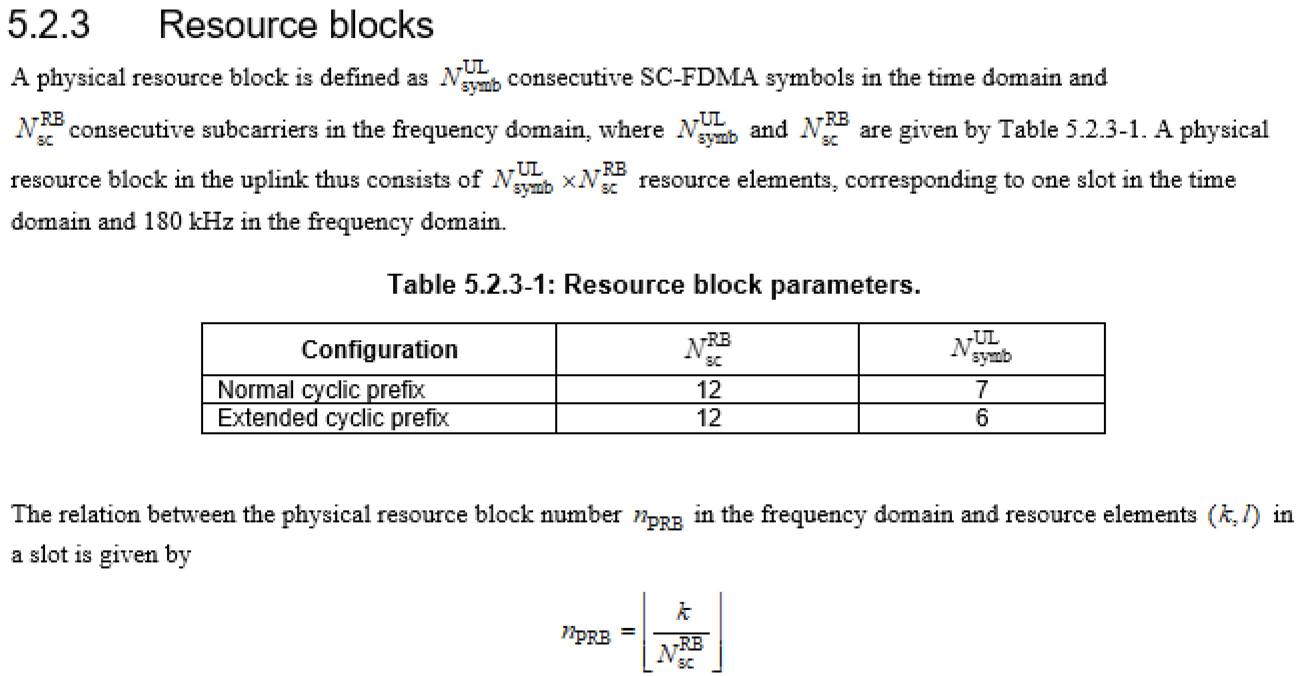


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

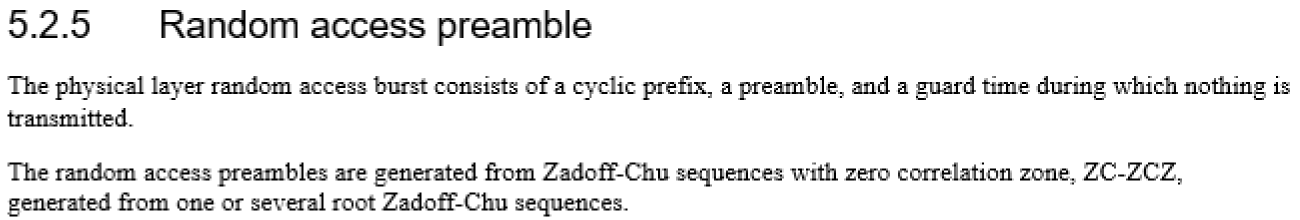
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

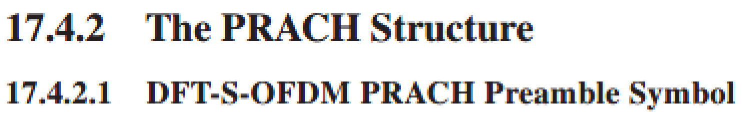


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

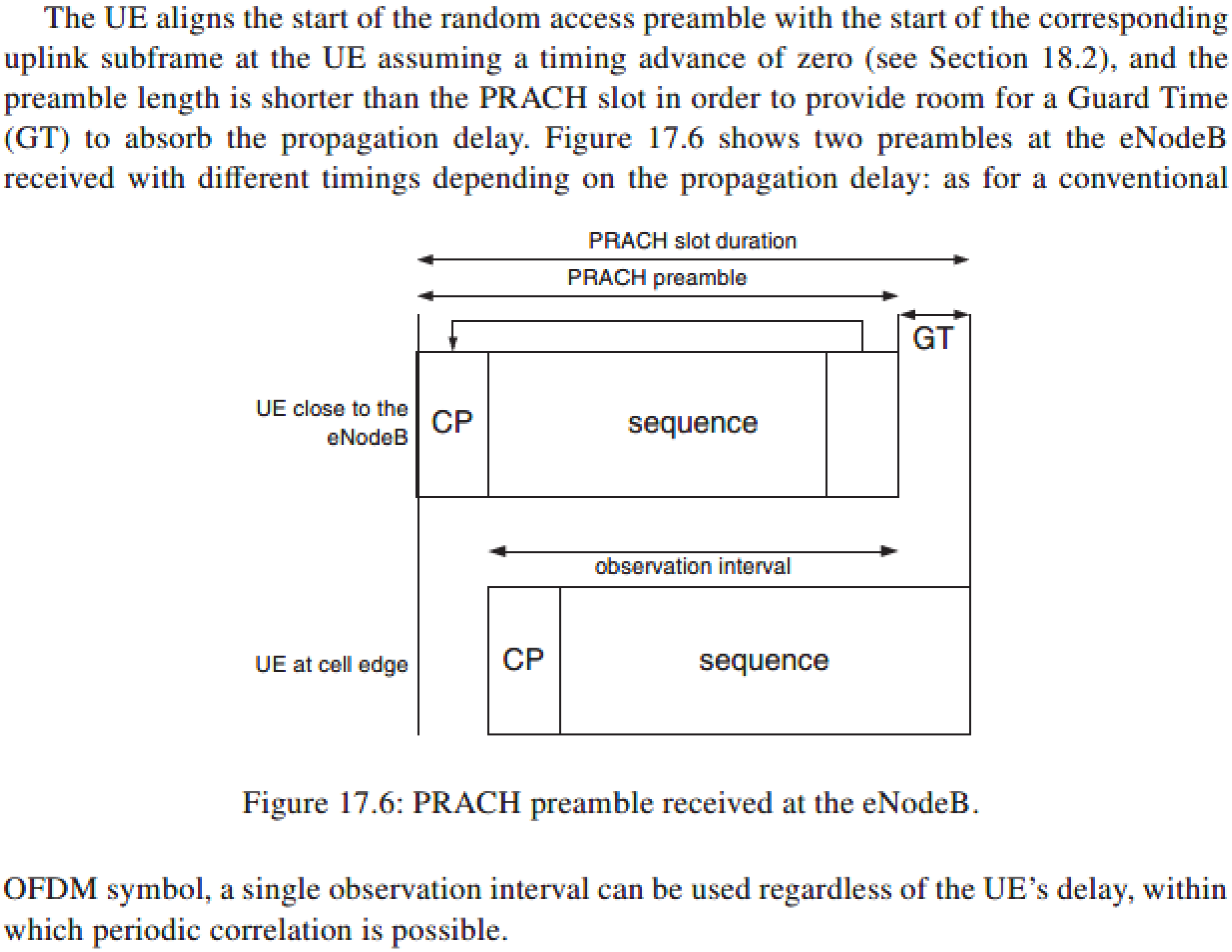


17.4.2 The PRACH Structure

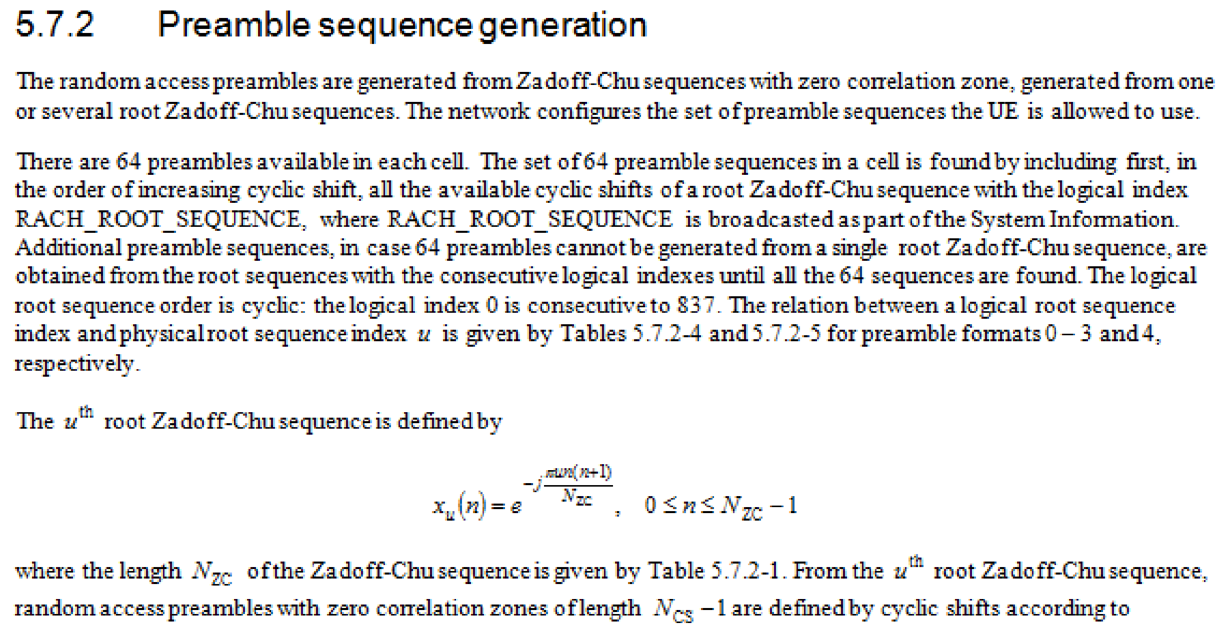
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

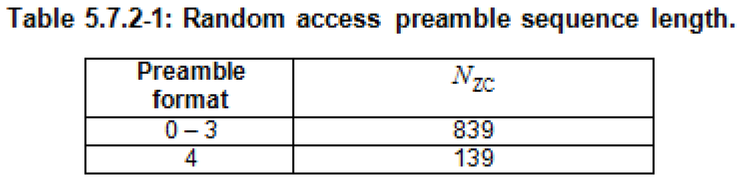
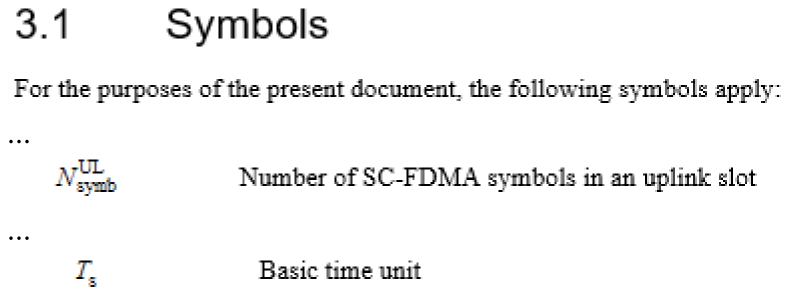
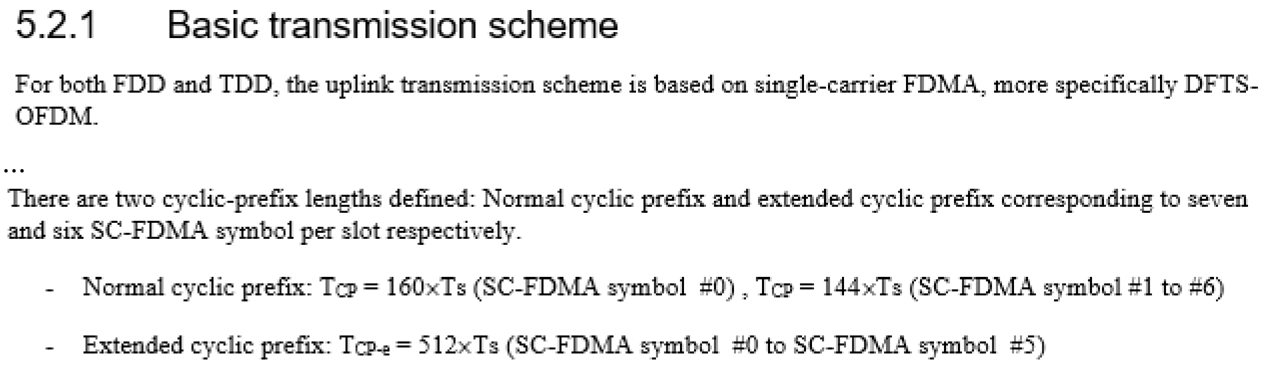


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

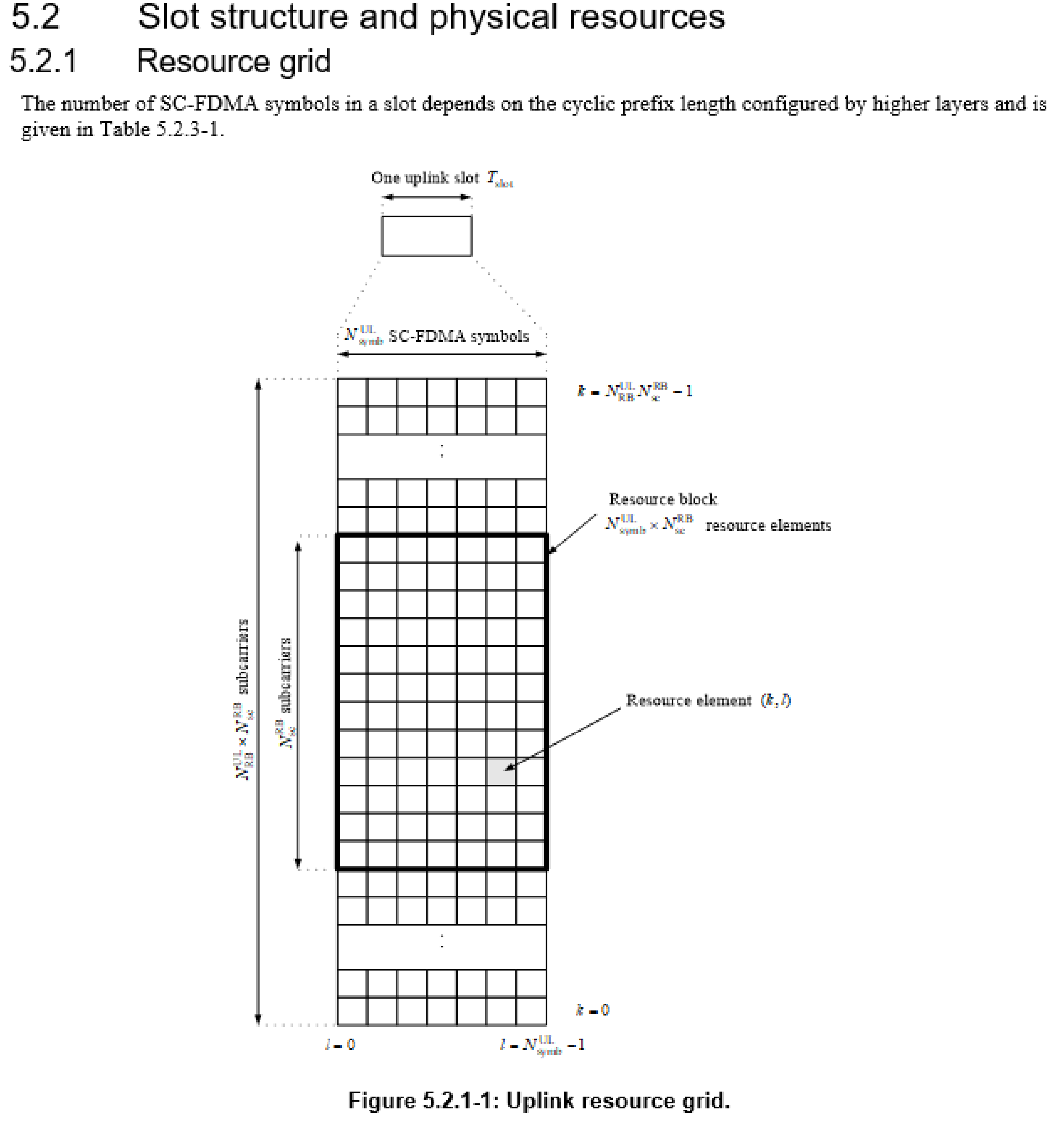
See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Toyota's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs. **3.1 Symbols** For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals. **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)

"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



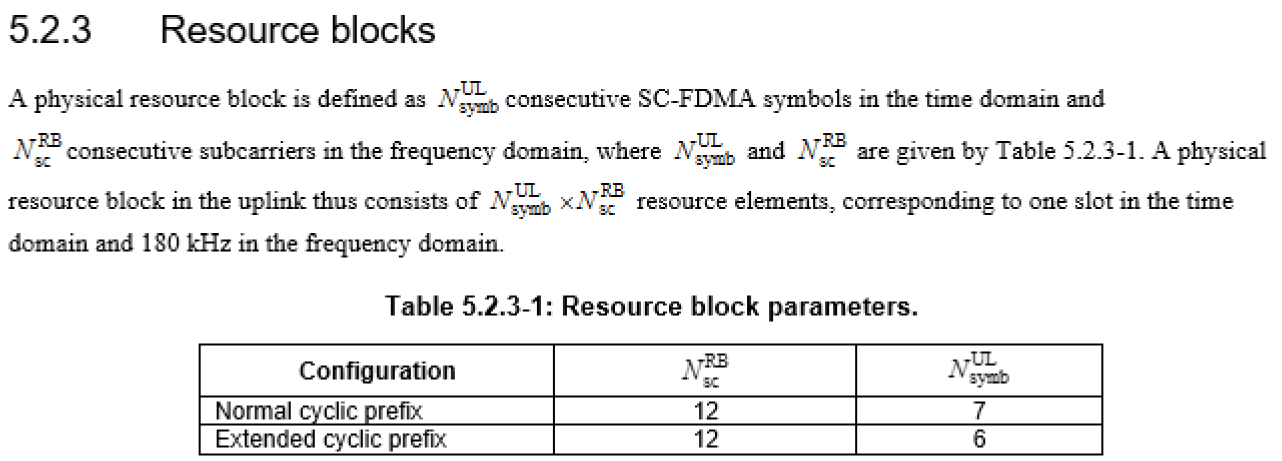
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

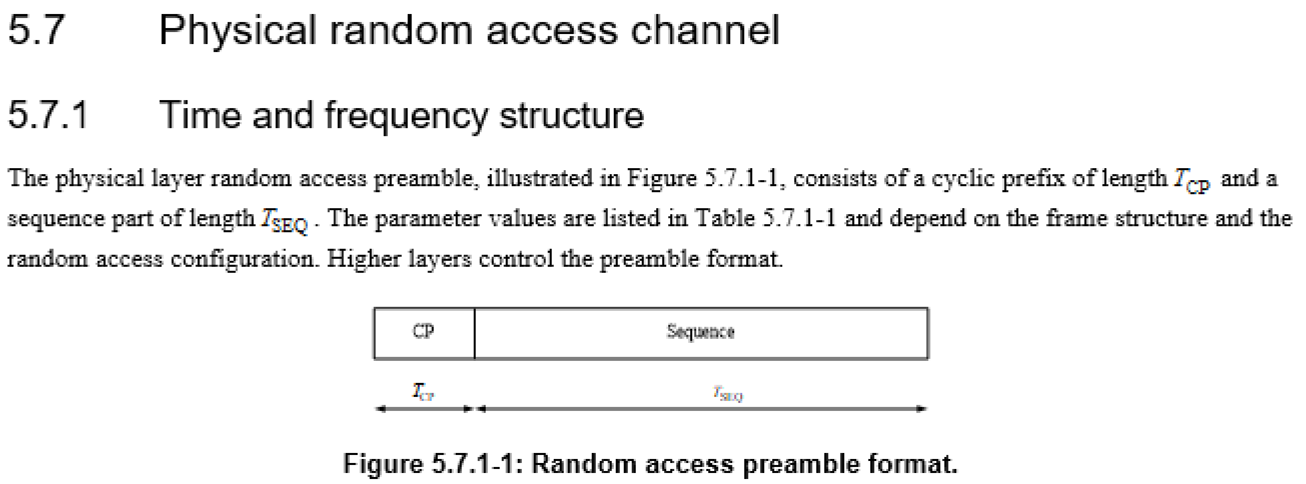
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

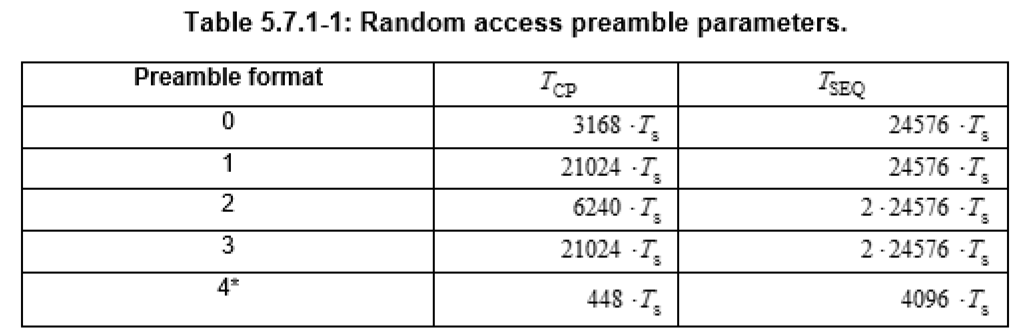
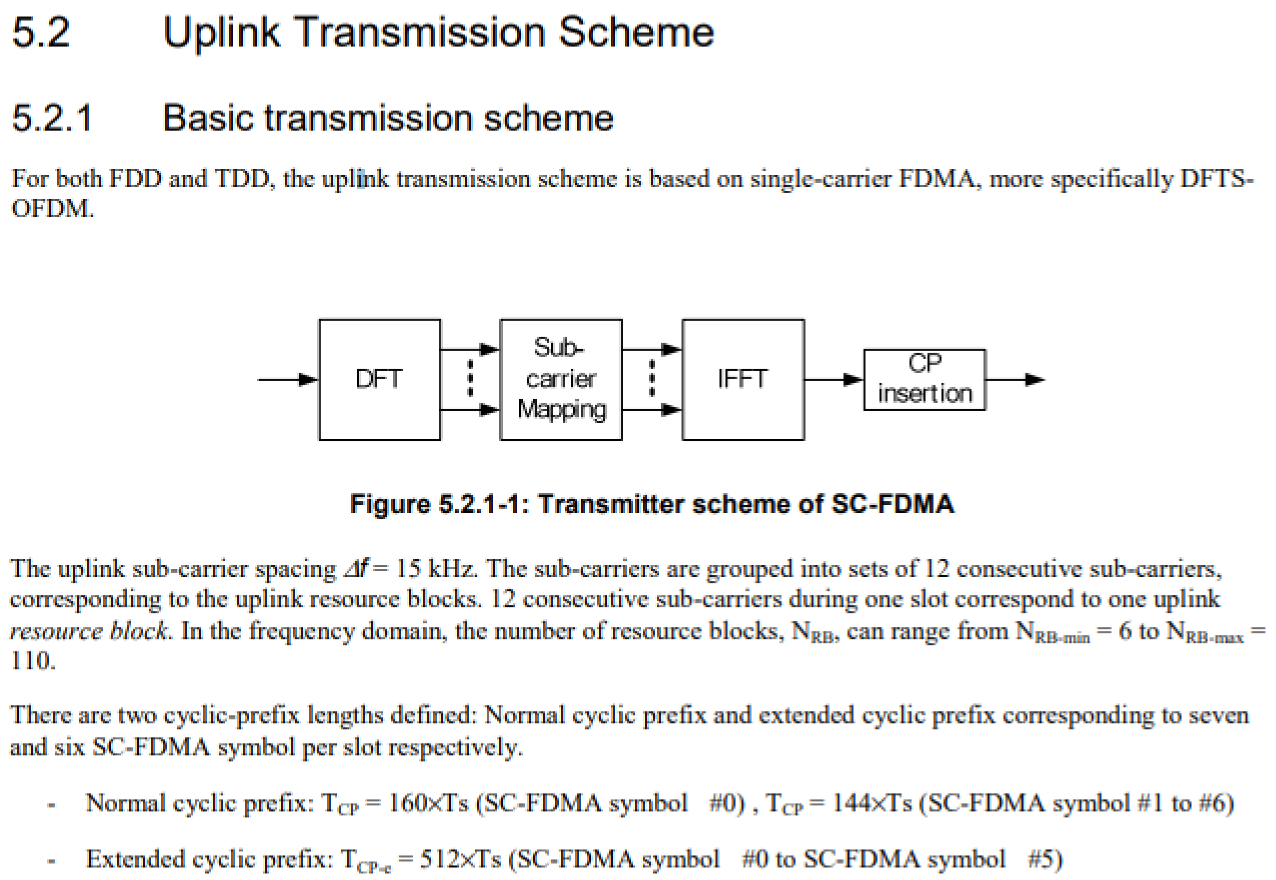


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	Toyota’s Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, Toyota’s Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)
"a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;"

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

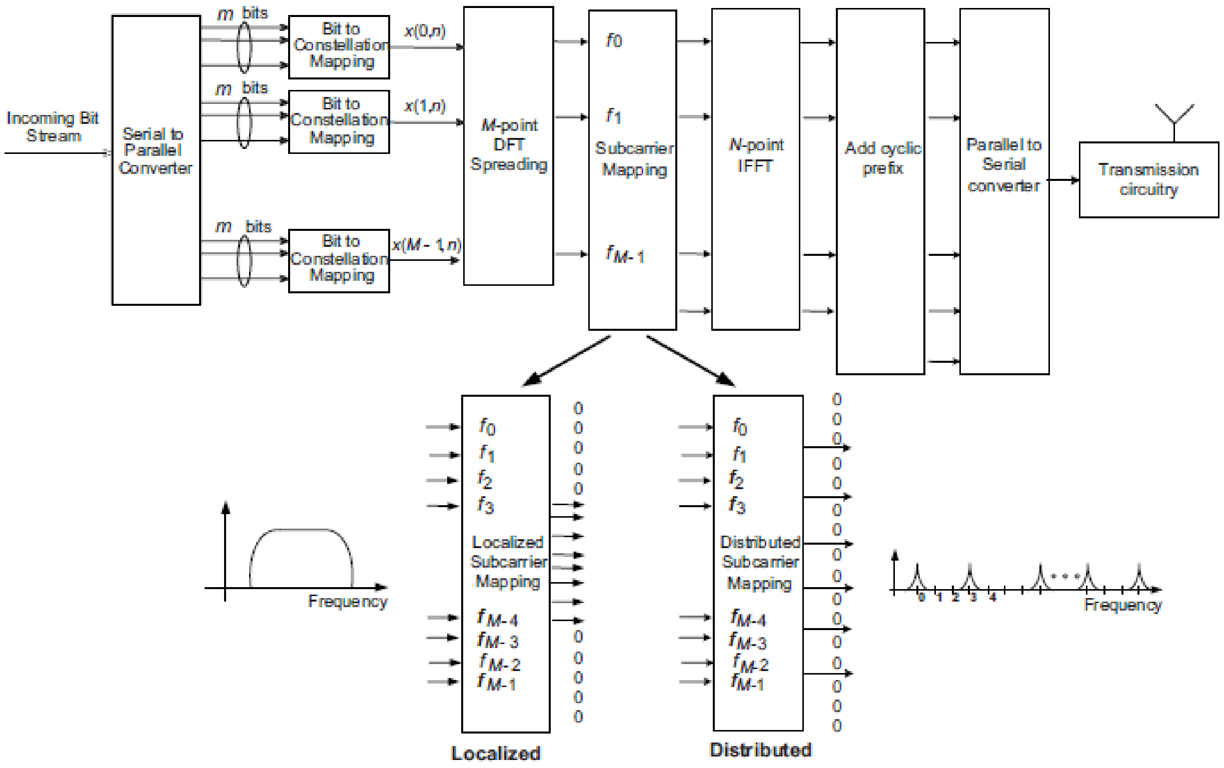


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

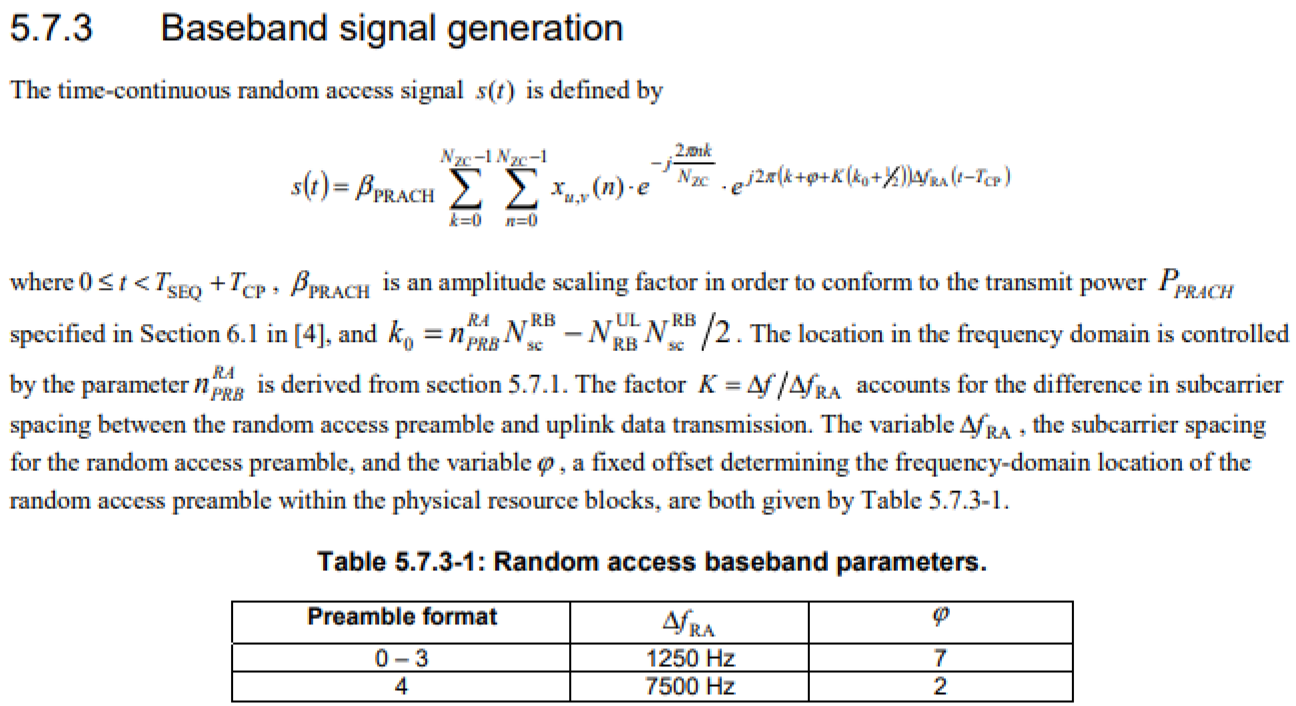
US Patent No. 10,833,908: Claim 21(f)

“wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band”

wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;

Toyota’s Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1} x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\text{RA}}\left(t-T_{\text{CP}}\right)}$$

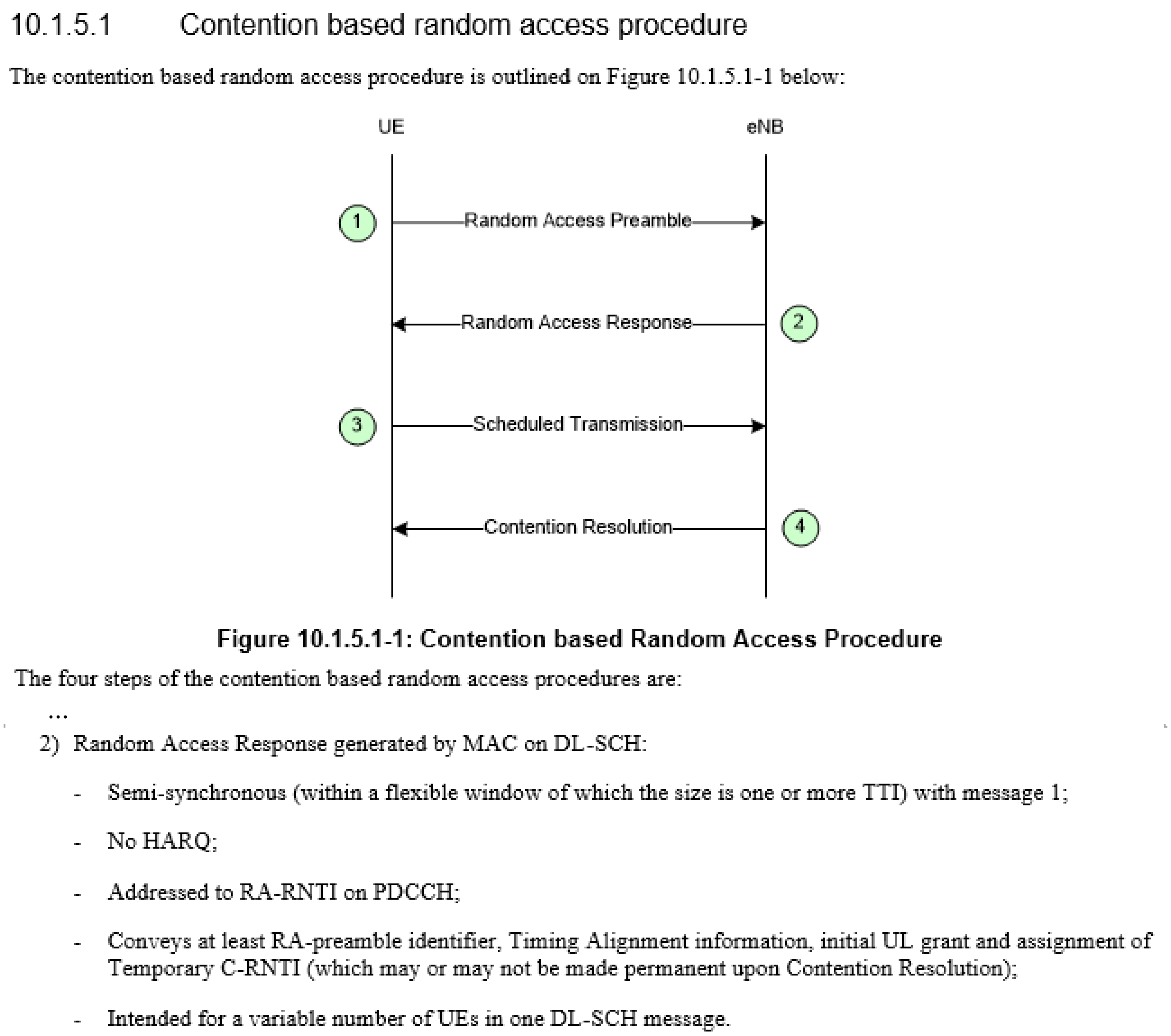
where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

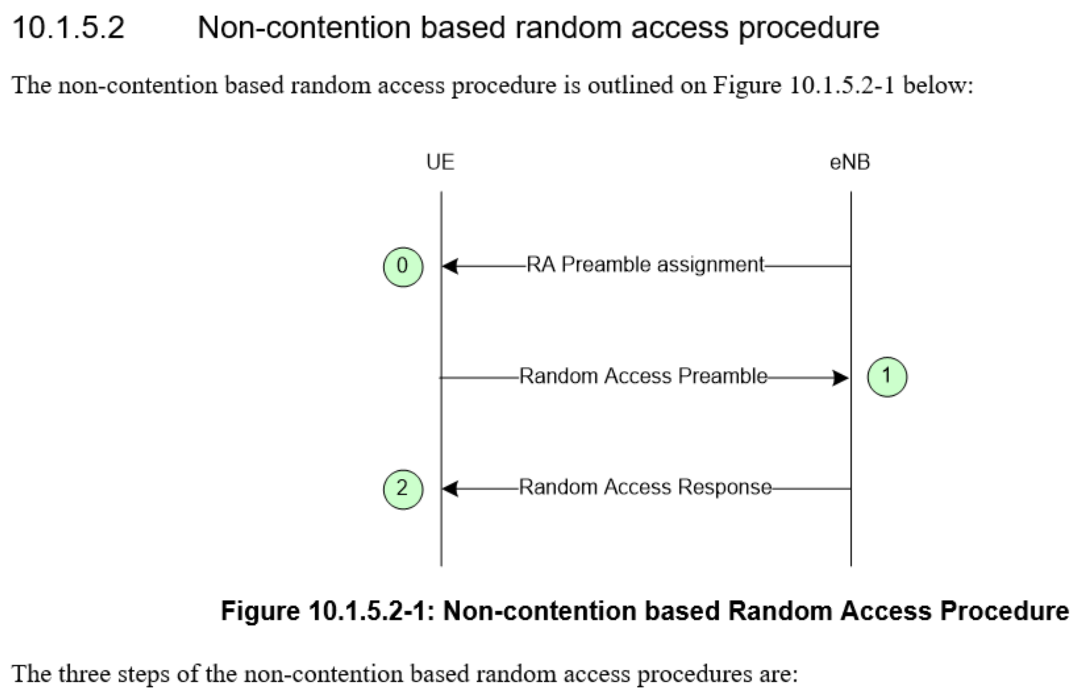
See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

wherein the mobile station is further configured to receive, from the base station, a second analog signal	Toyota's Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



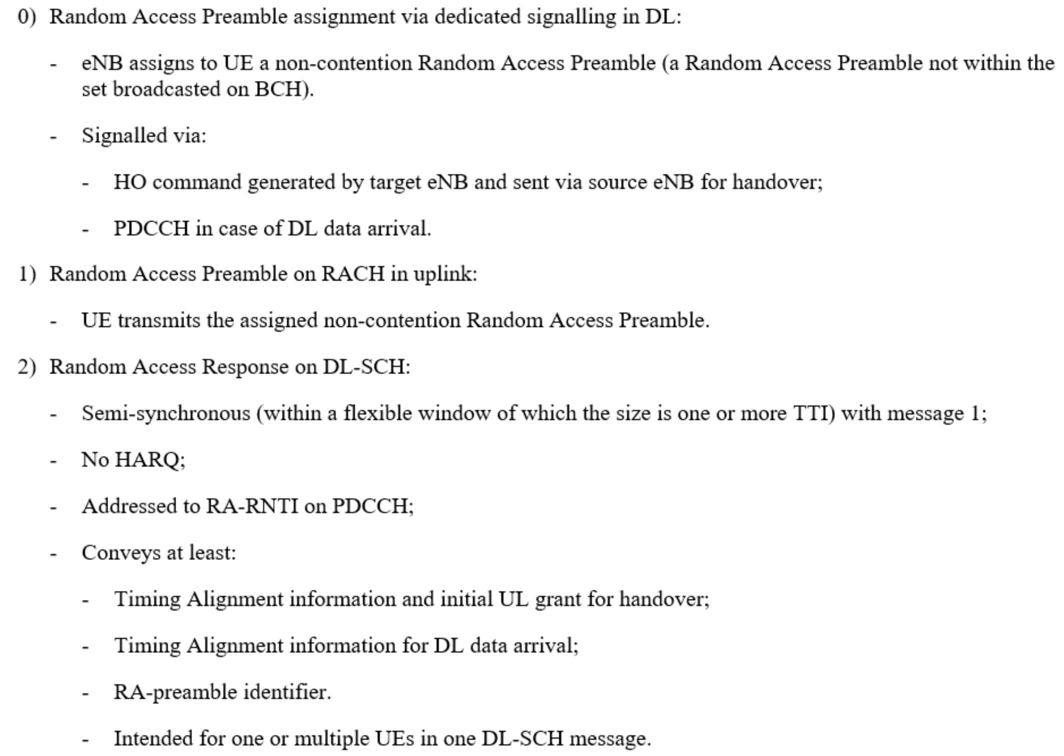
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

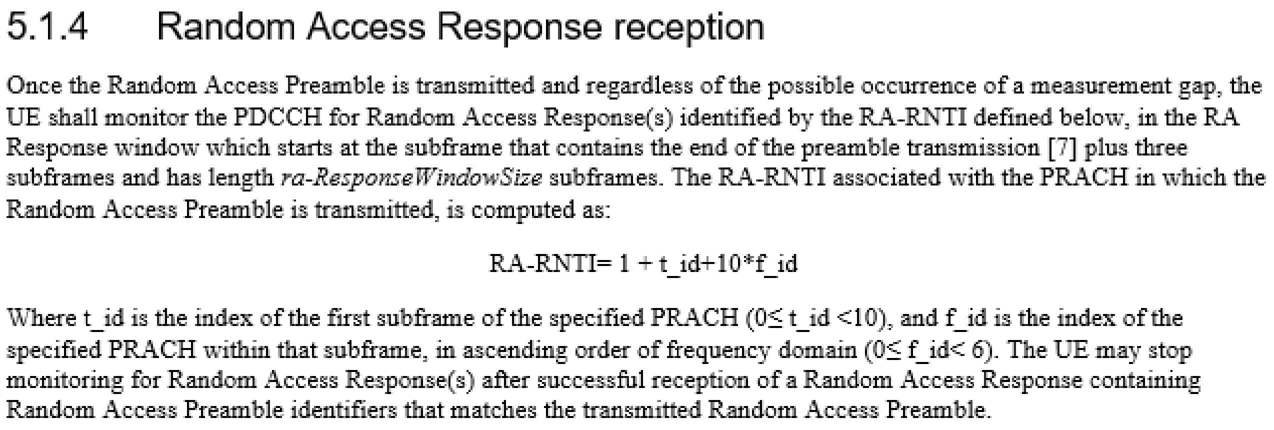


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

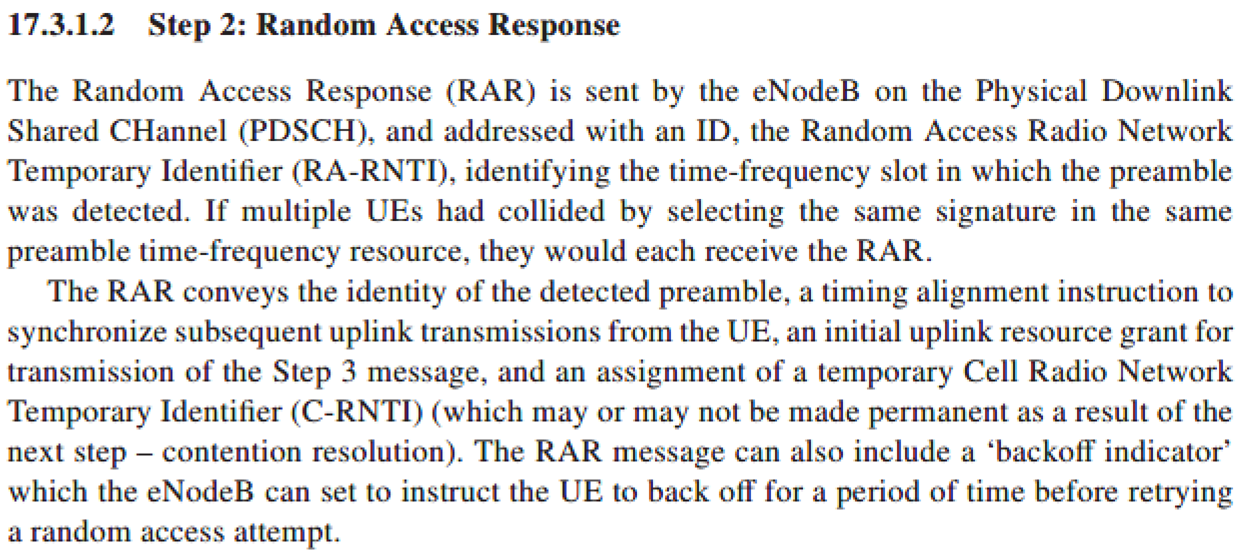
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\le t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\le f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

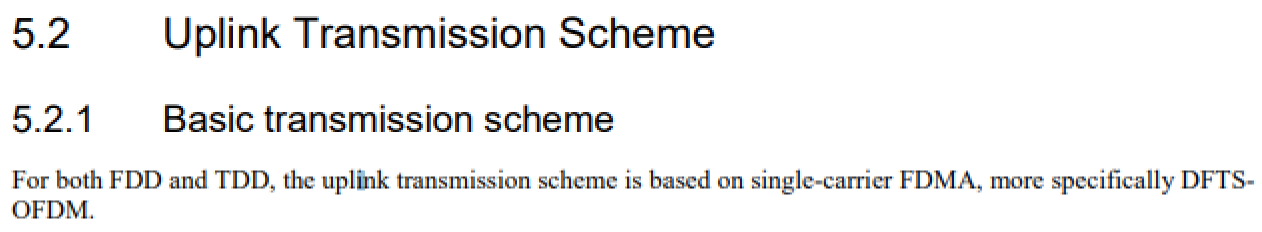
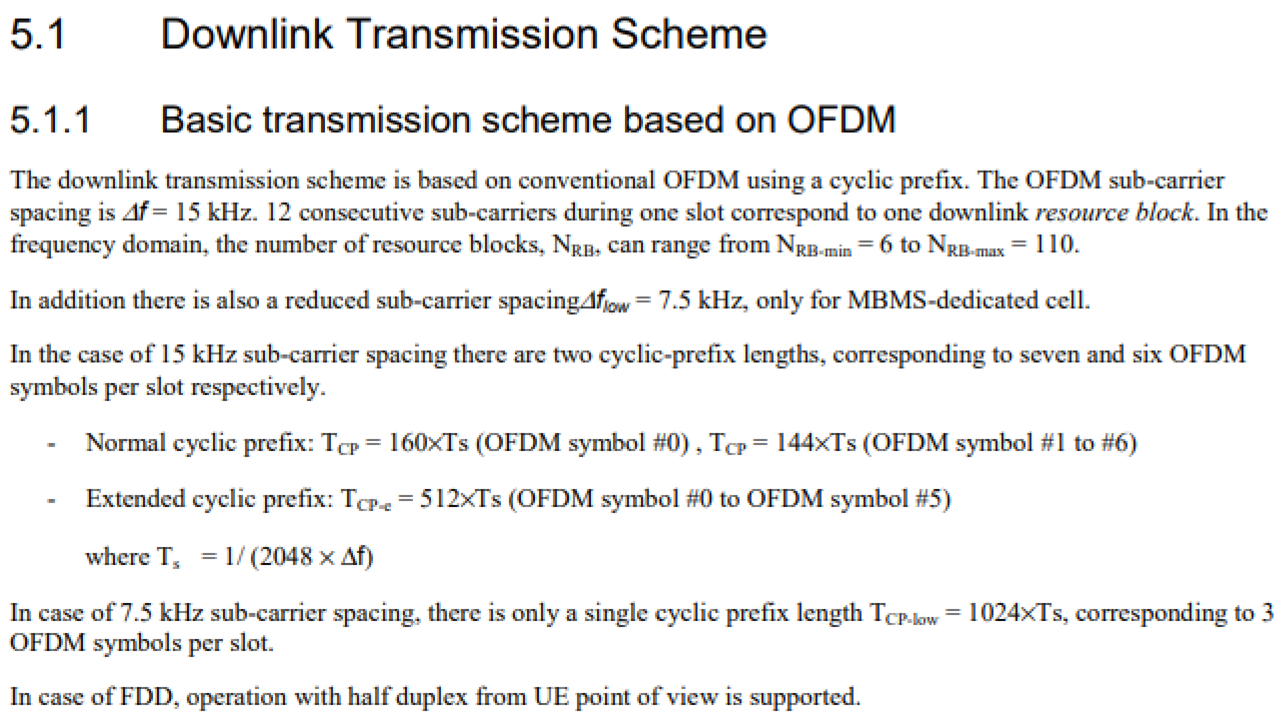
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	Toyota's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, Toyota's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.  5.1 Downlink Transmission Scheme 5.1.1 Basic transmission scheme based on OFDM The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

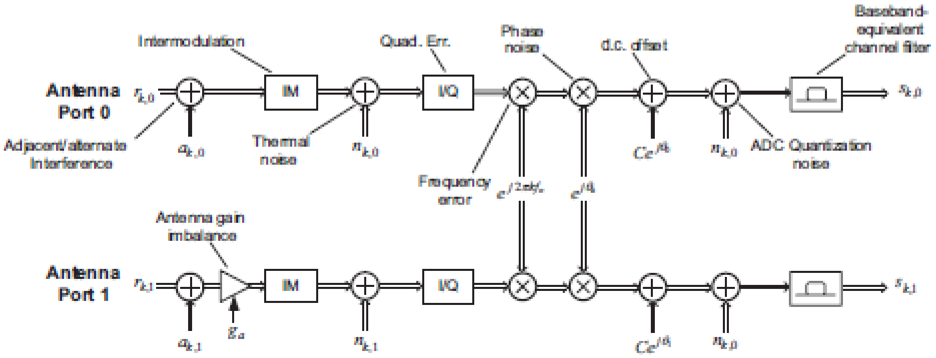


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.

- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

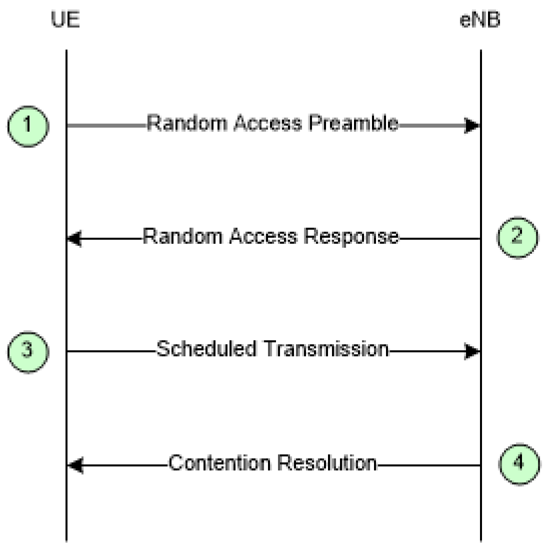


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

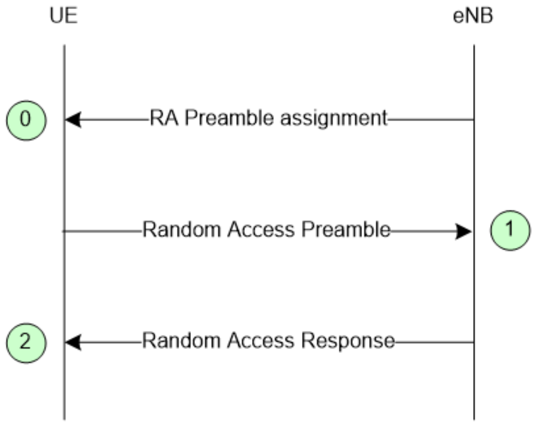
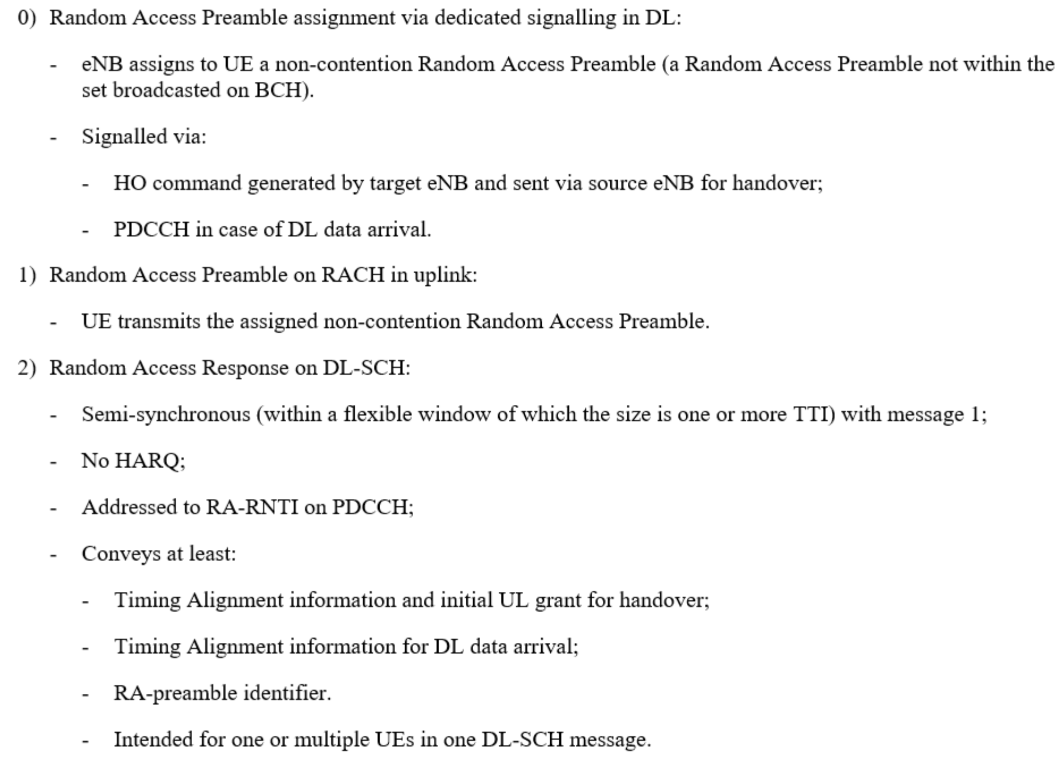


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

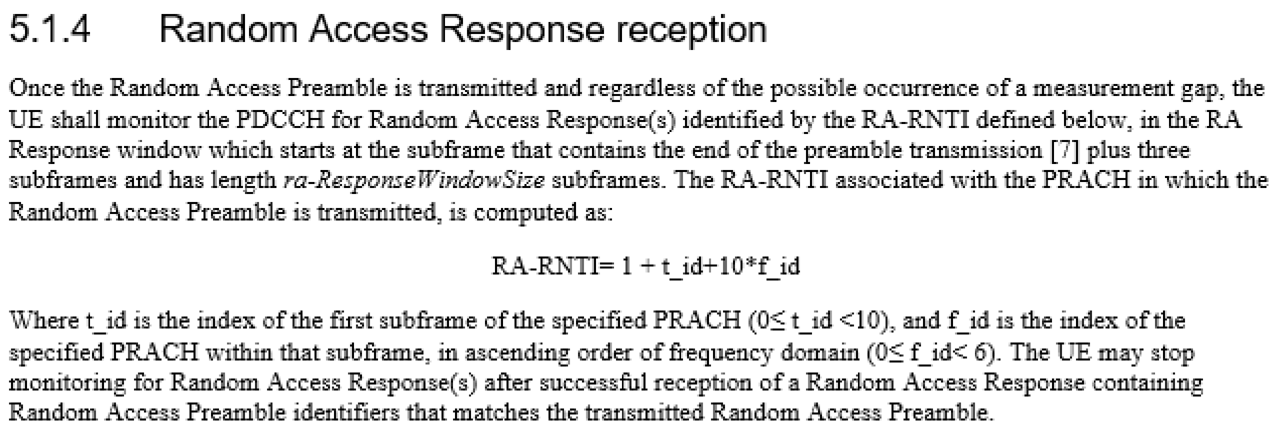


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.

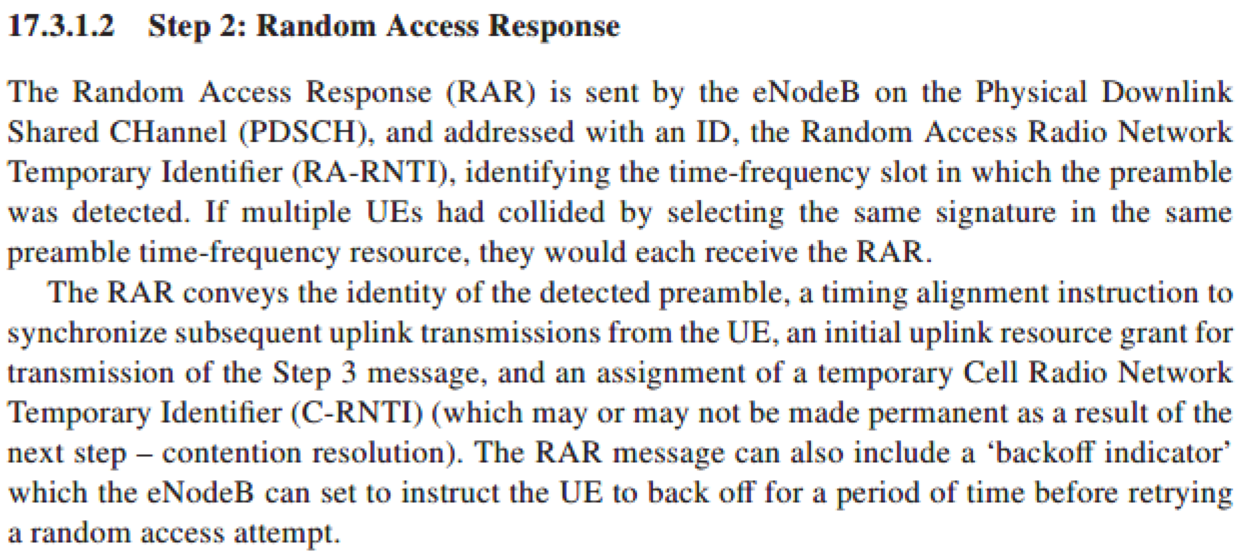


5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

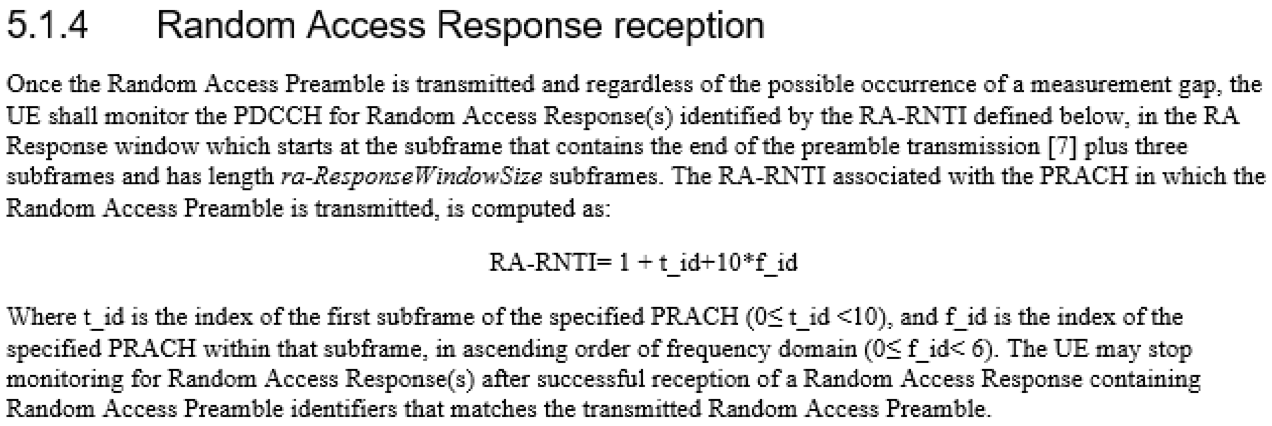
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

	See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

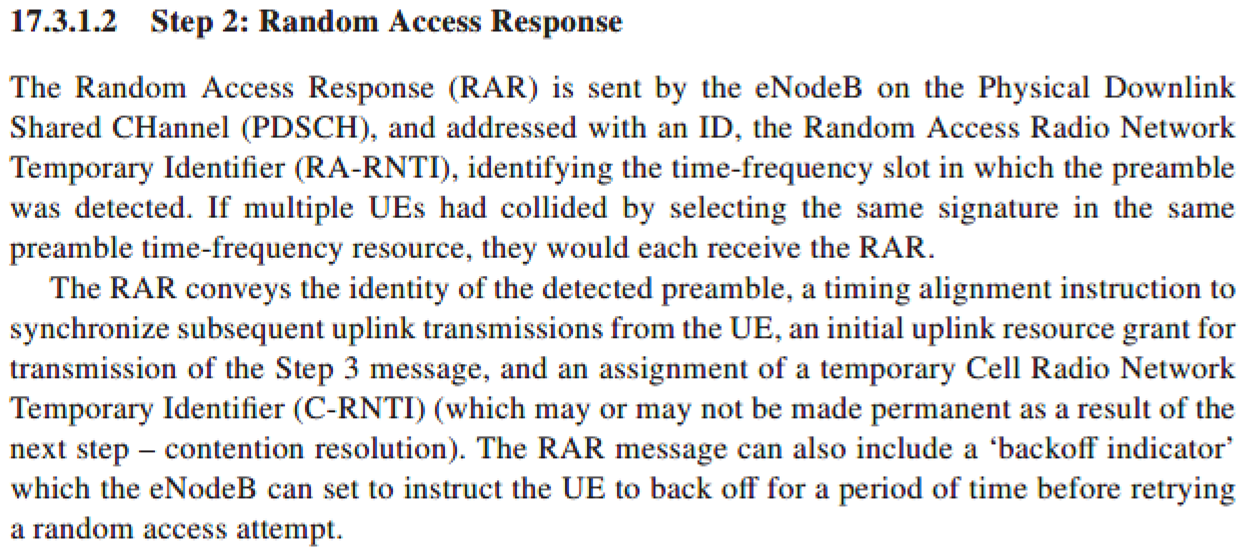
US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

22. The mobile station of claim 21, wherein:	*See* Claim 21.

US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

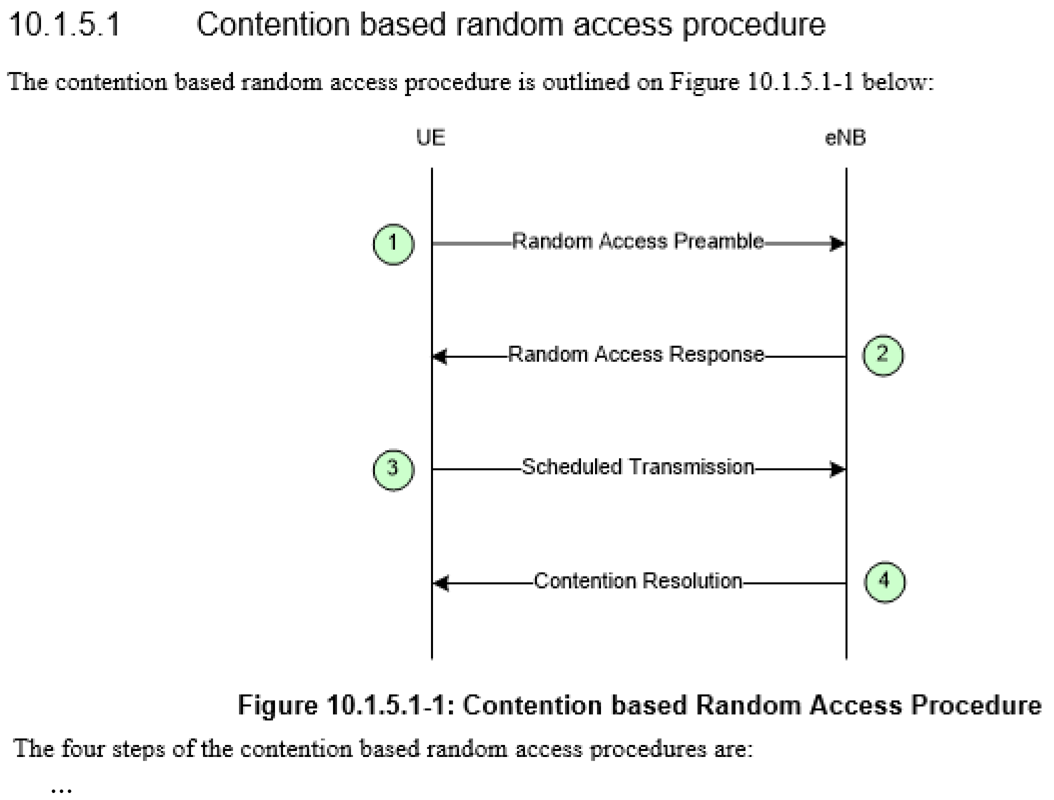
the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	Toyota’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

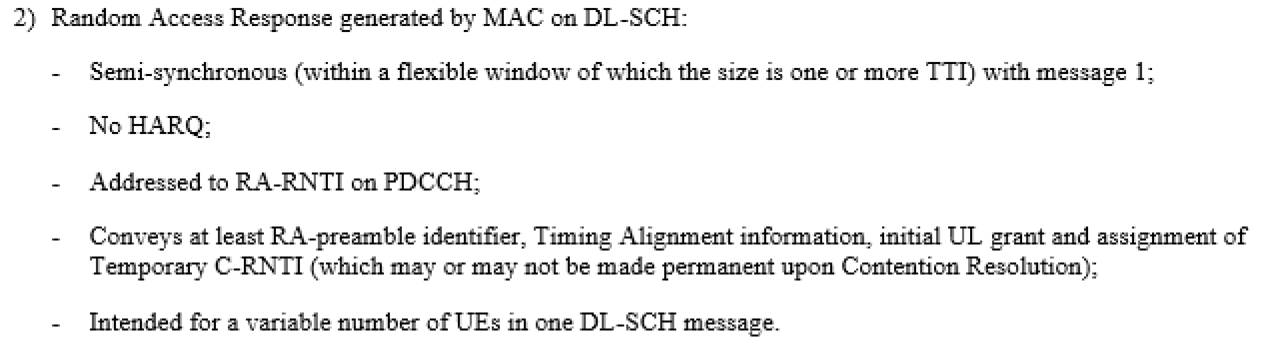
US Patent No. 10,833,908: Claim 22(c)

“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Toyota’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 22(c)

"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

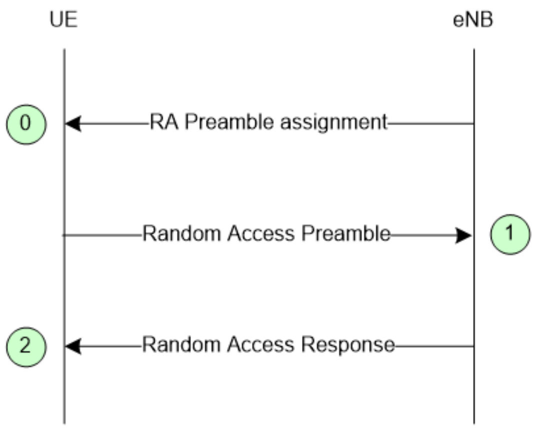
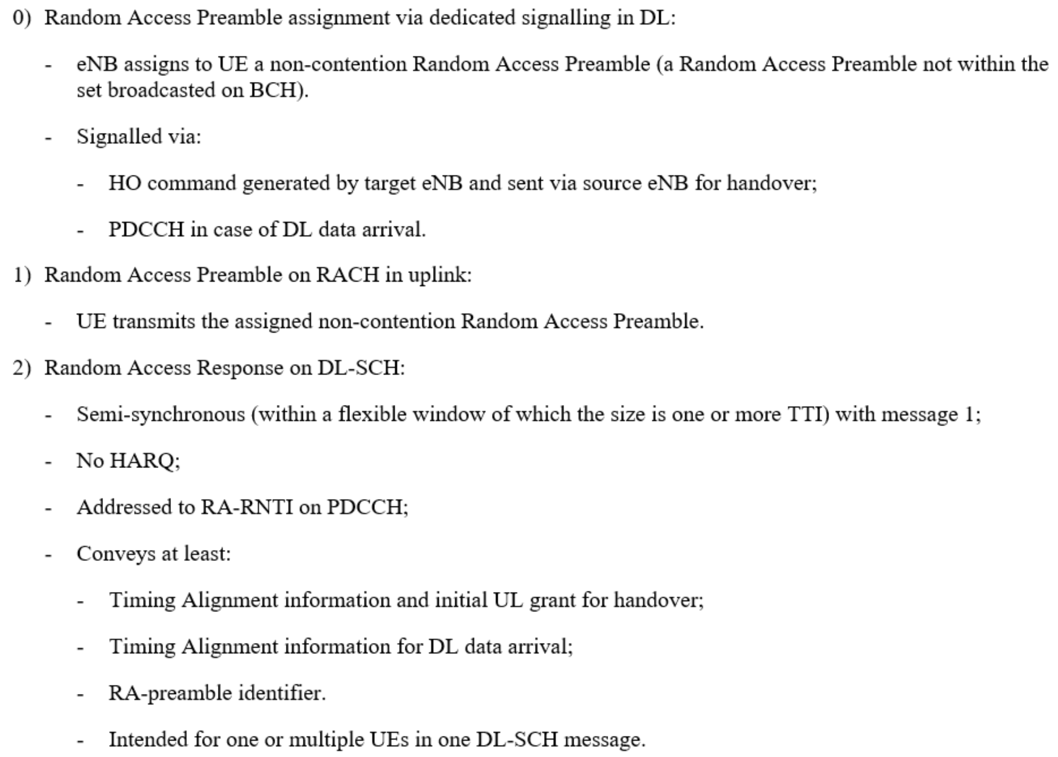


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."


0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

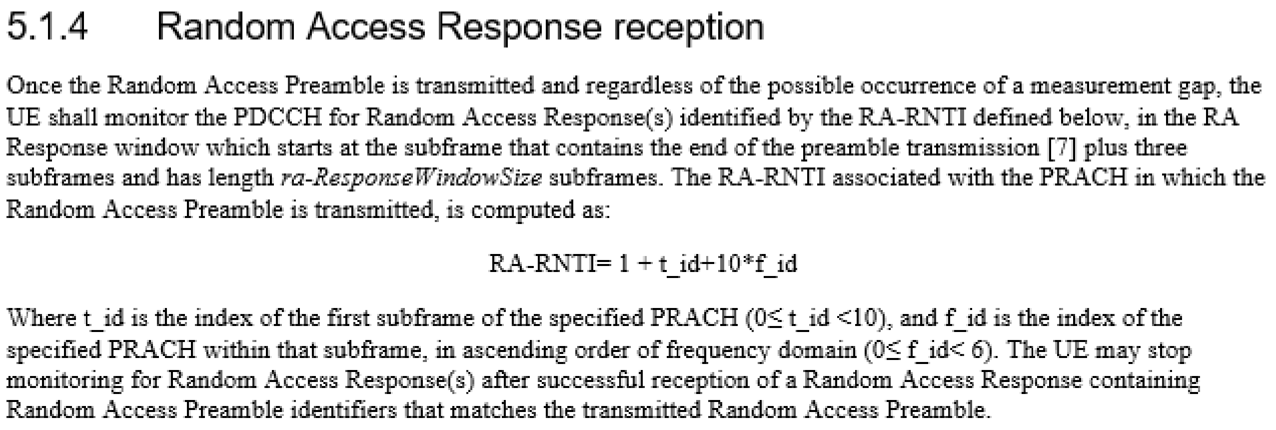
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.


5.1.4 Random Access Response reception

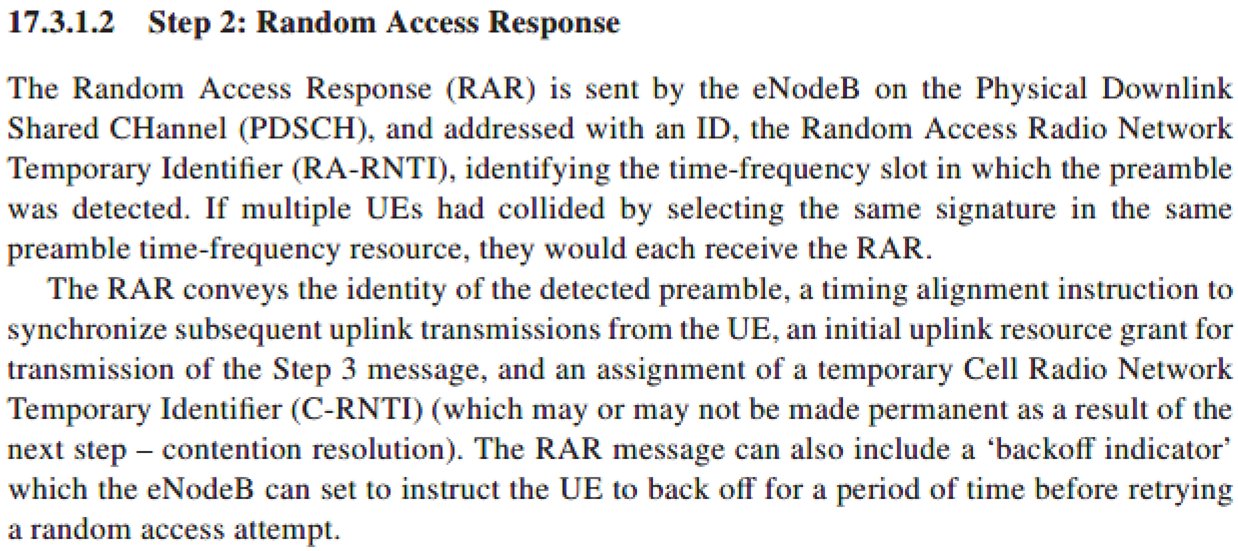
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

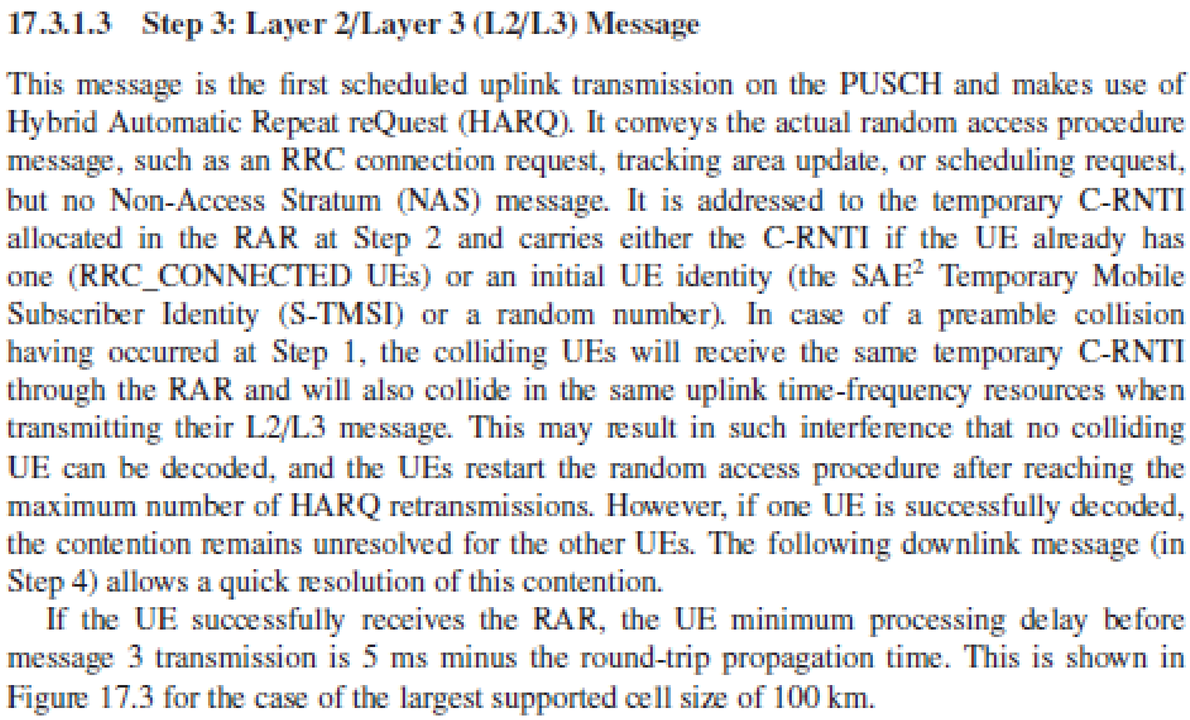
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message

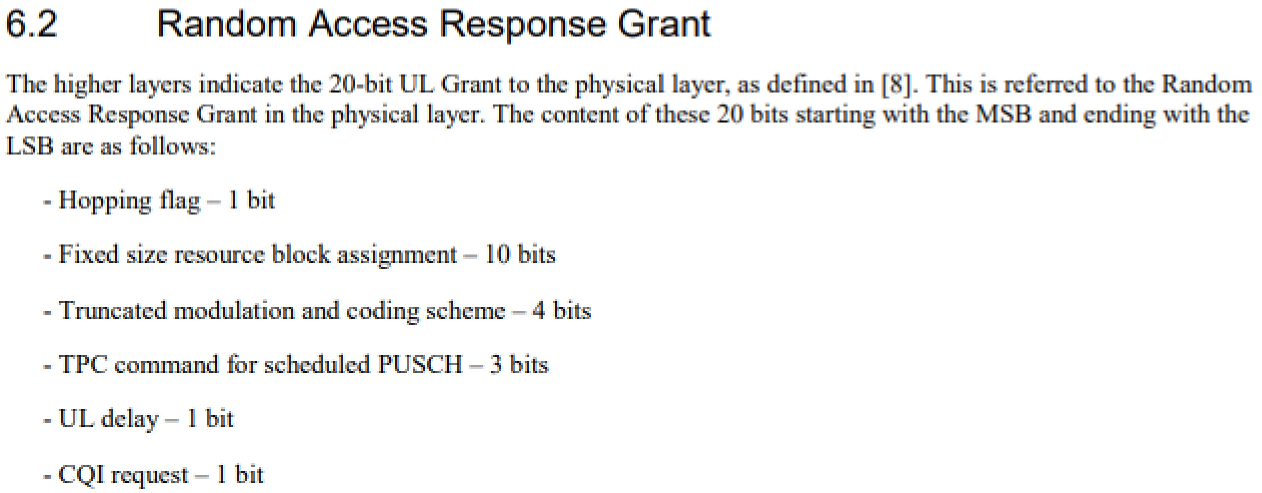
This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention.

If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km.

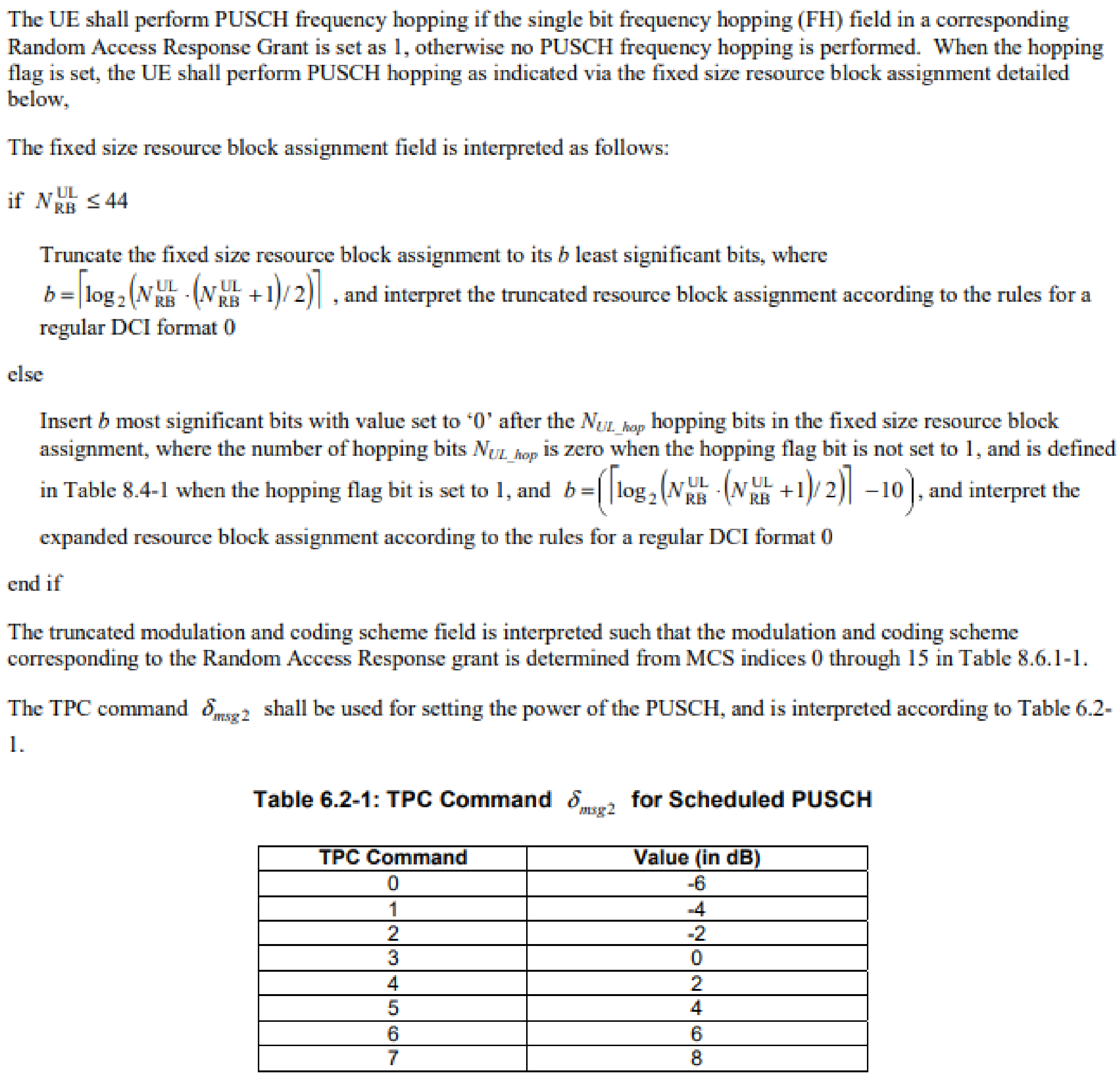
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

See also Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by Toyota's Accused Instrumentalities includes power adjustment information. *E.g.,* *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

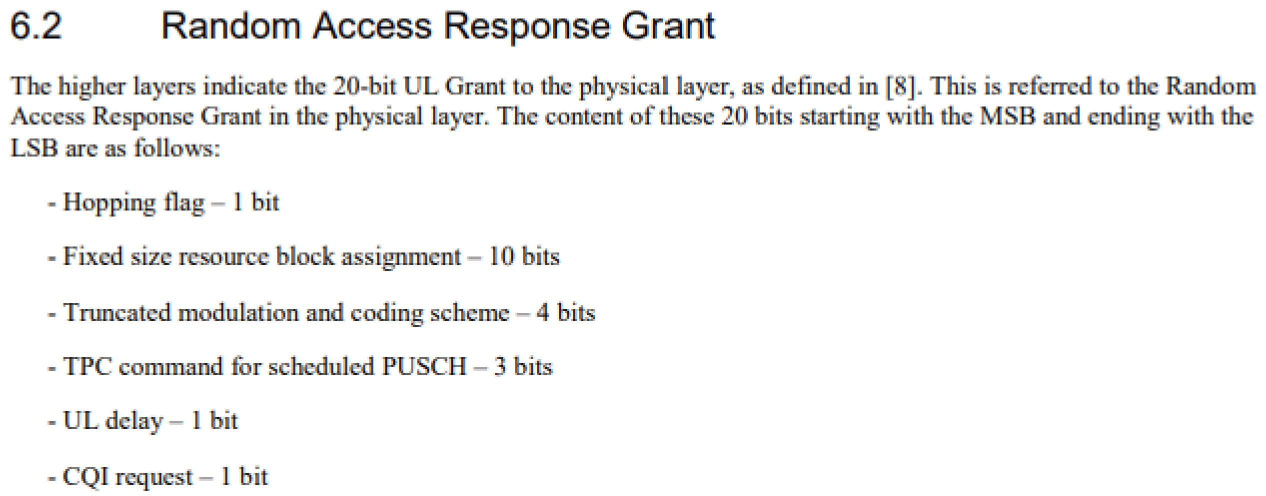
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

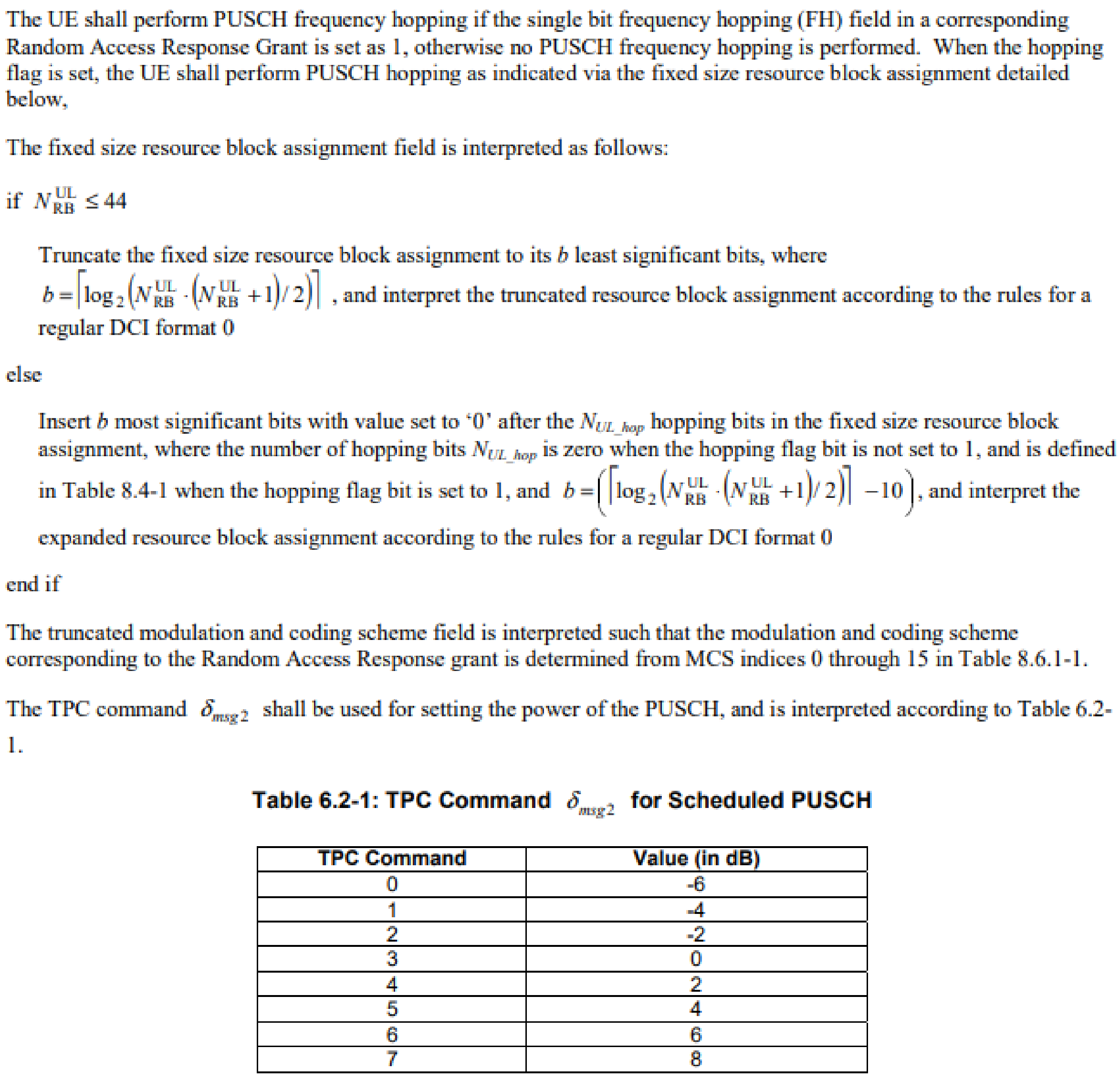
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	Toyota’s Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

> Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

> Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

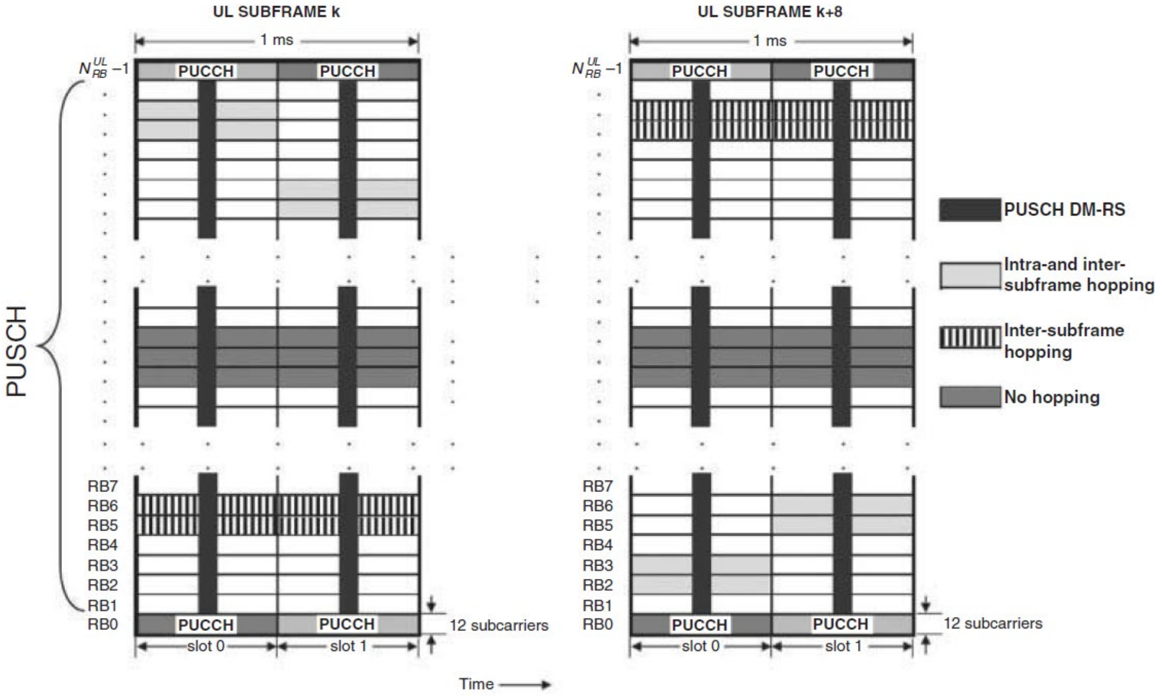
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 24

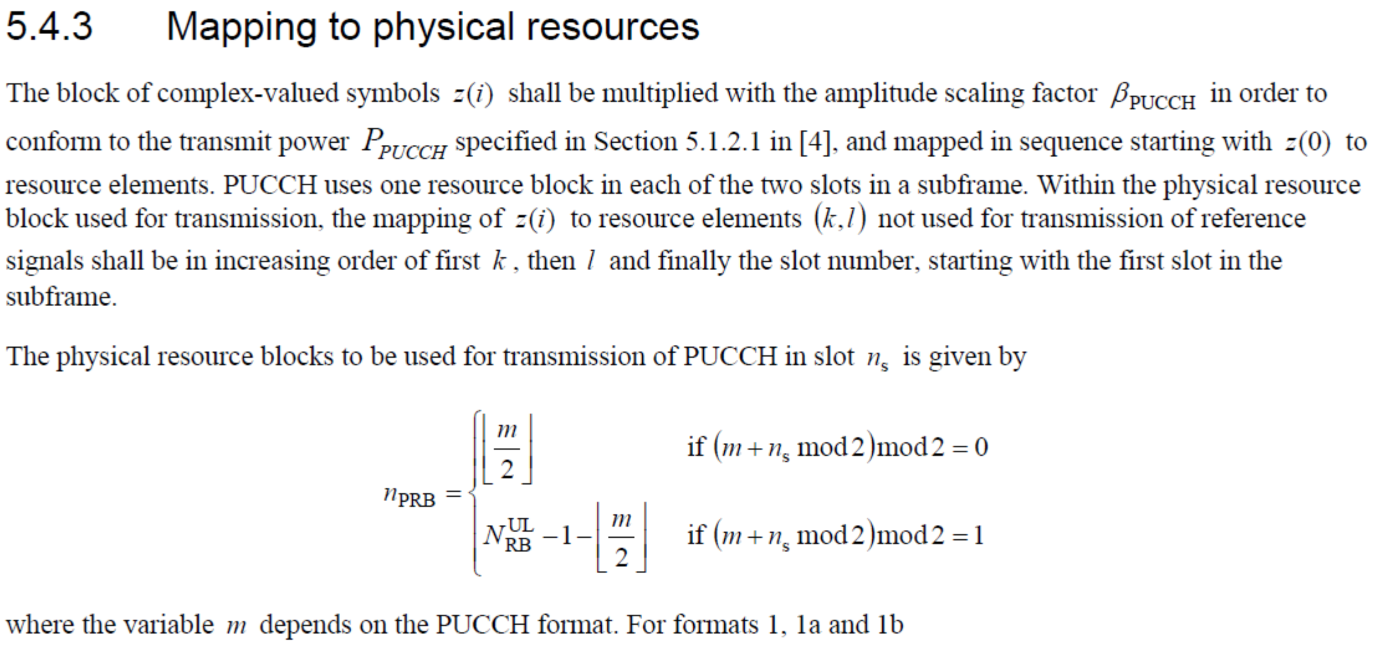
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Toyota’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\text{s}} \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\text{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

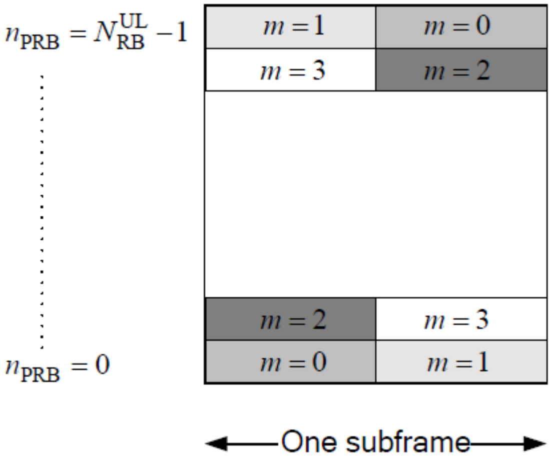


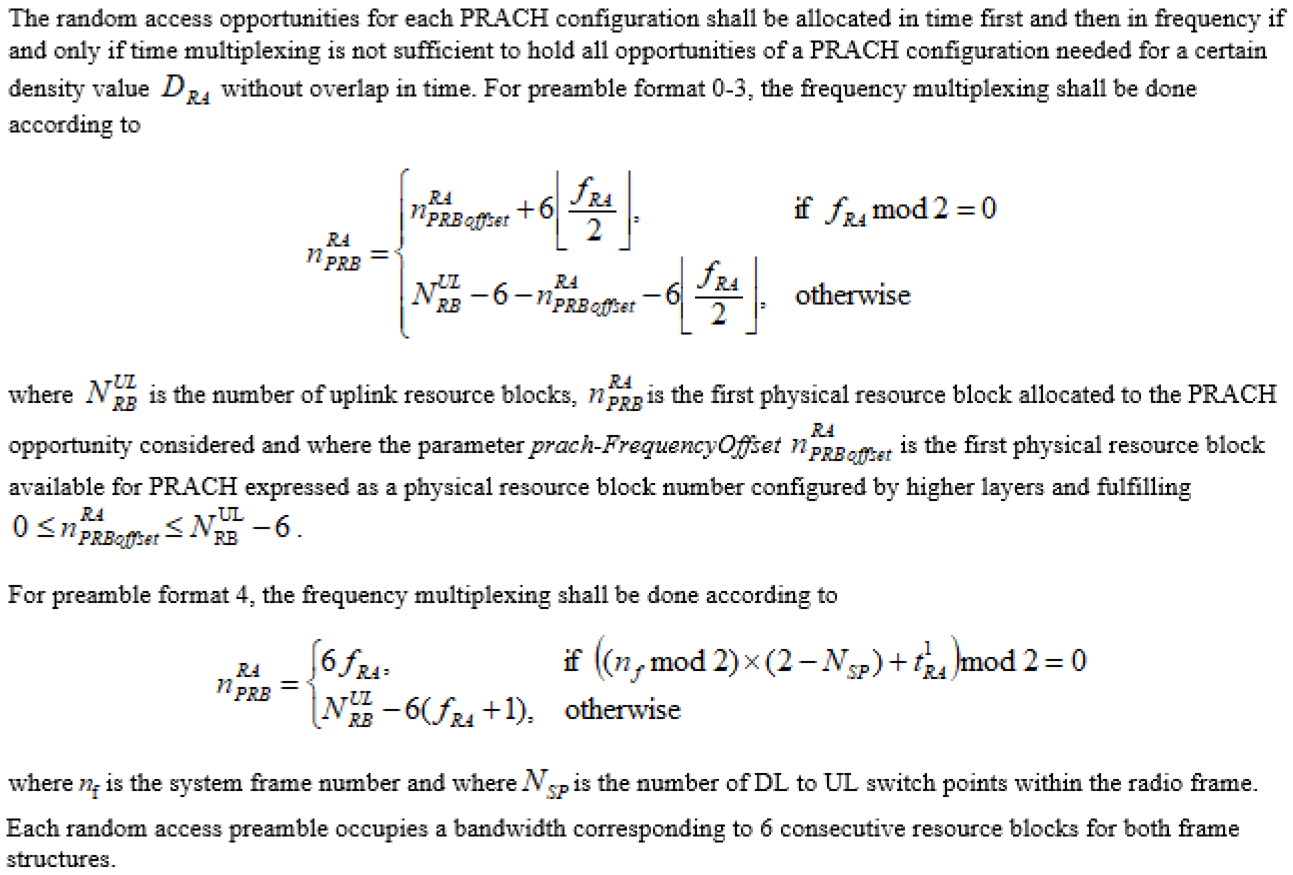
Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH. 5.7 Physical random access channel 5.7.1 Time and frequency structure ... For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\text{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\ offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\text{UL}}_{\text{RB}} - 6$. …

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 24

" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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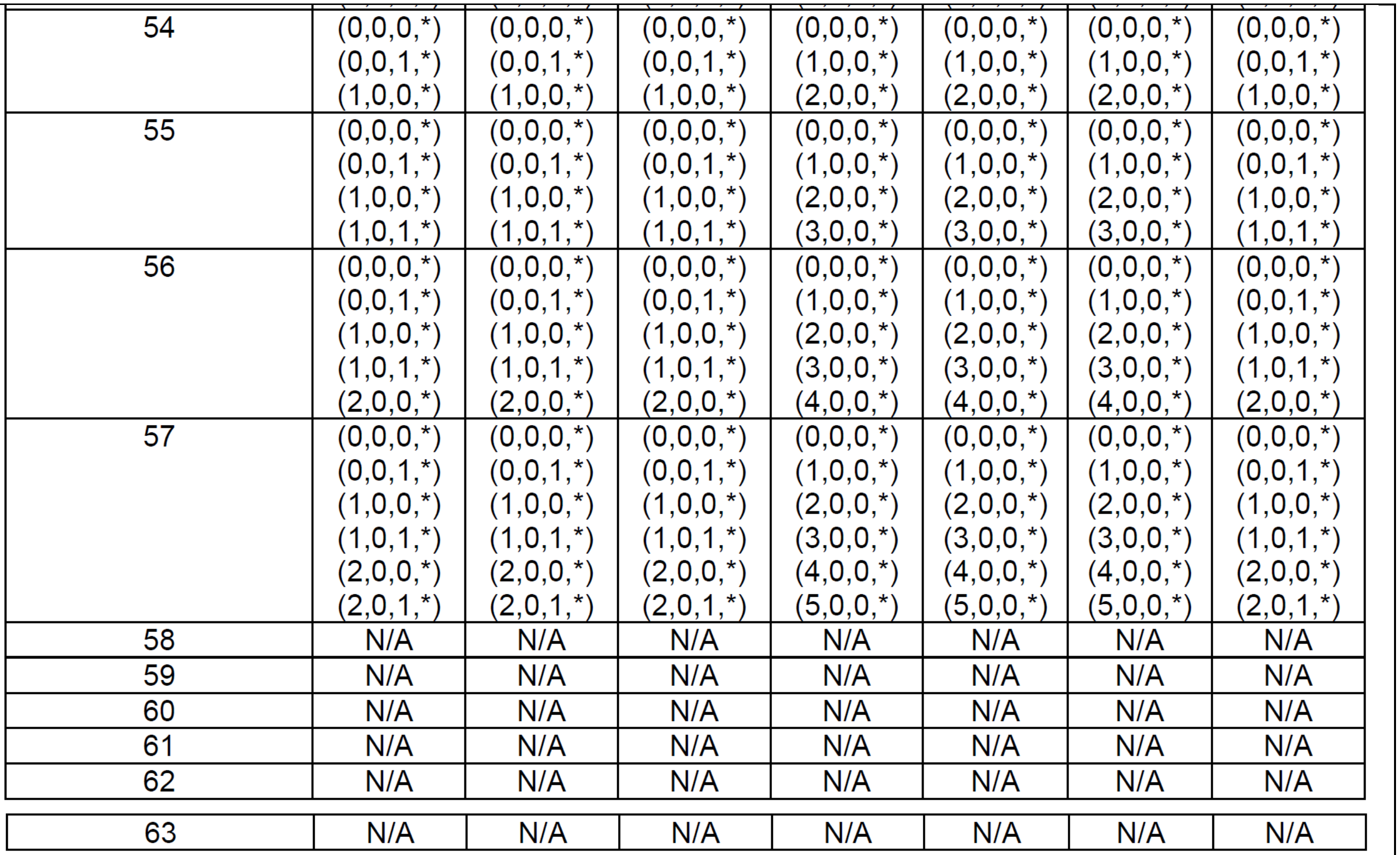
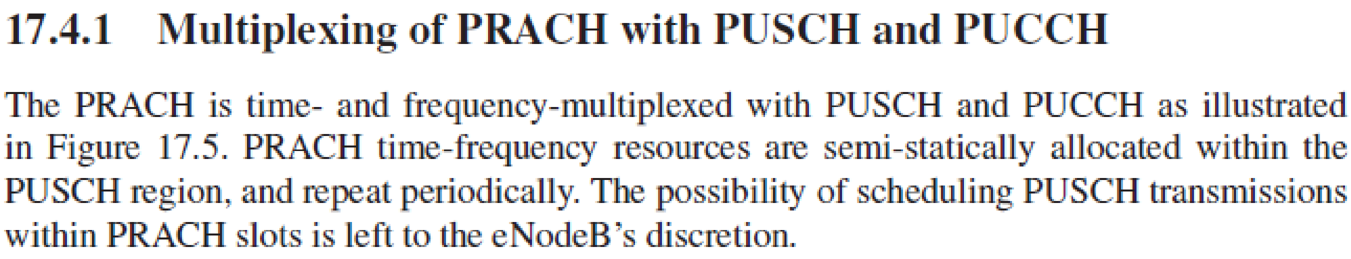


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

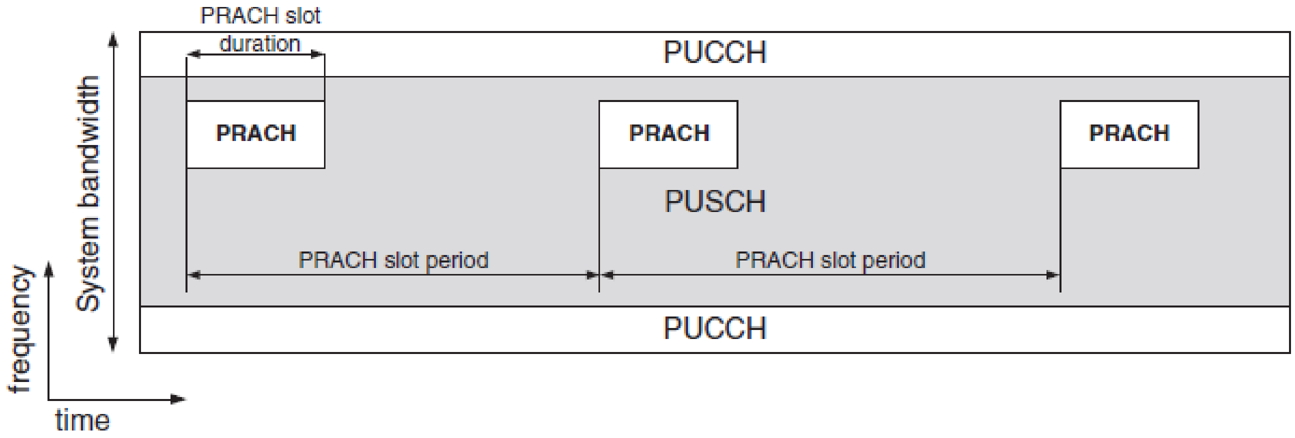


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

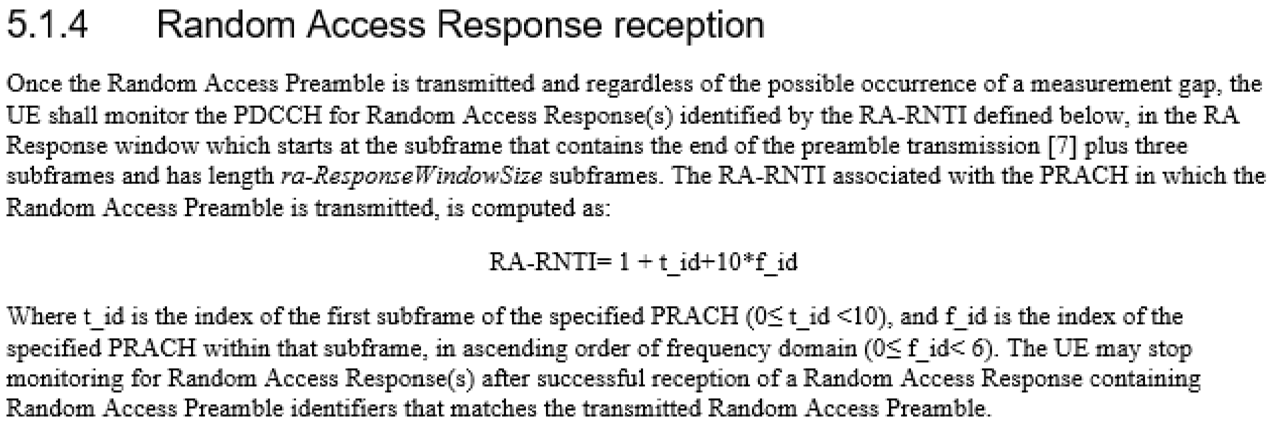
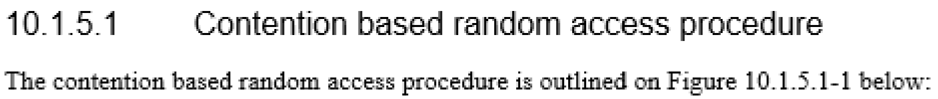
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 25
“25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.”

25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Toyota’s Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

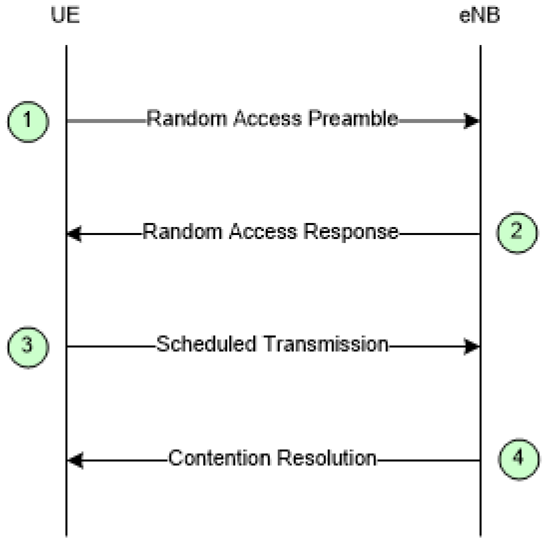
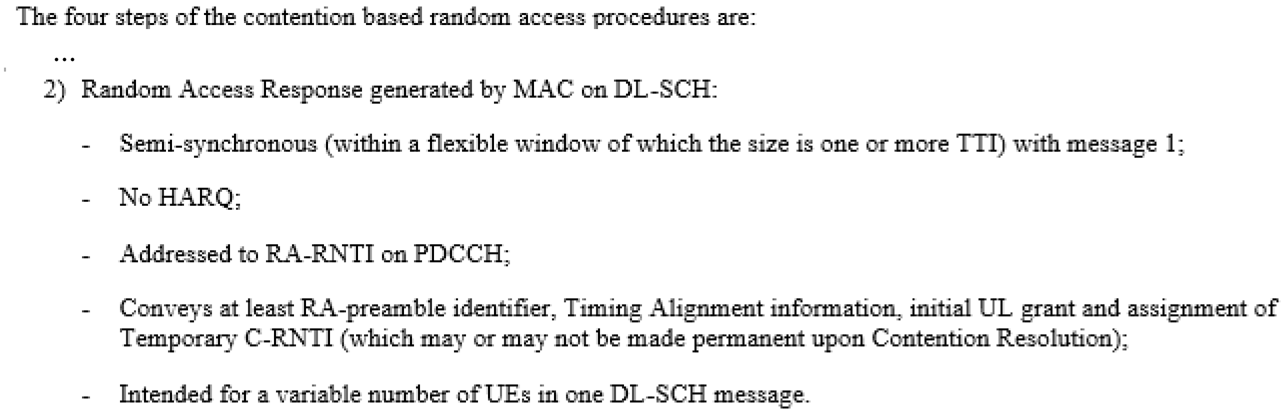


Figure 10.1.5.1-1: Contention based Random Access Procedure


The four steps of the contention based random access procedures are:

...

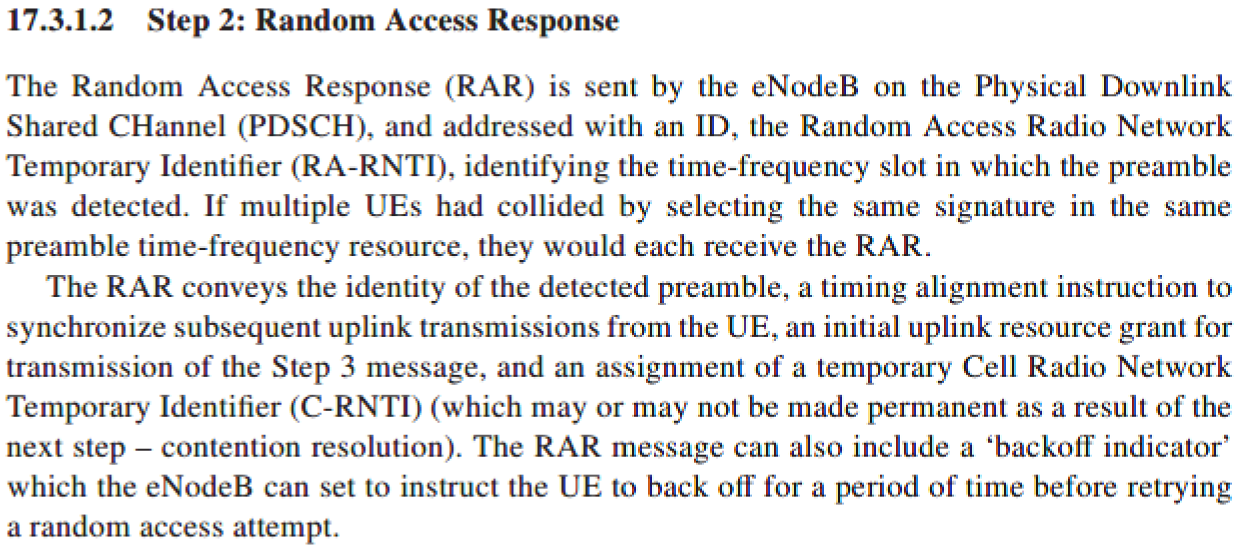
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25

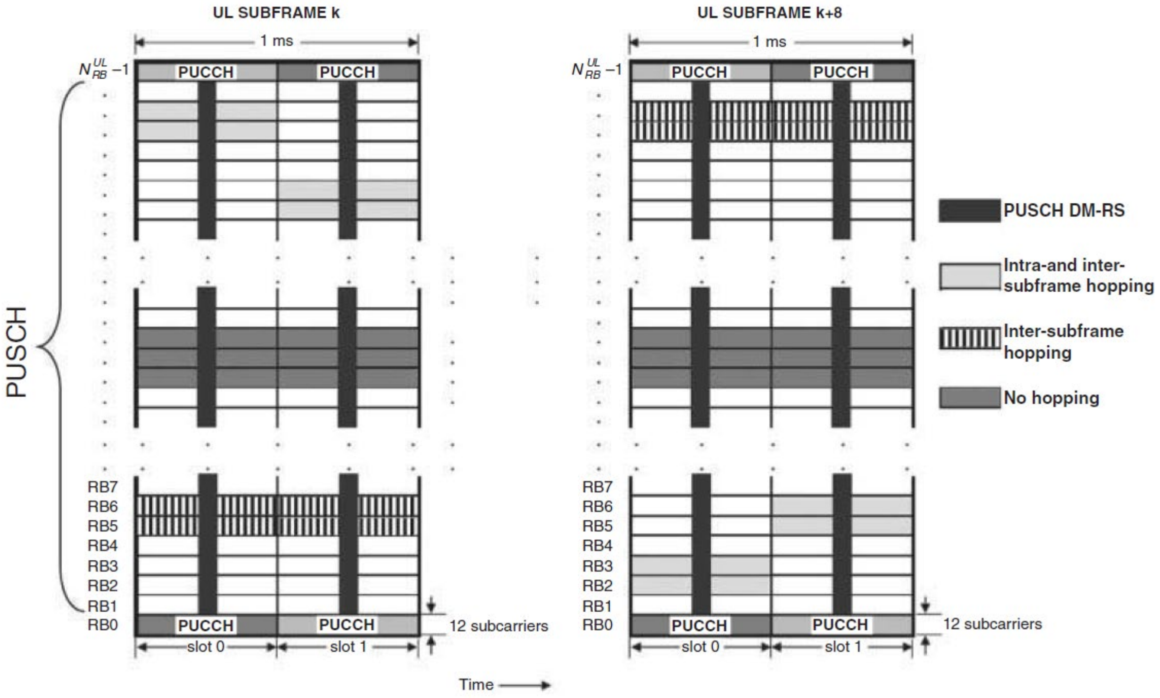
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Toyota's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

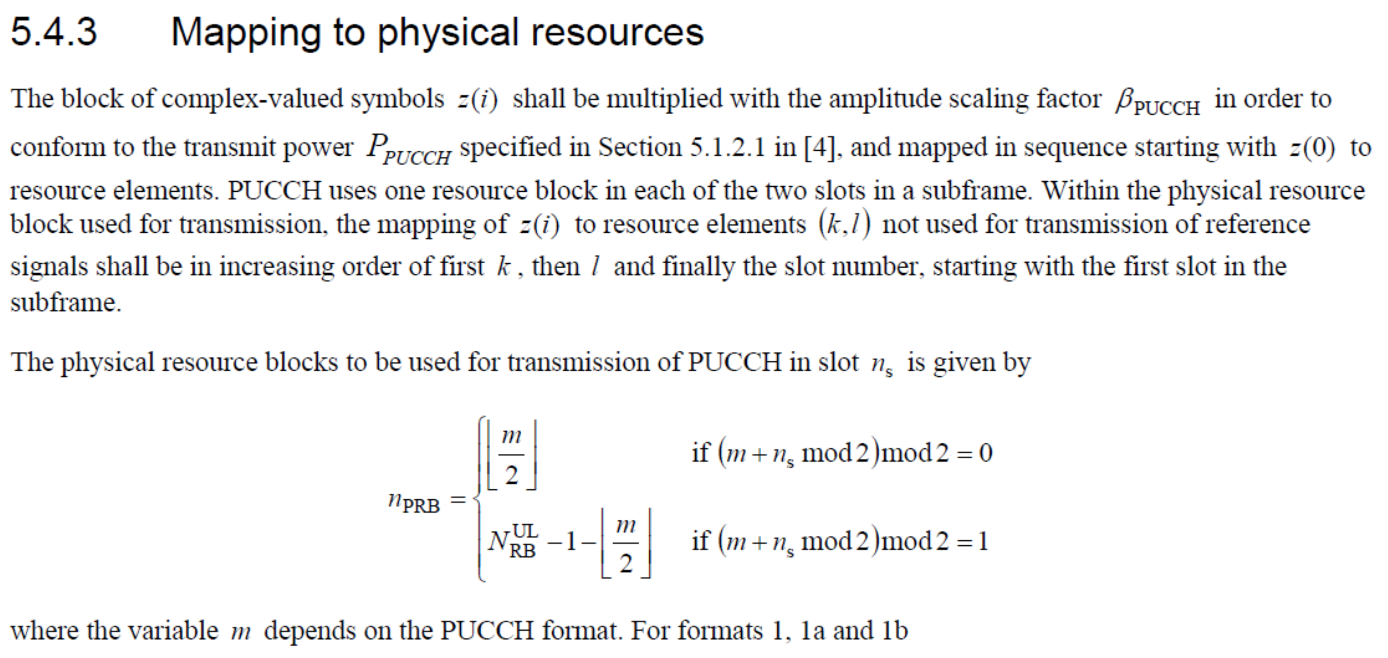
US Patent No. 10,833,908: Claim 27
“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Toyota’s Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing.

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

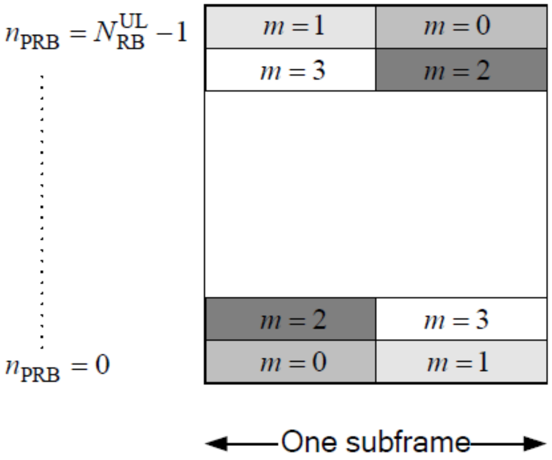


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

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For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\ offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_s$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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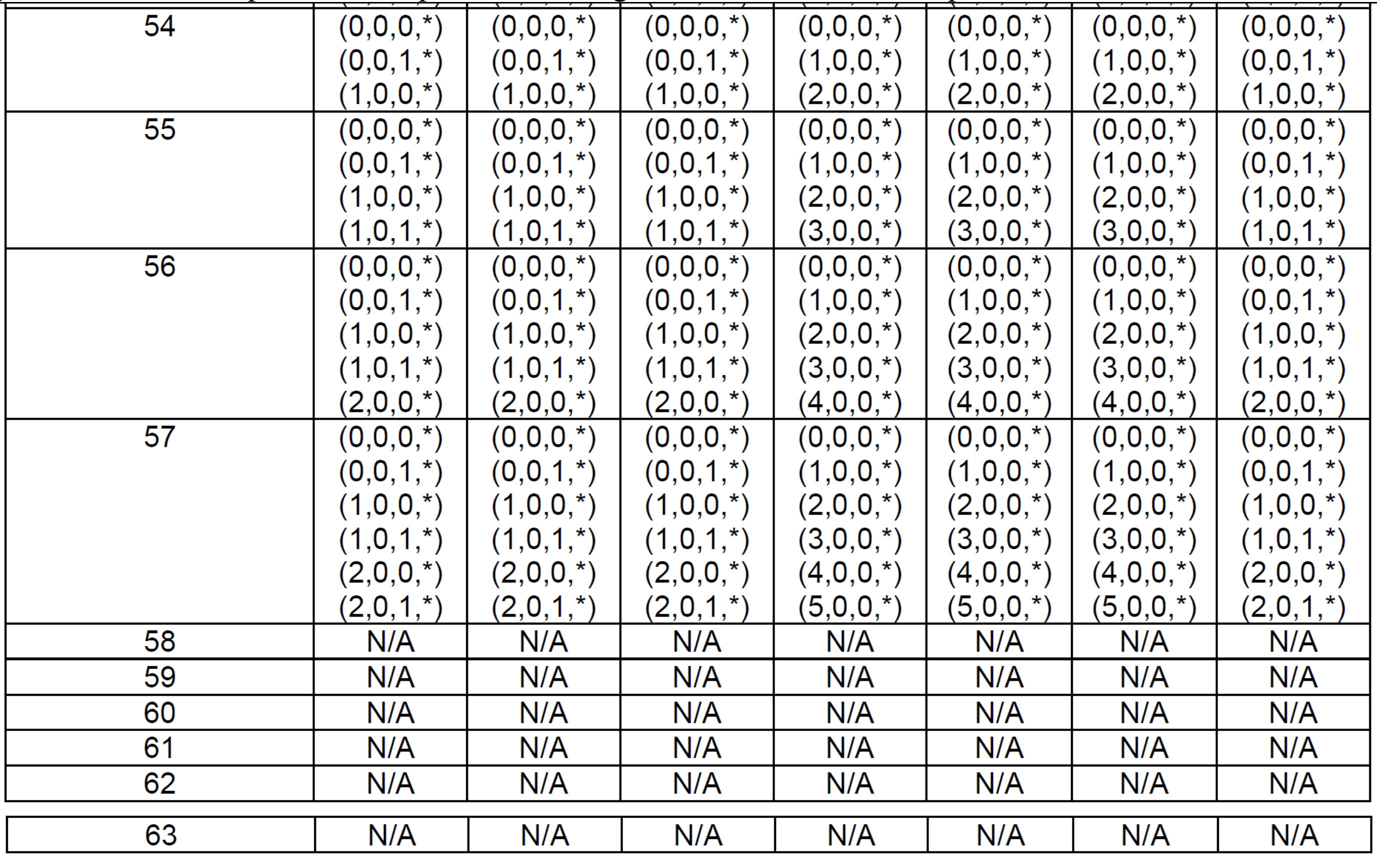
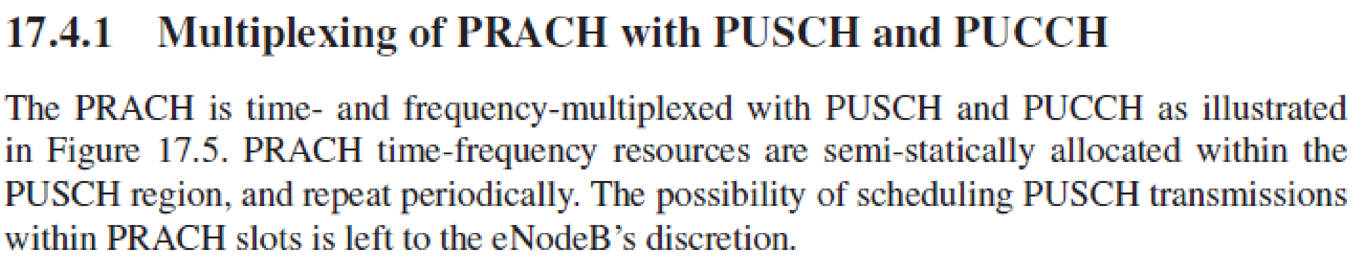
US Patent No. 10,833,908: Claim 27
“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

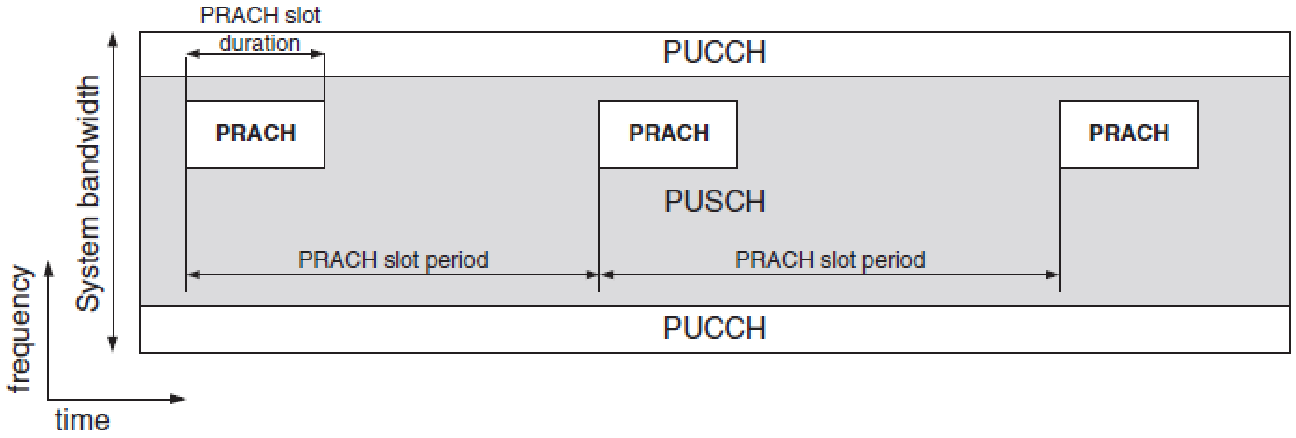
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



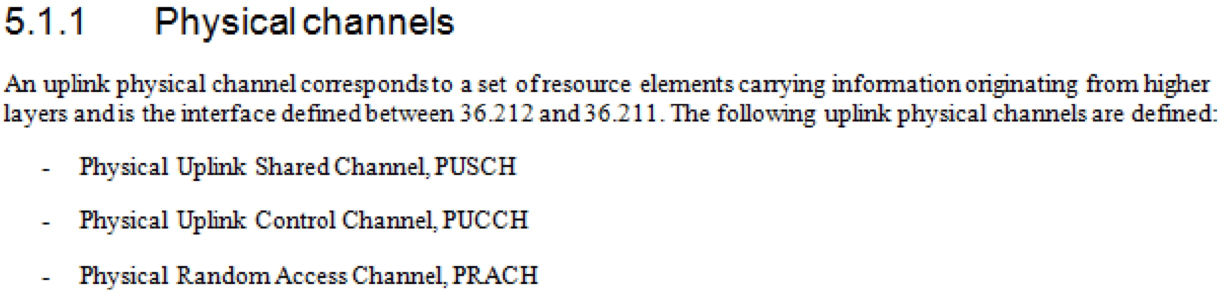
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

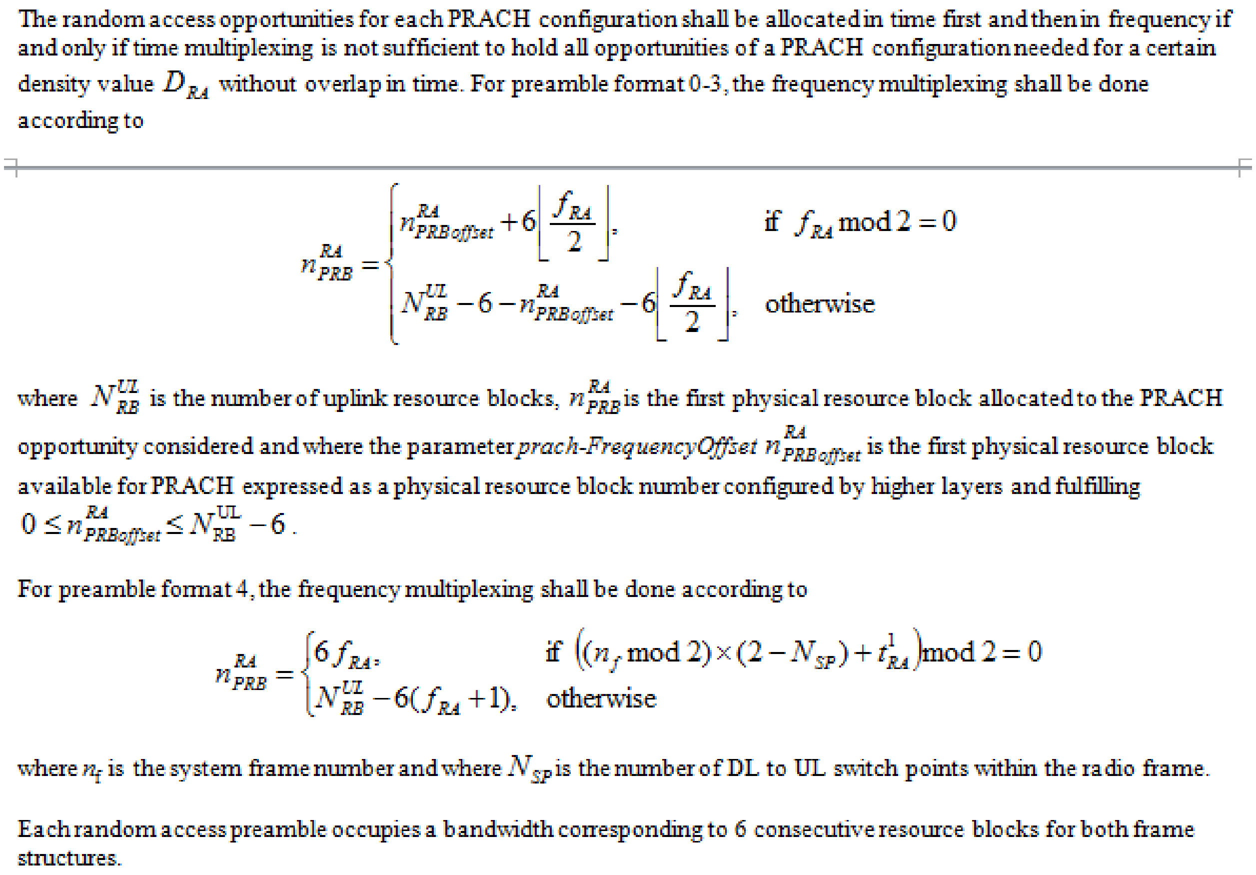
US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with Toyota’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

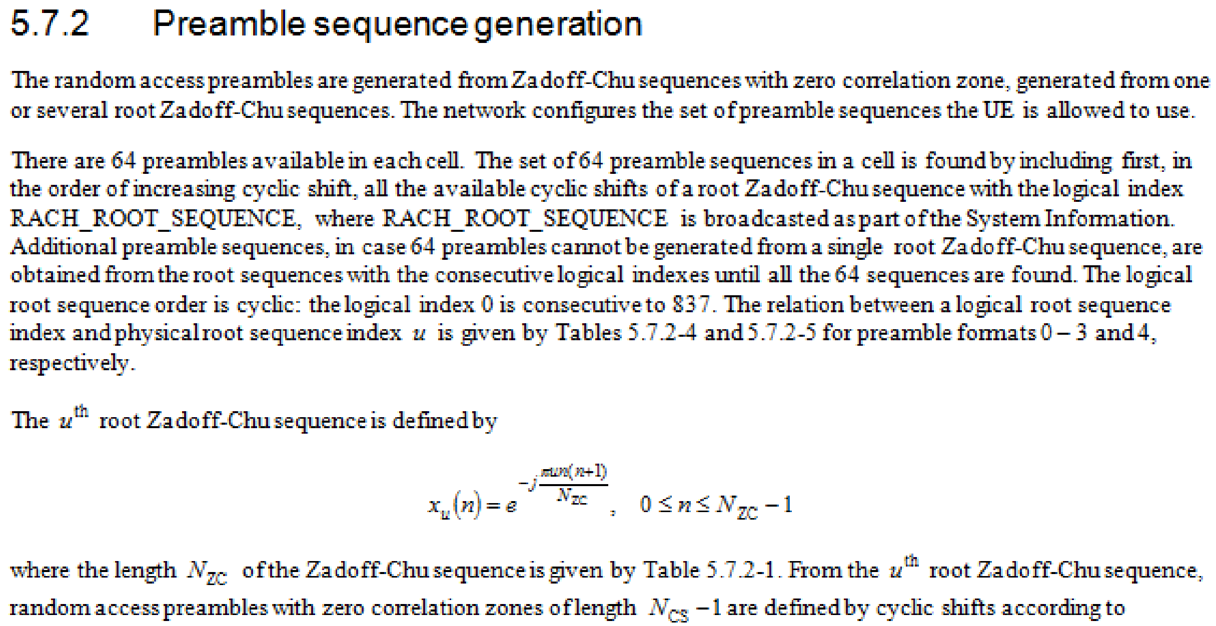
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

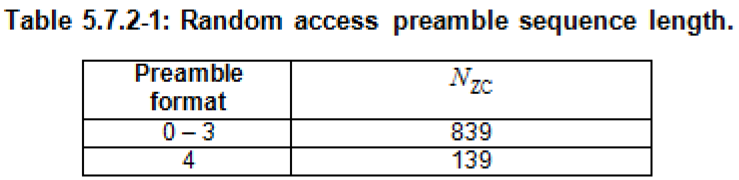
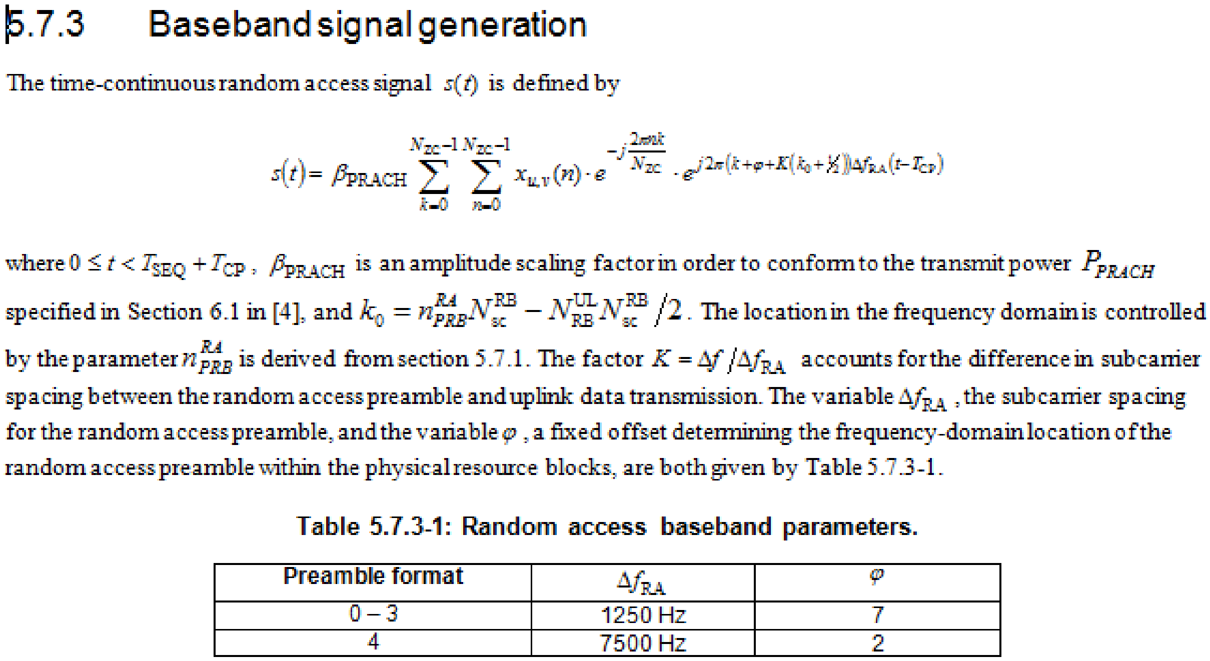


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

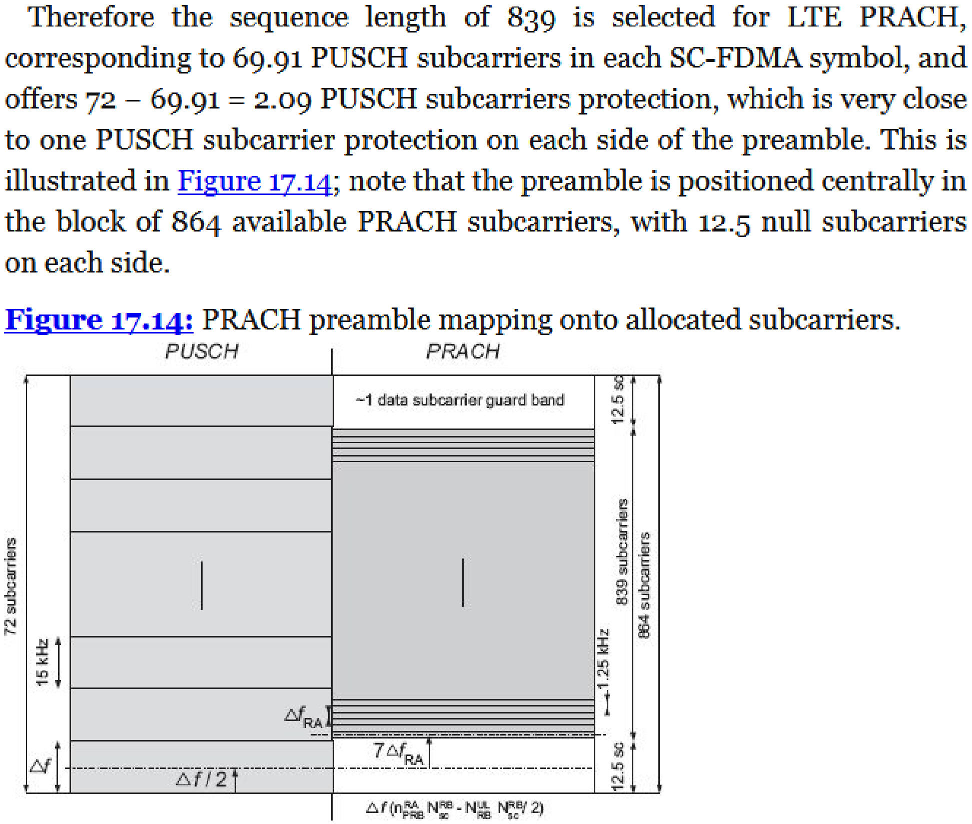
where $0\leq t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

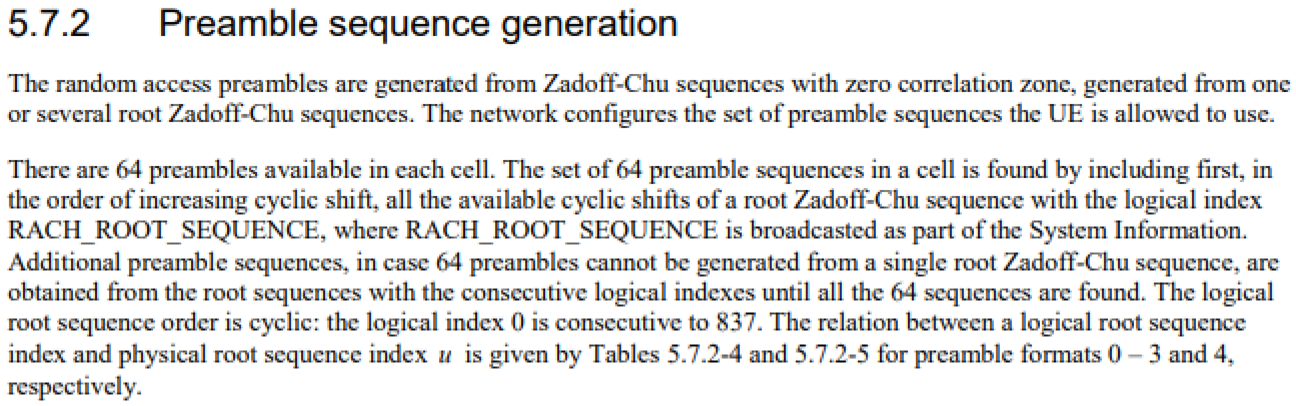
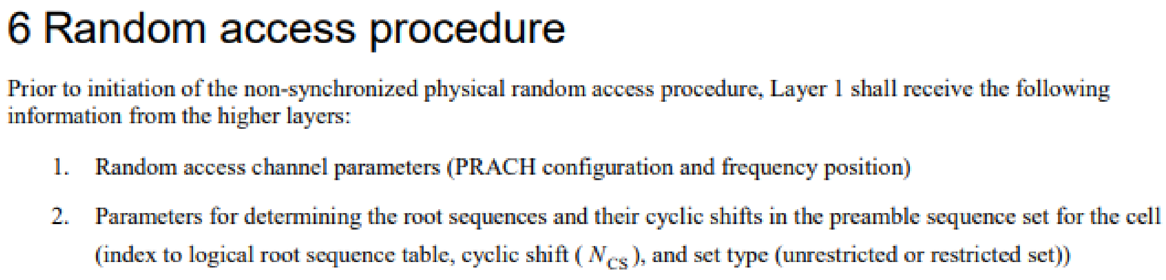


Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Toyota's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

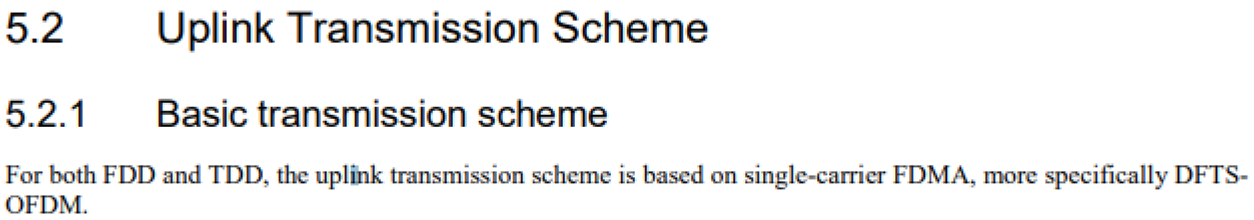
RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 Toyota's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Toyota's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

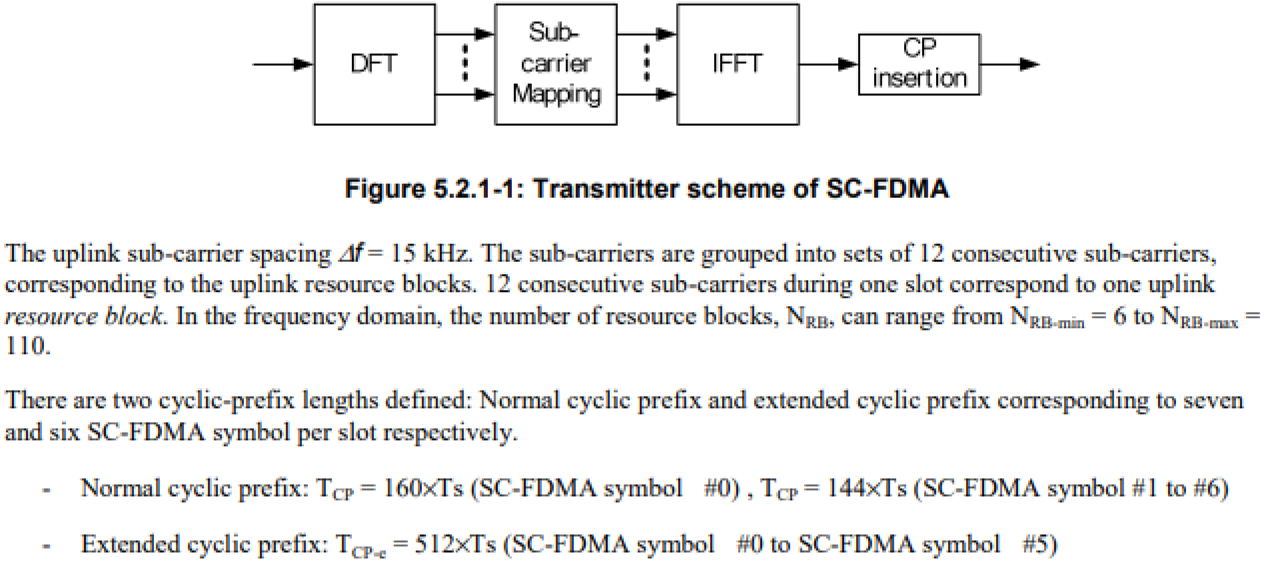


Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

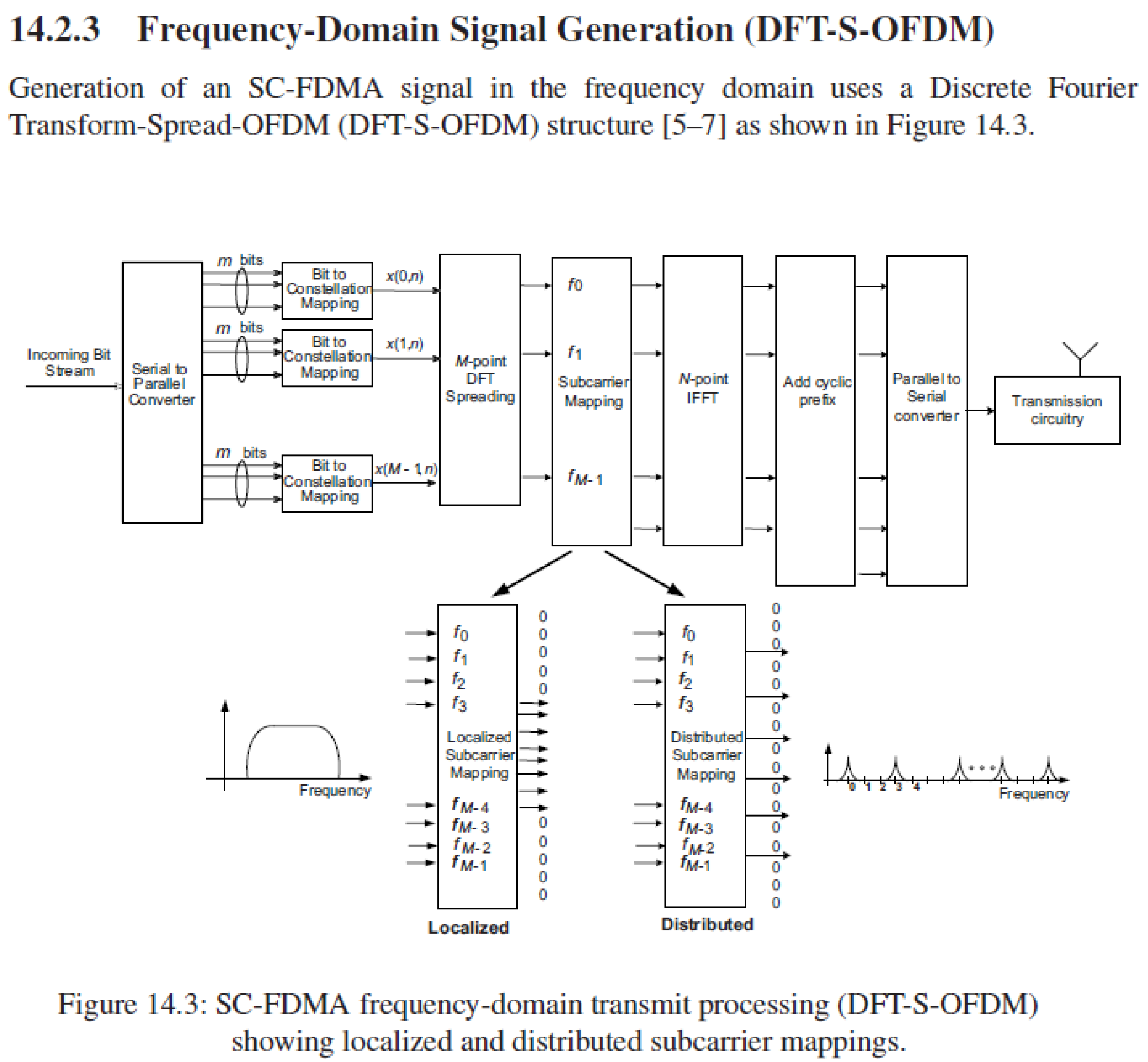
There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

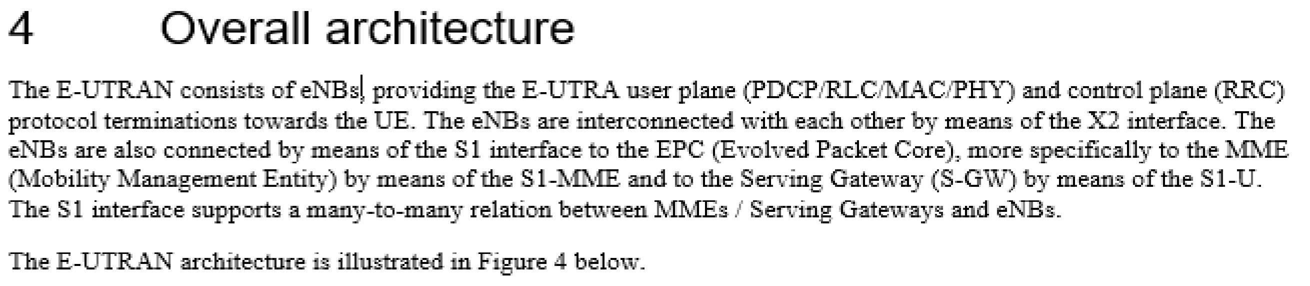
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

See also Claim 10.

Plaintiff's Infringement Contentions to GM

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, GM's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* GM's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, GM offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

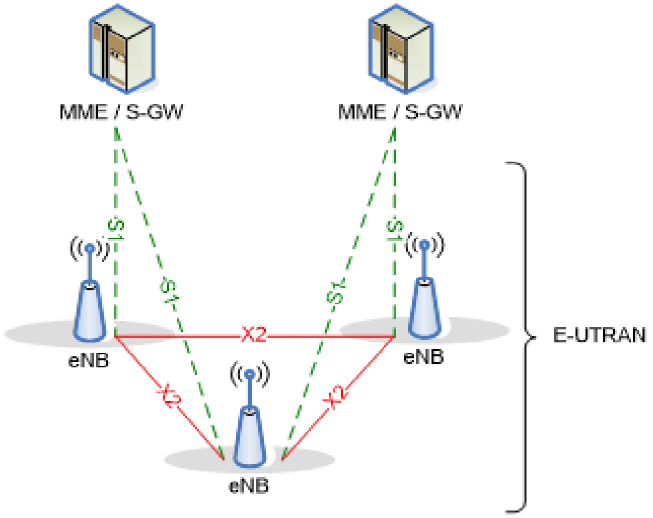
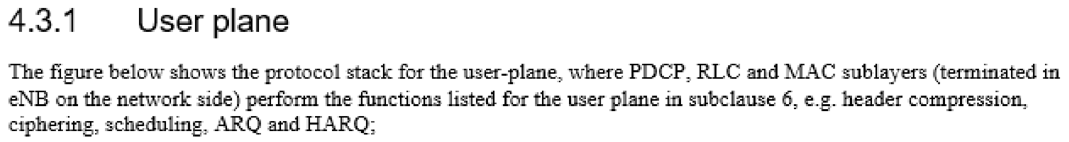


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

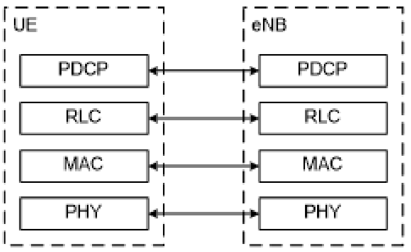


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

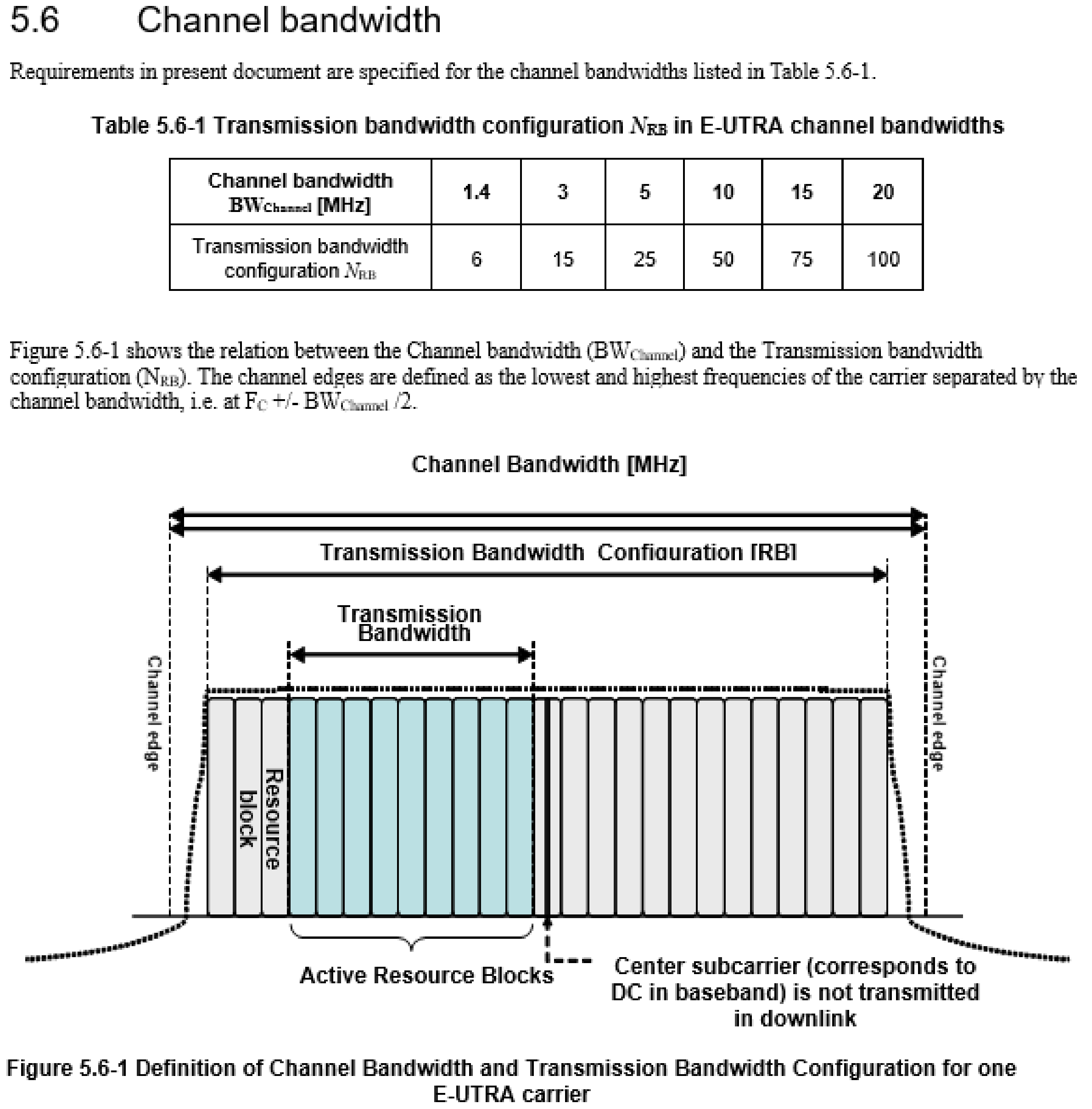
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	GM's Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, GM's Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

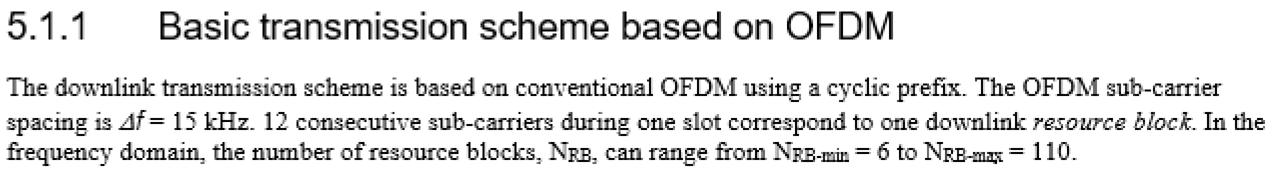
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

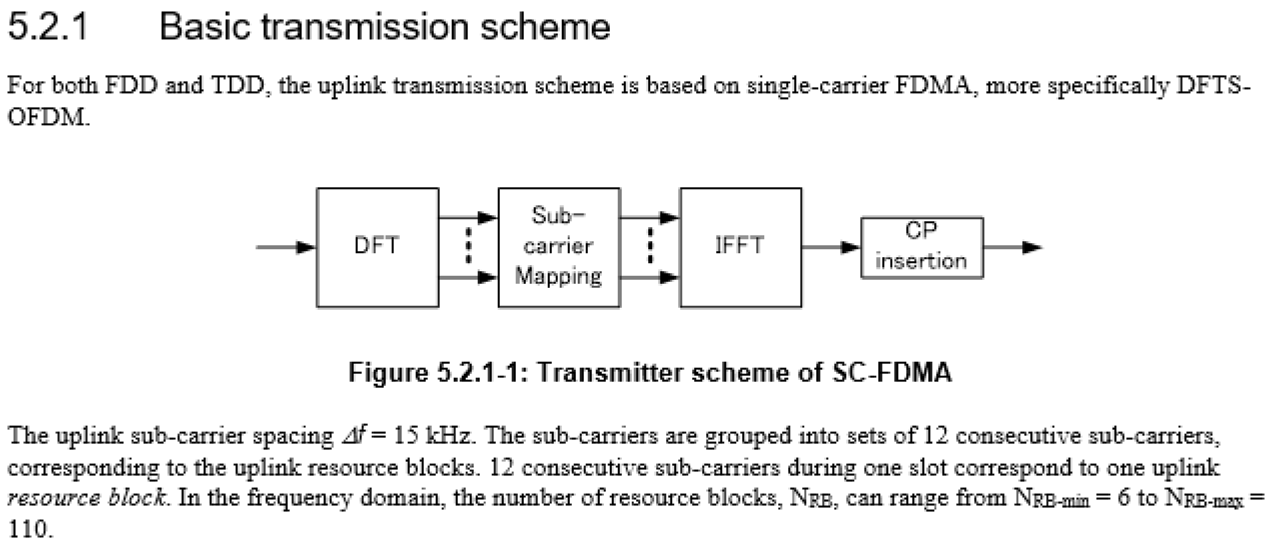
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

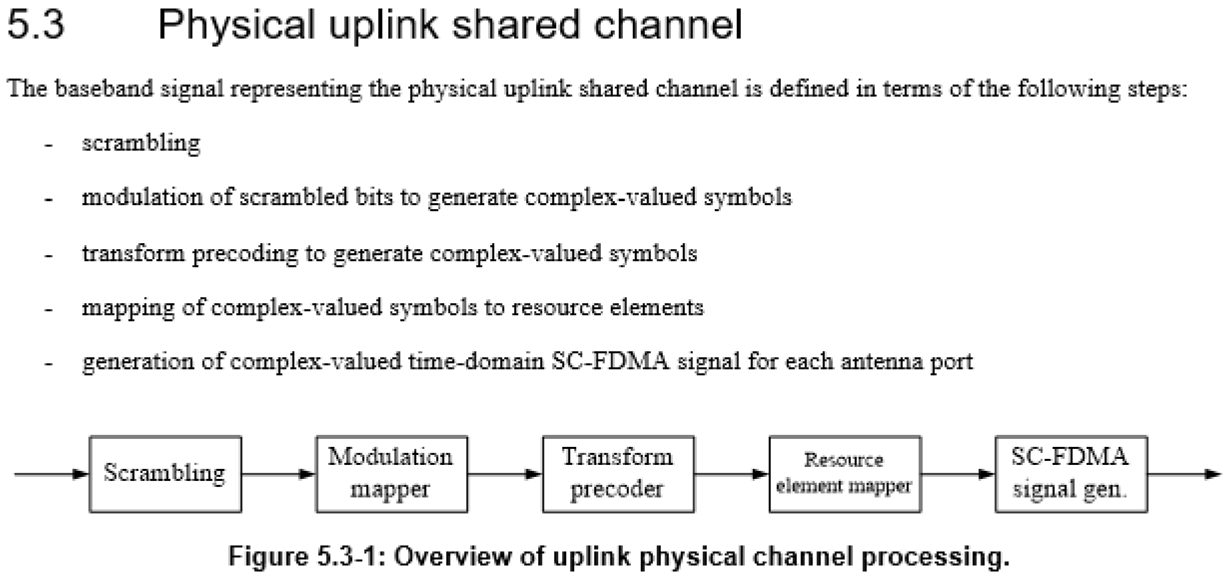
The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”



5.3 Physical uplink shared channel

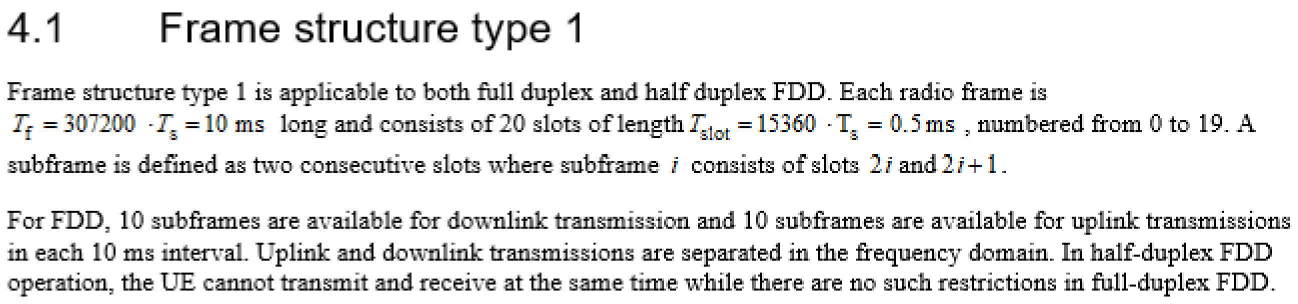
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

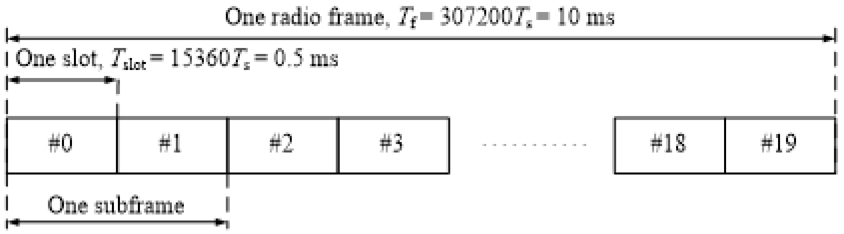
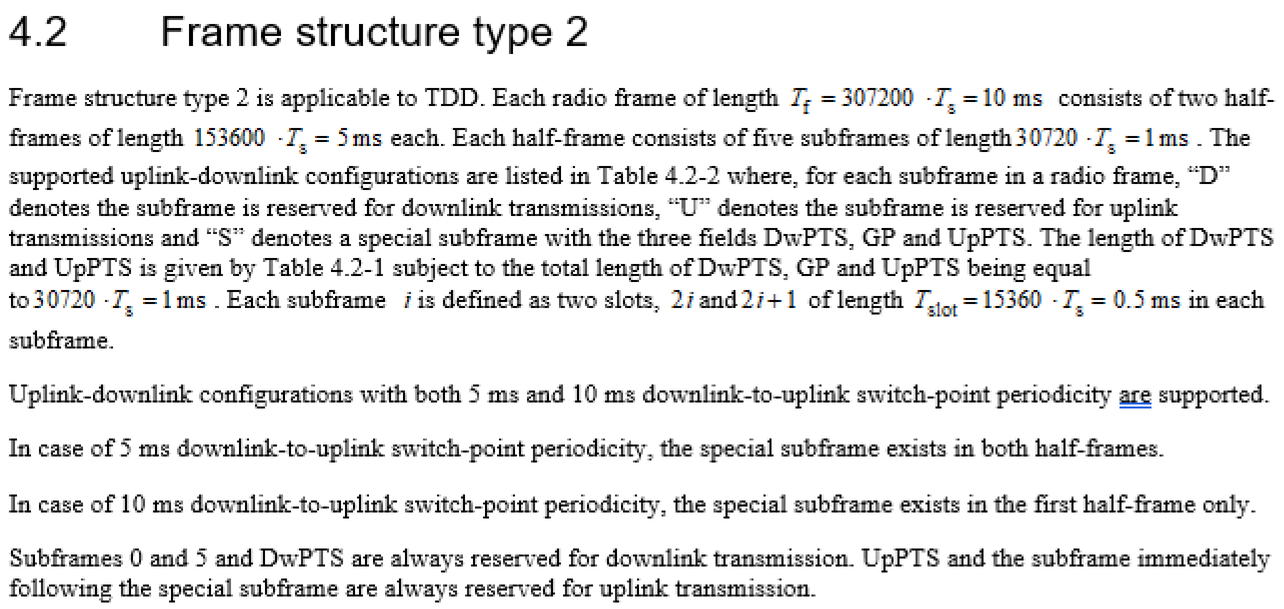


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

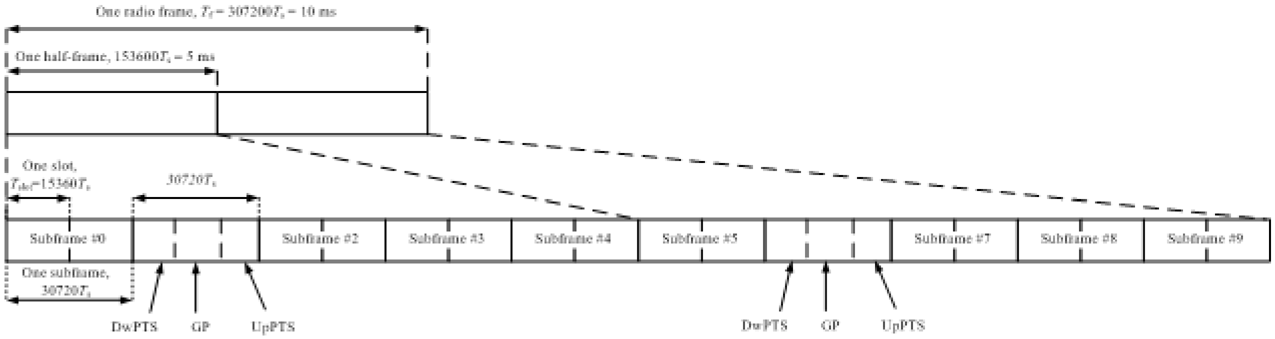
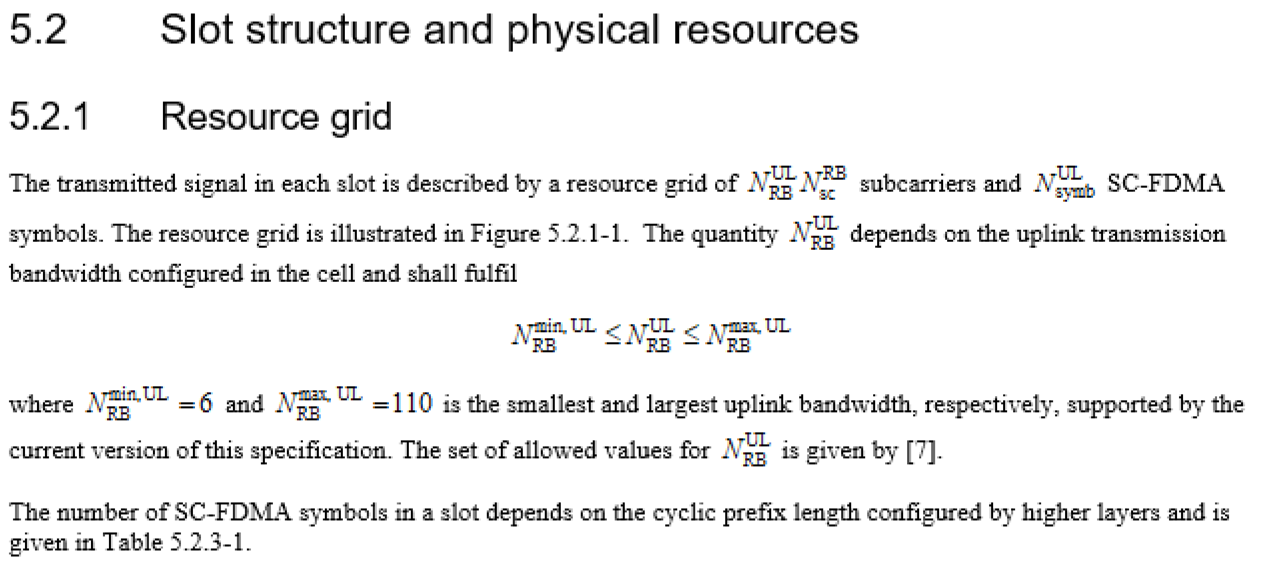


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

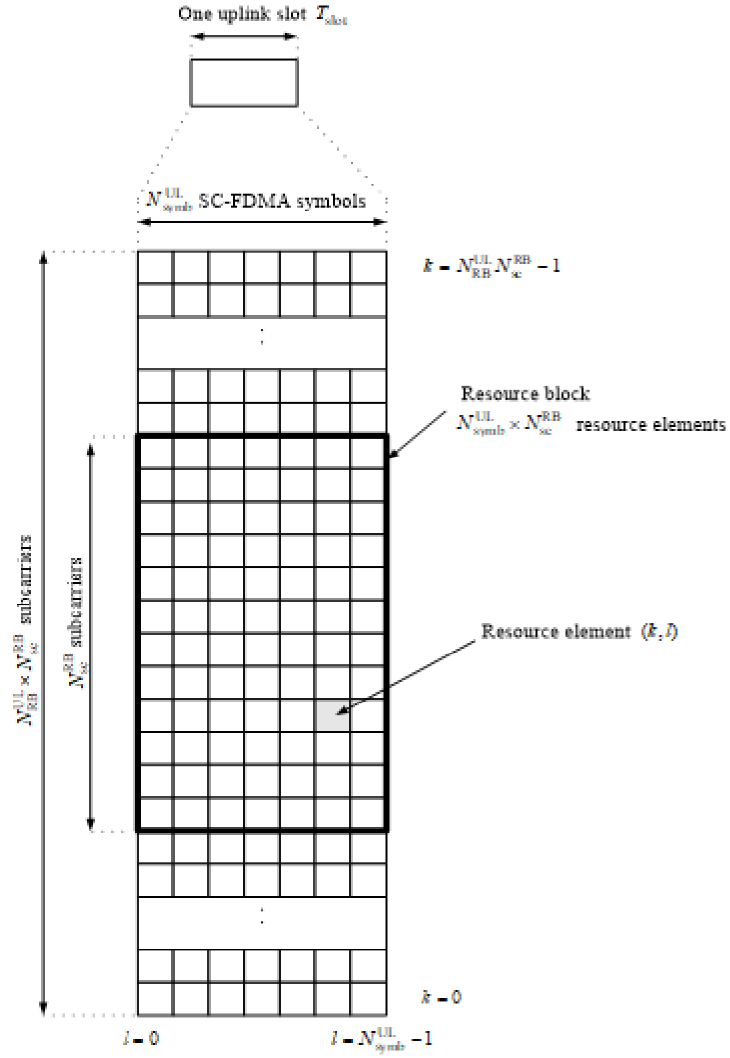
$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

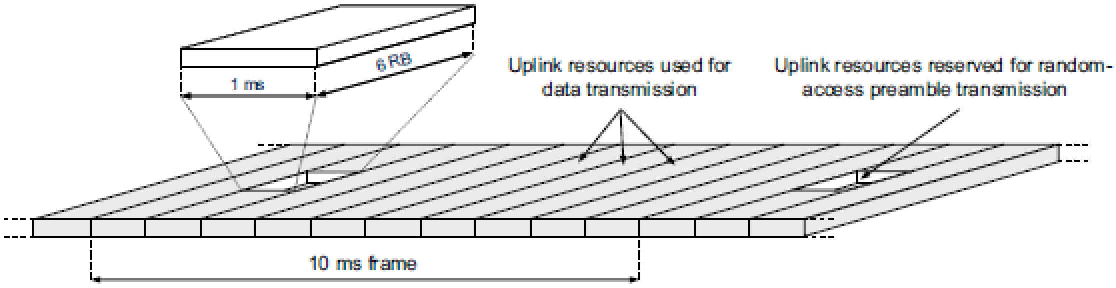
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 1(b)

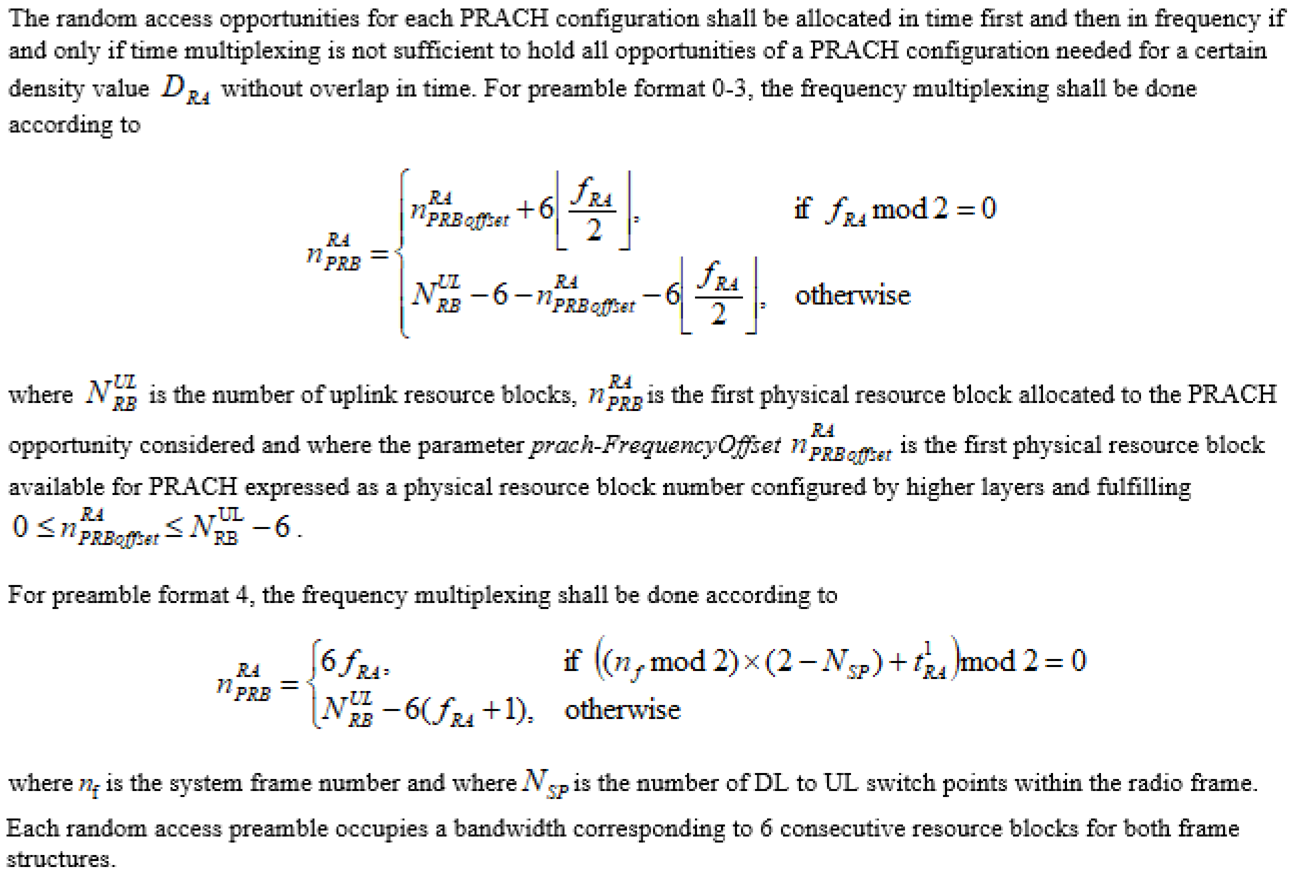
"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	GM’s Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

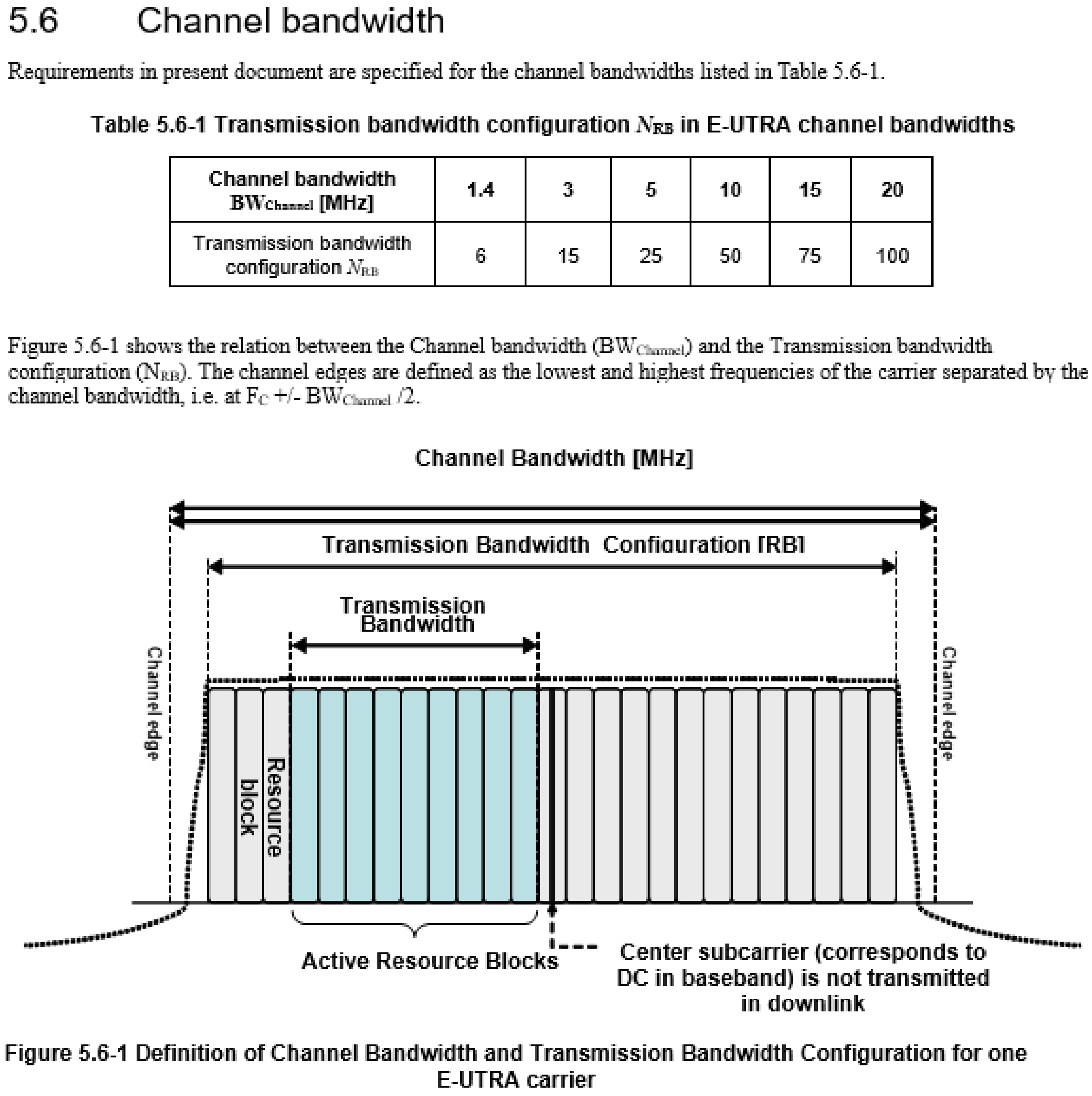
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

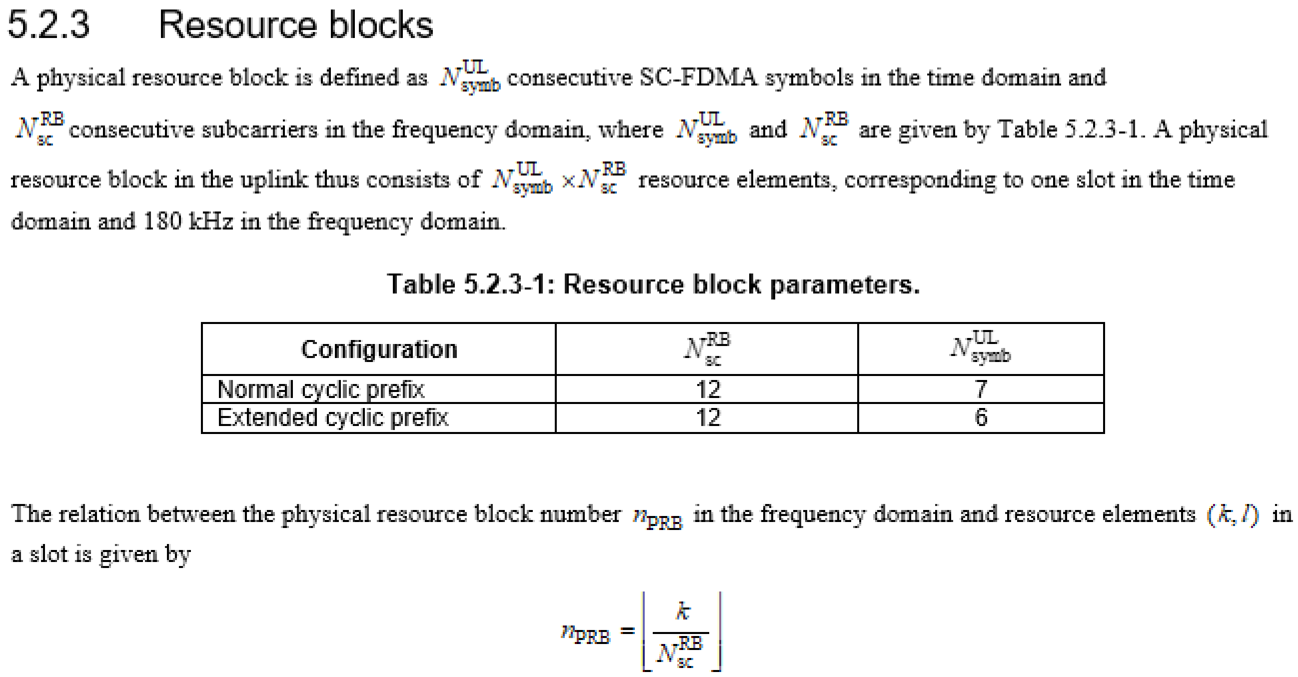
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

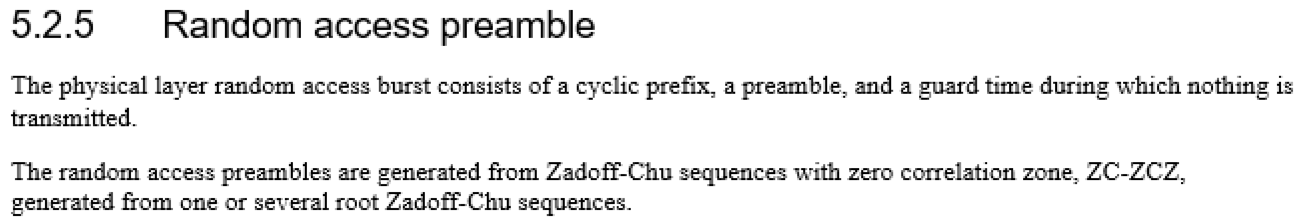
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

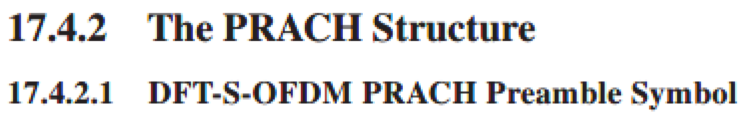


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

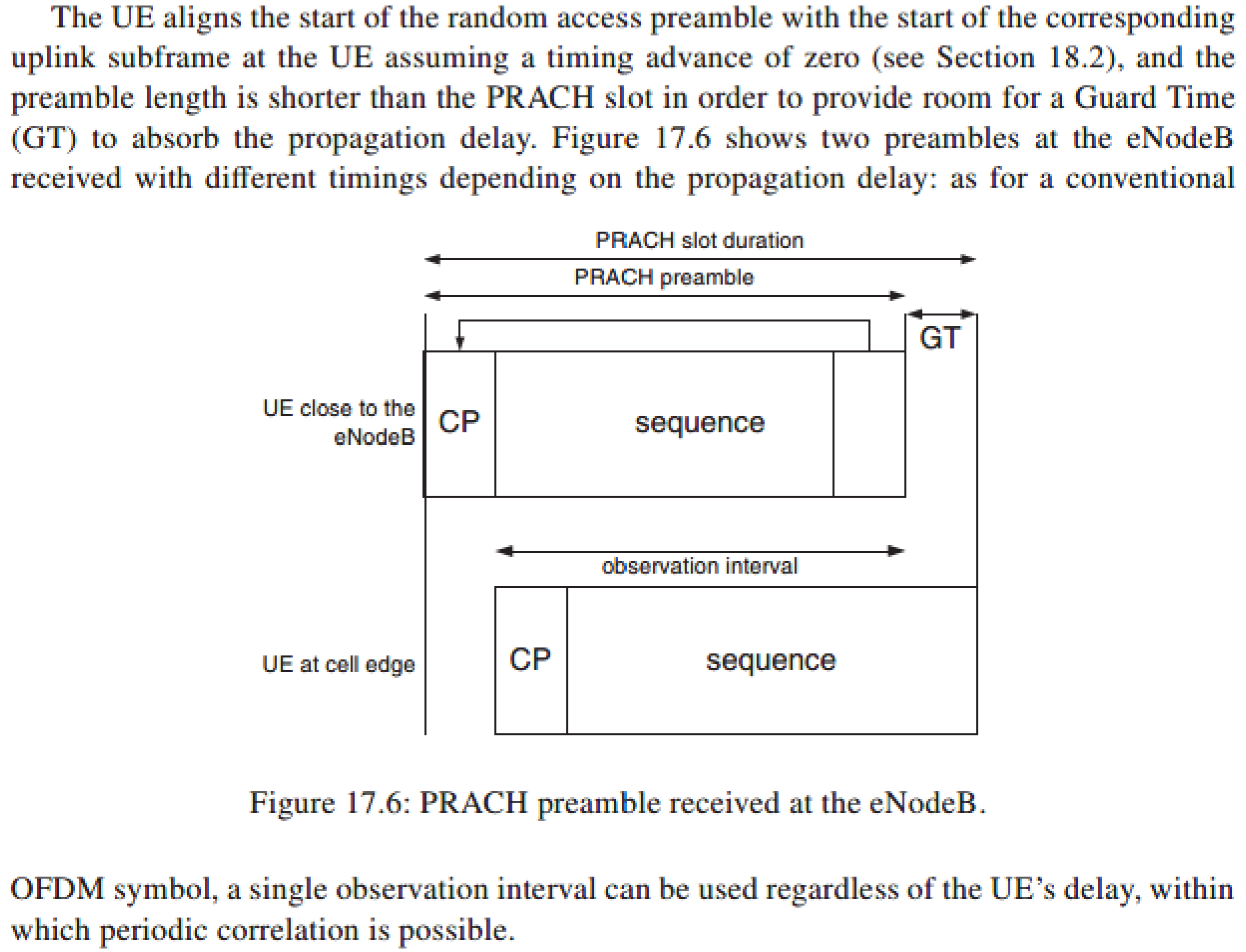


17.4.2 The PRACH Structure

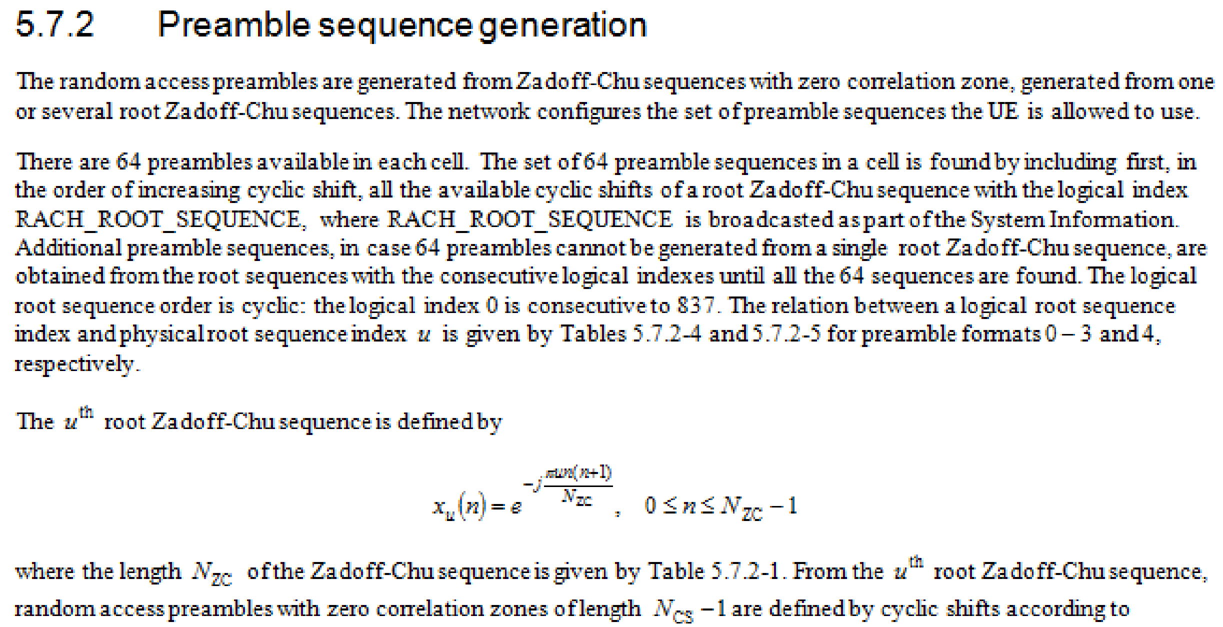
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. Figure 17.6: PRACH preamble received at the eNodeB. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

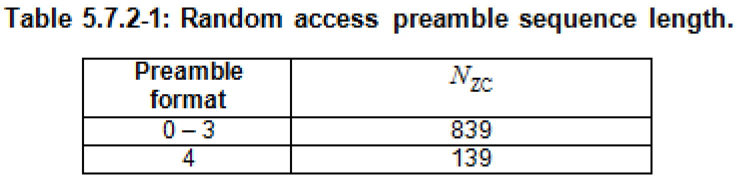
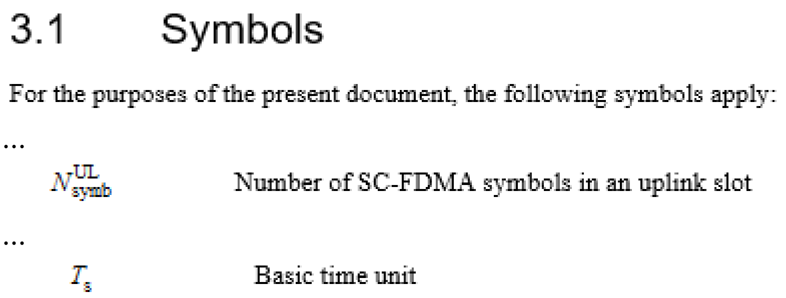
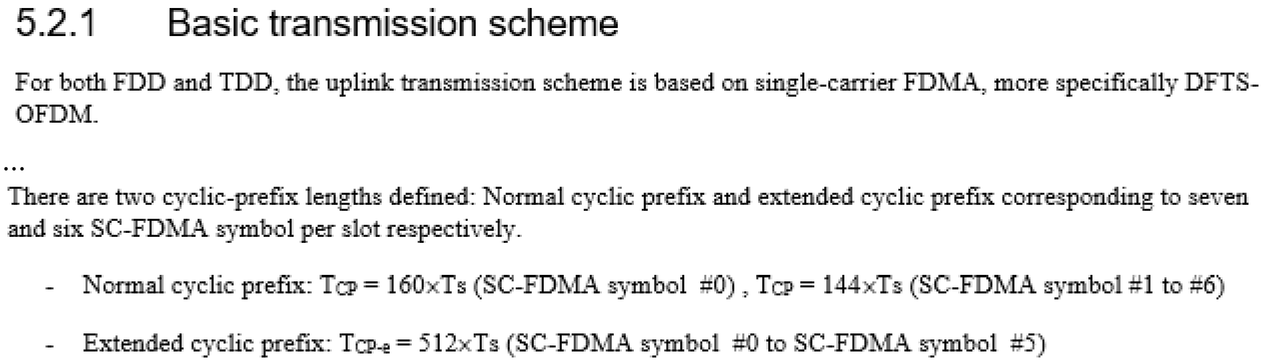


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using GM's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs. 3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals. 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

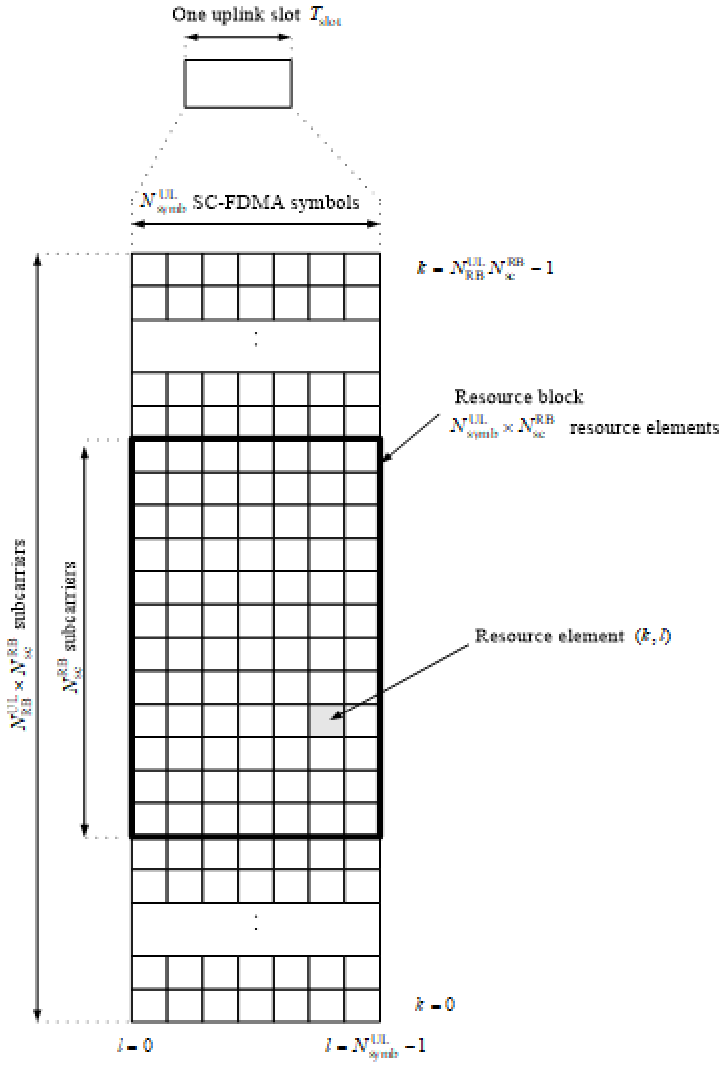
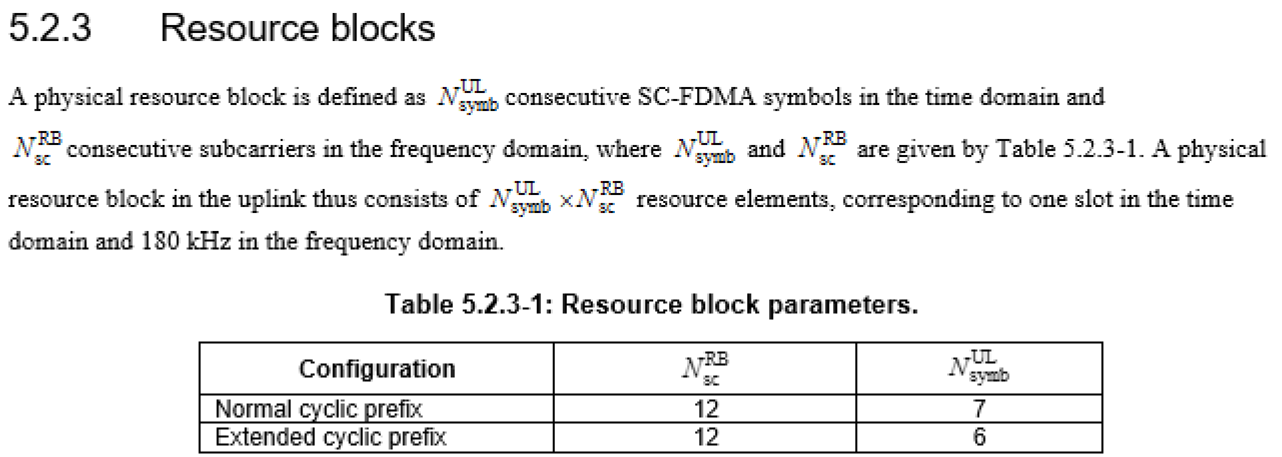


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

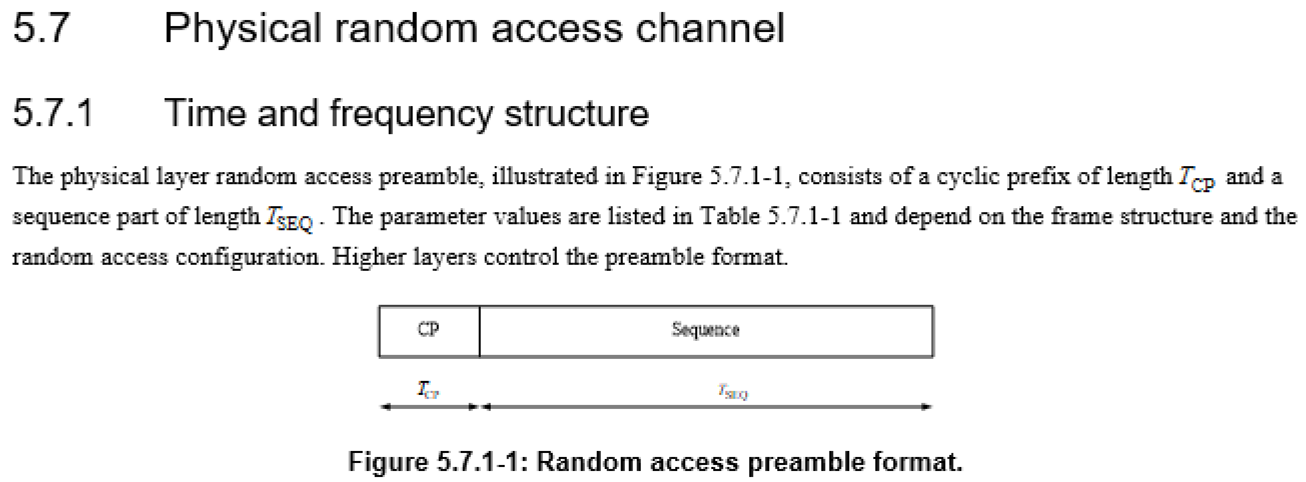
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

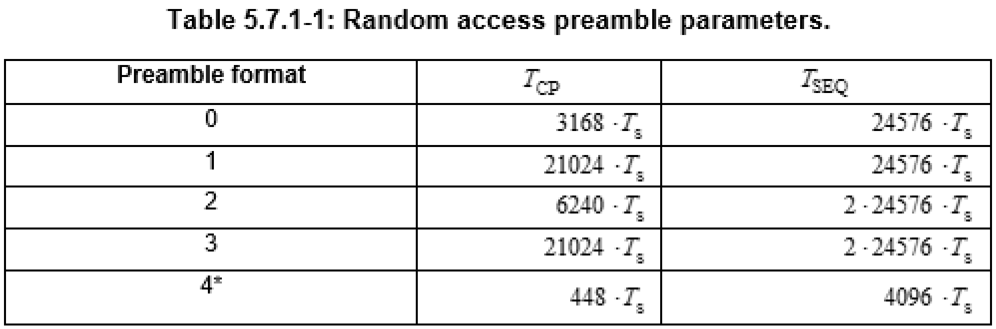
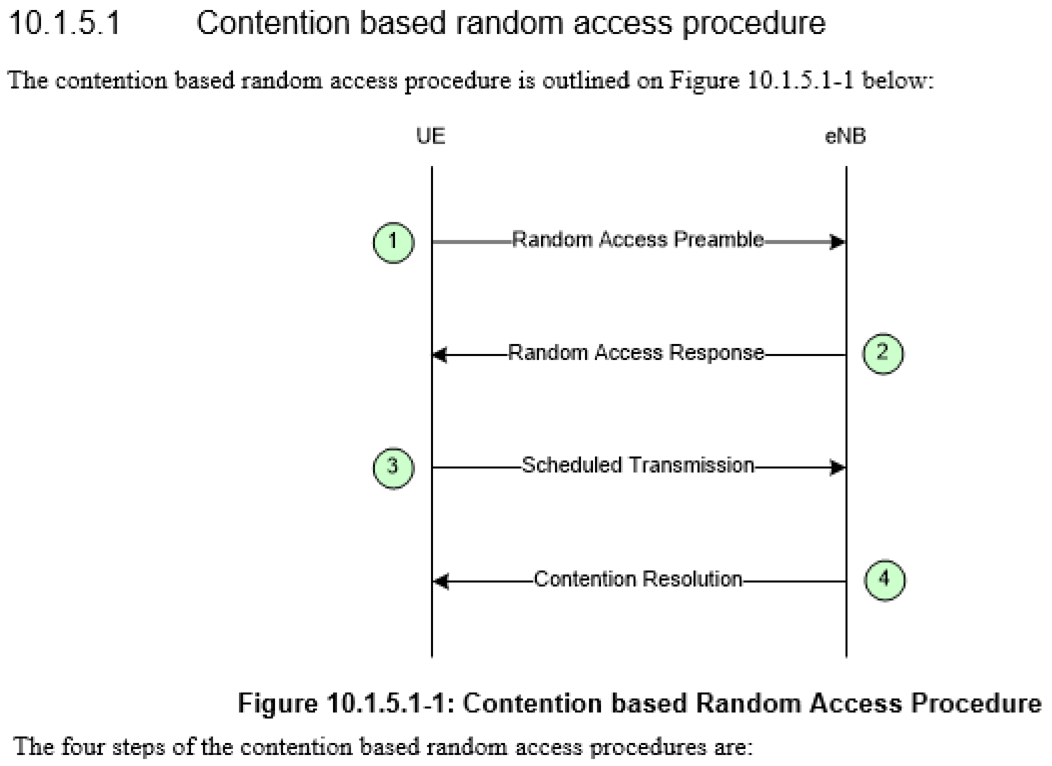


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

a receiver configured to receive, from the base station, a response message.	GM’s Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

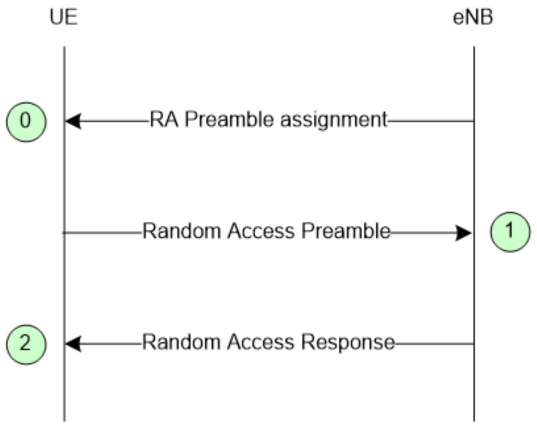
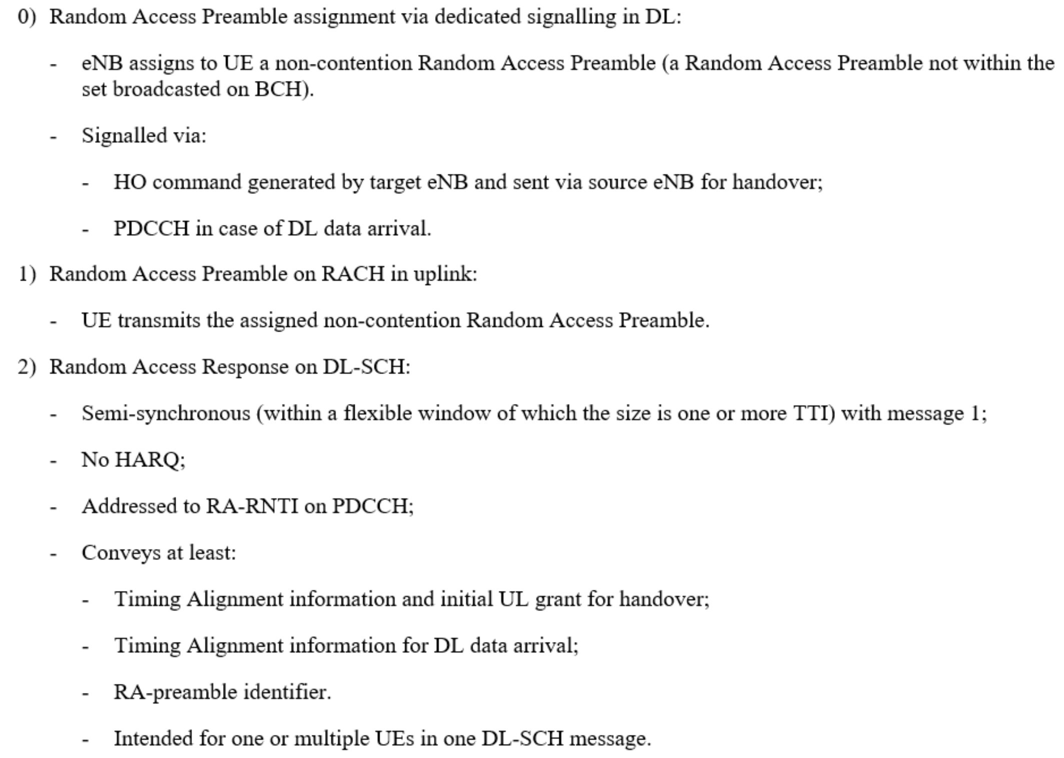


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

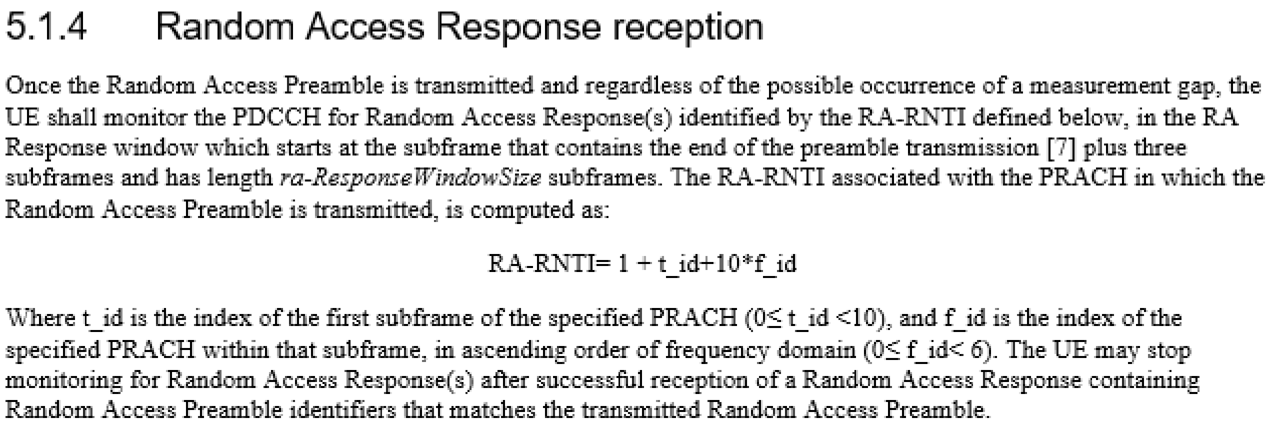
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

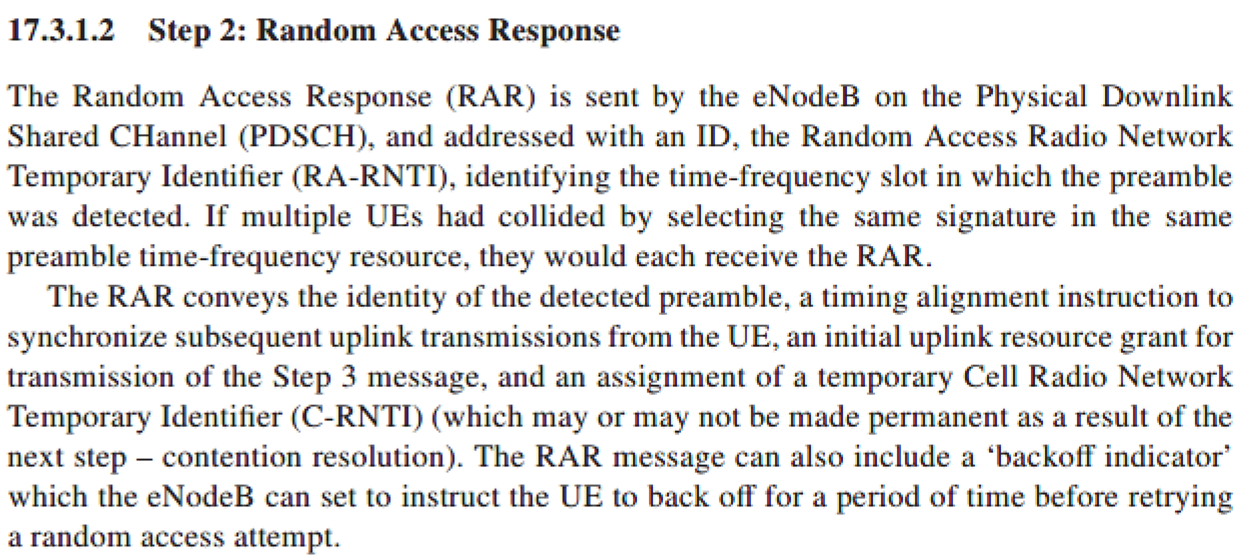
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

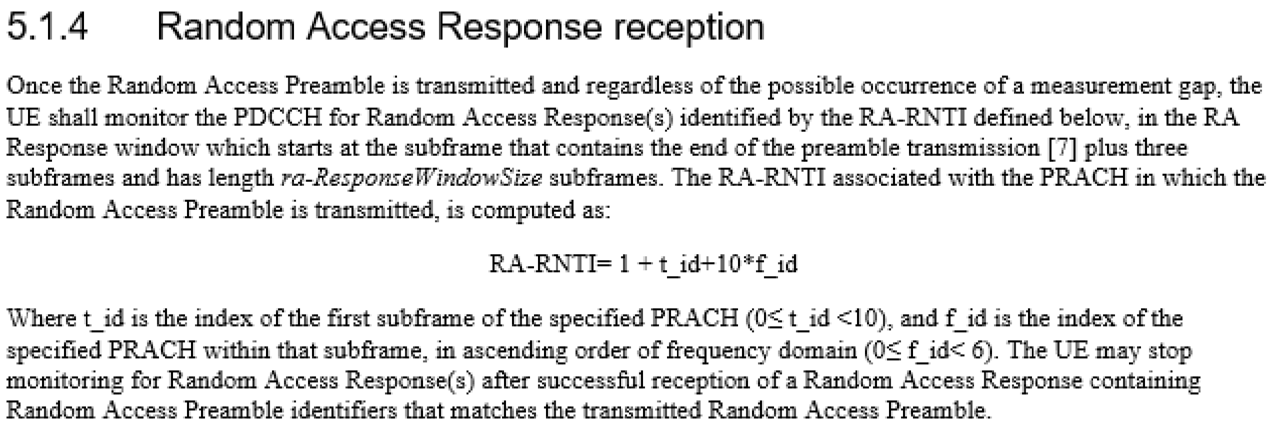
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

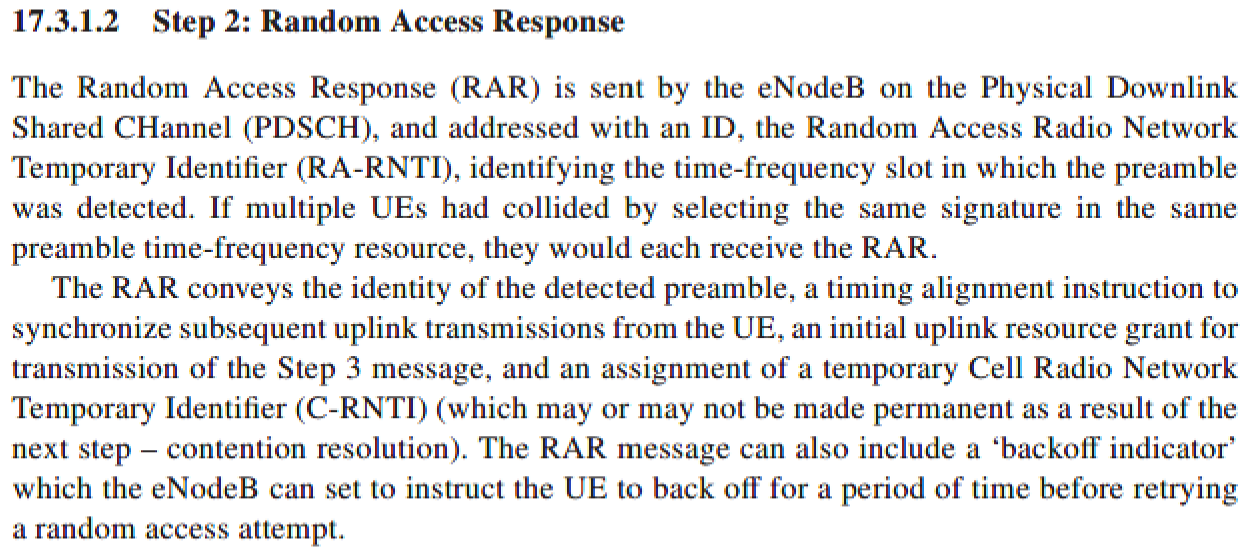
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

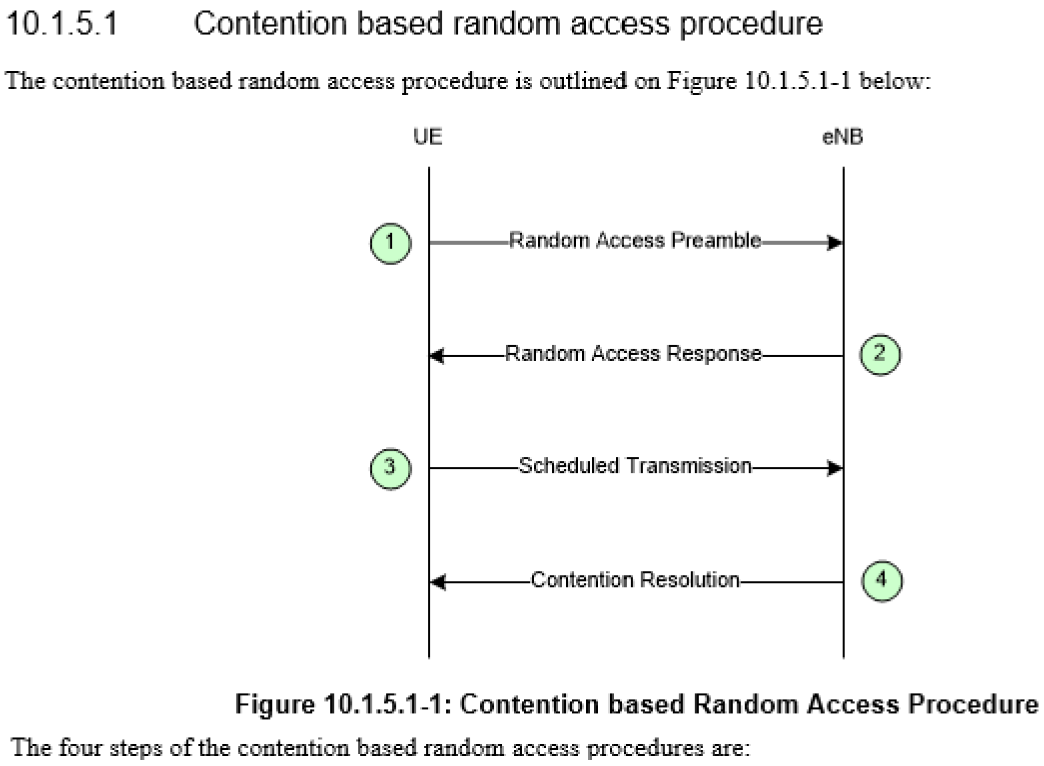
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of GM’s Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

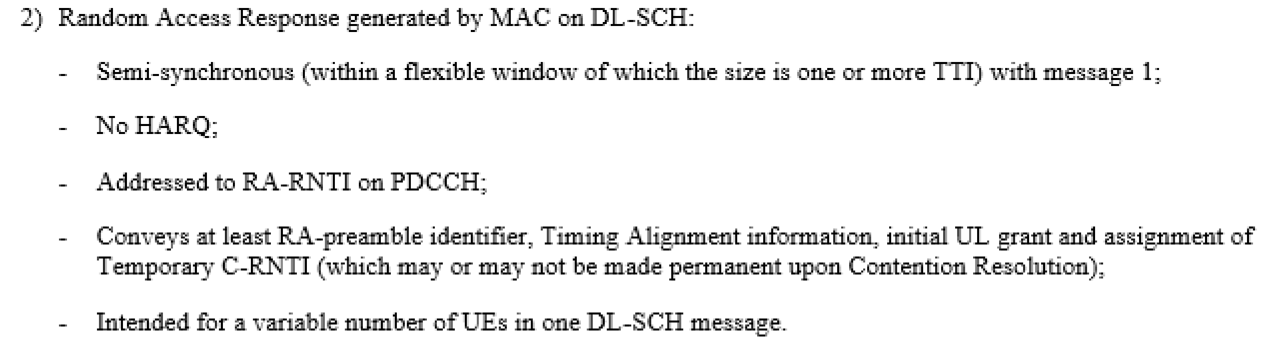
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in GM's Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

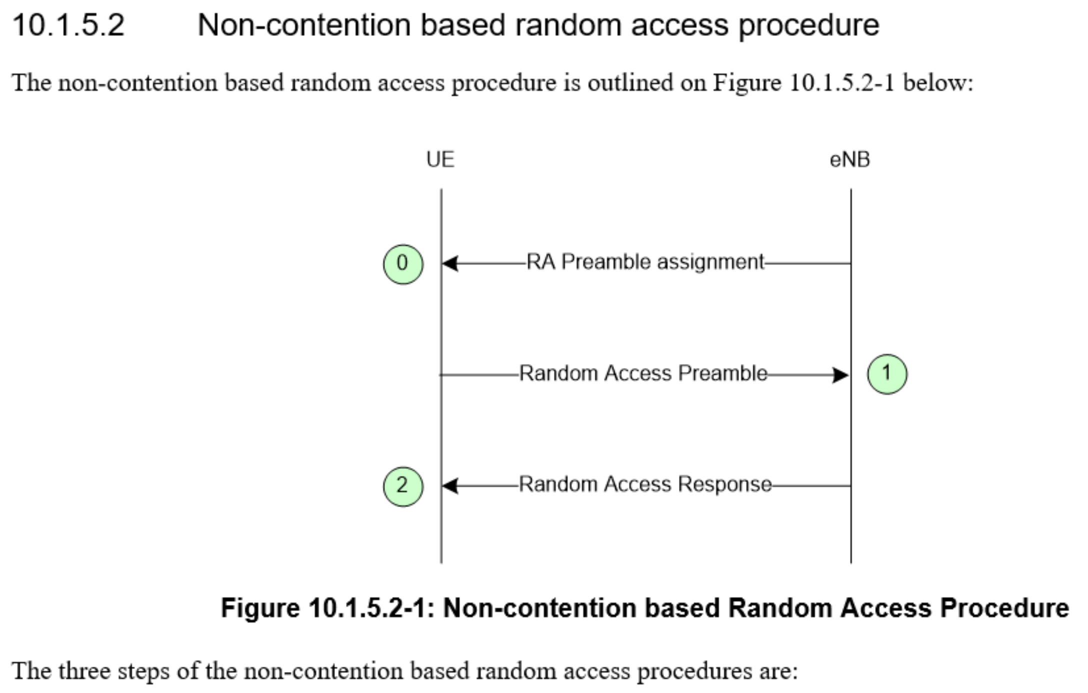
US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



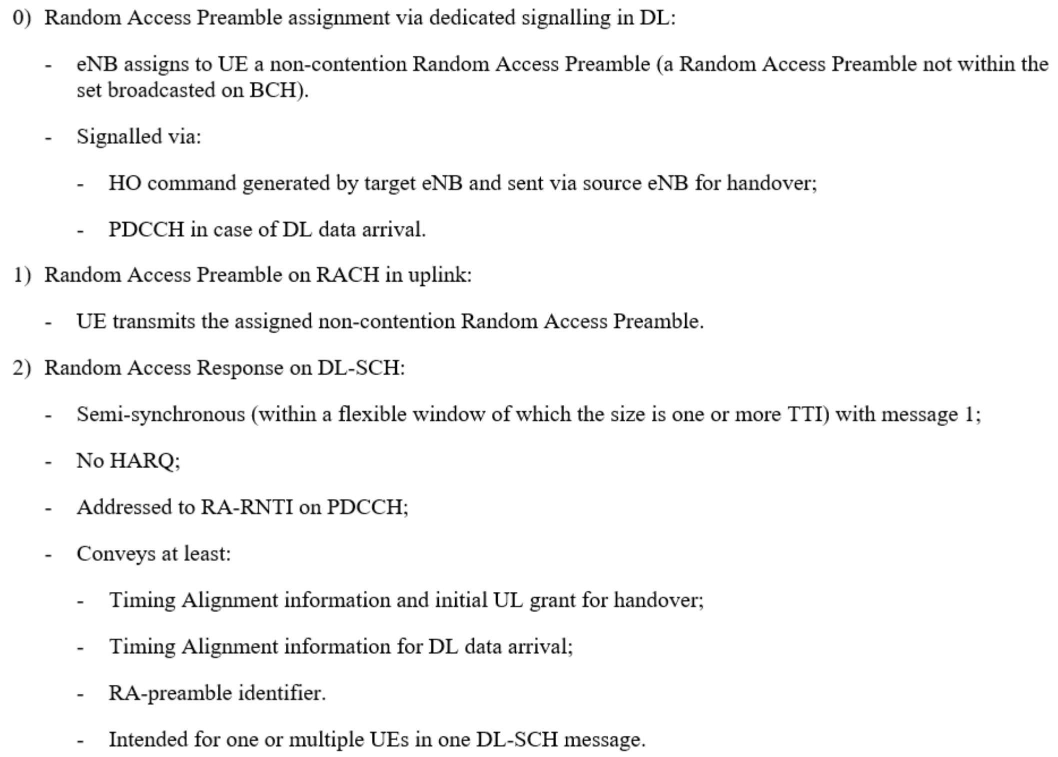
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"


0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

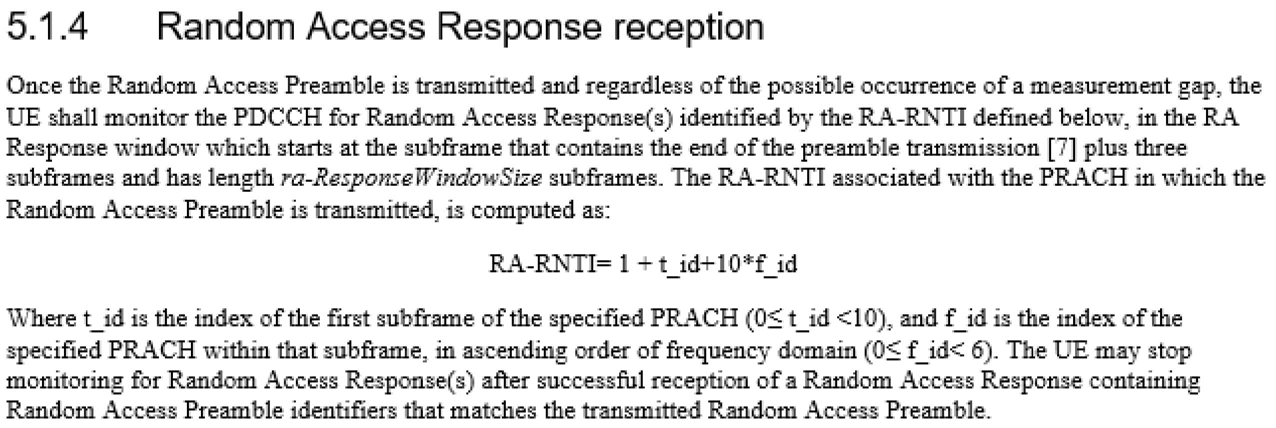
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.


5.1.4 Random Access Response reception

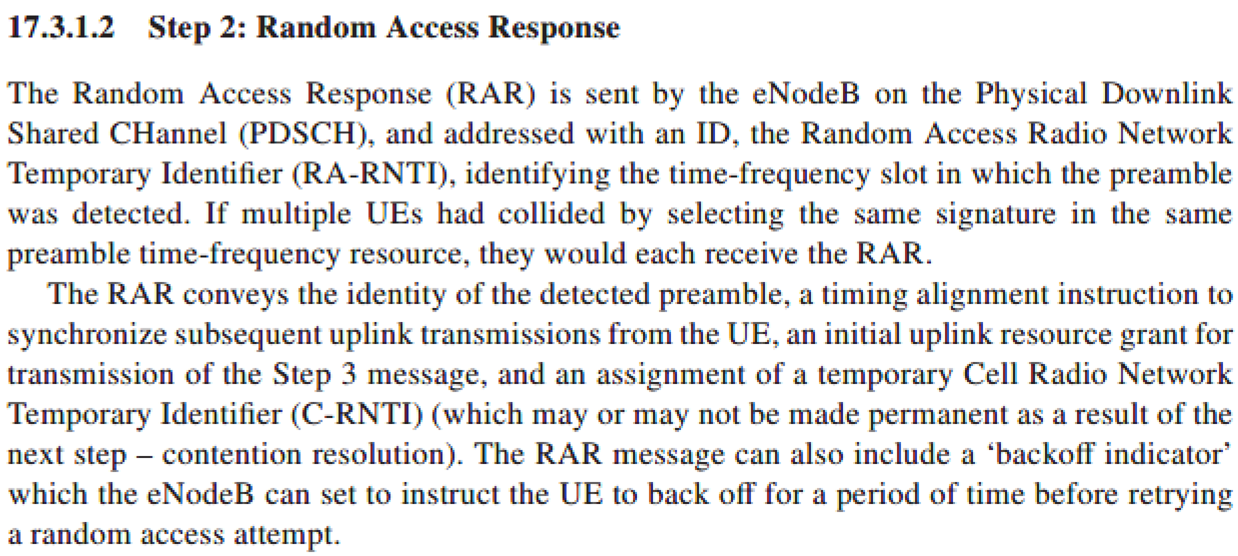
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

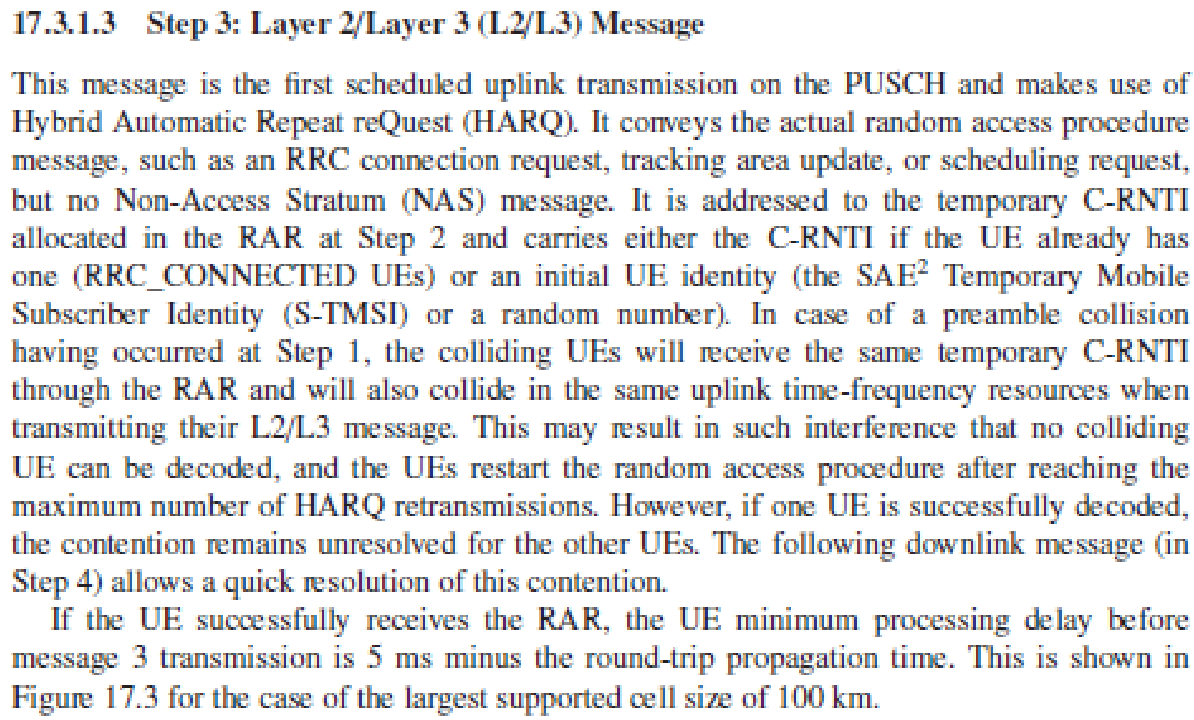
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

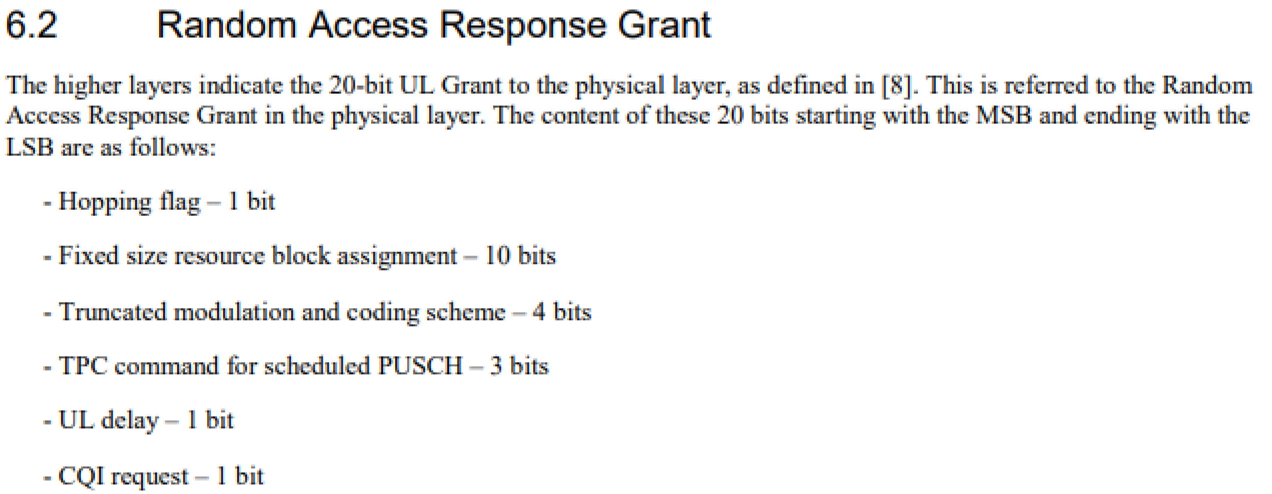
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

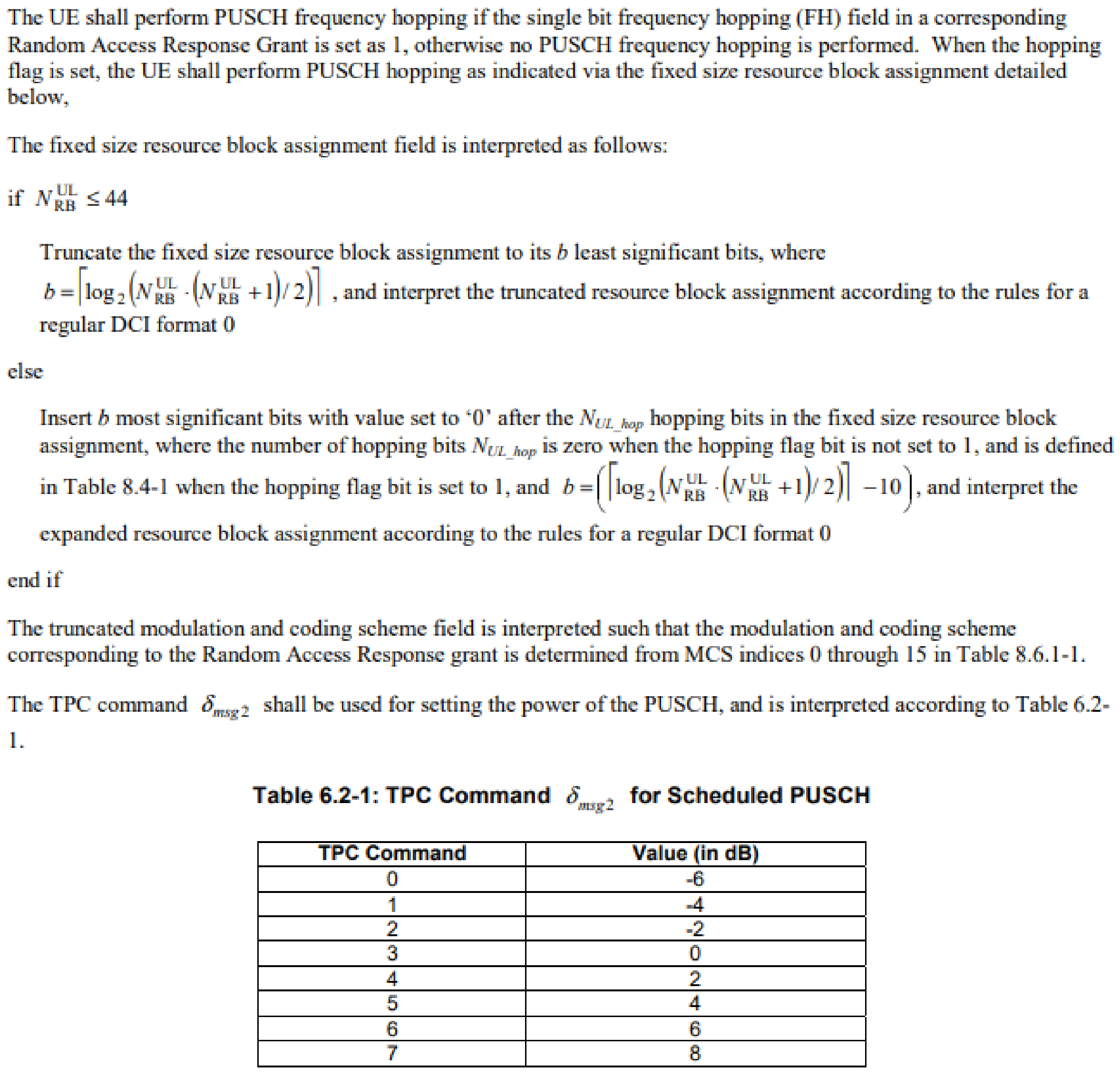
US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of GM's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

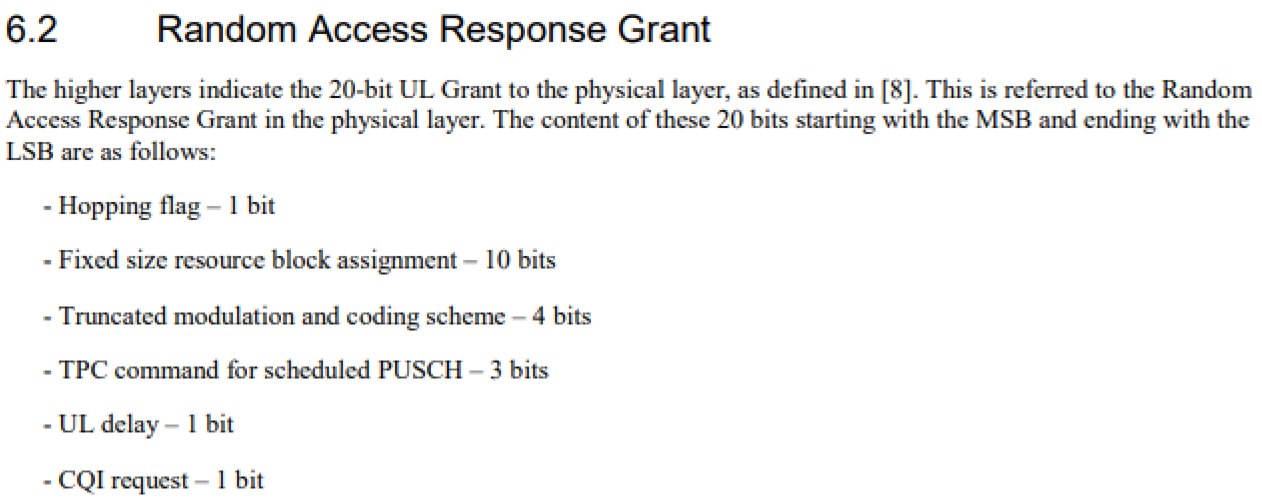
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

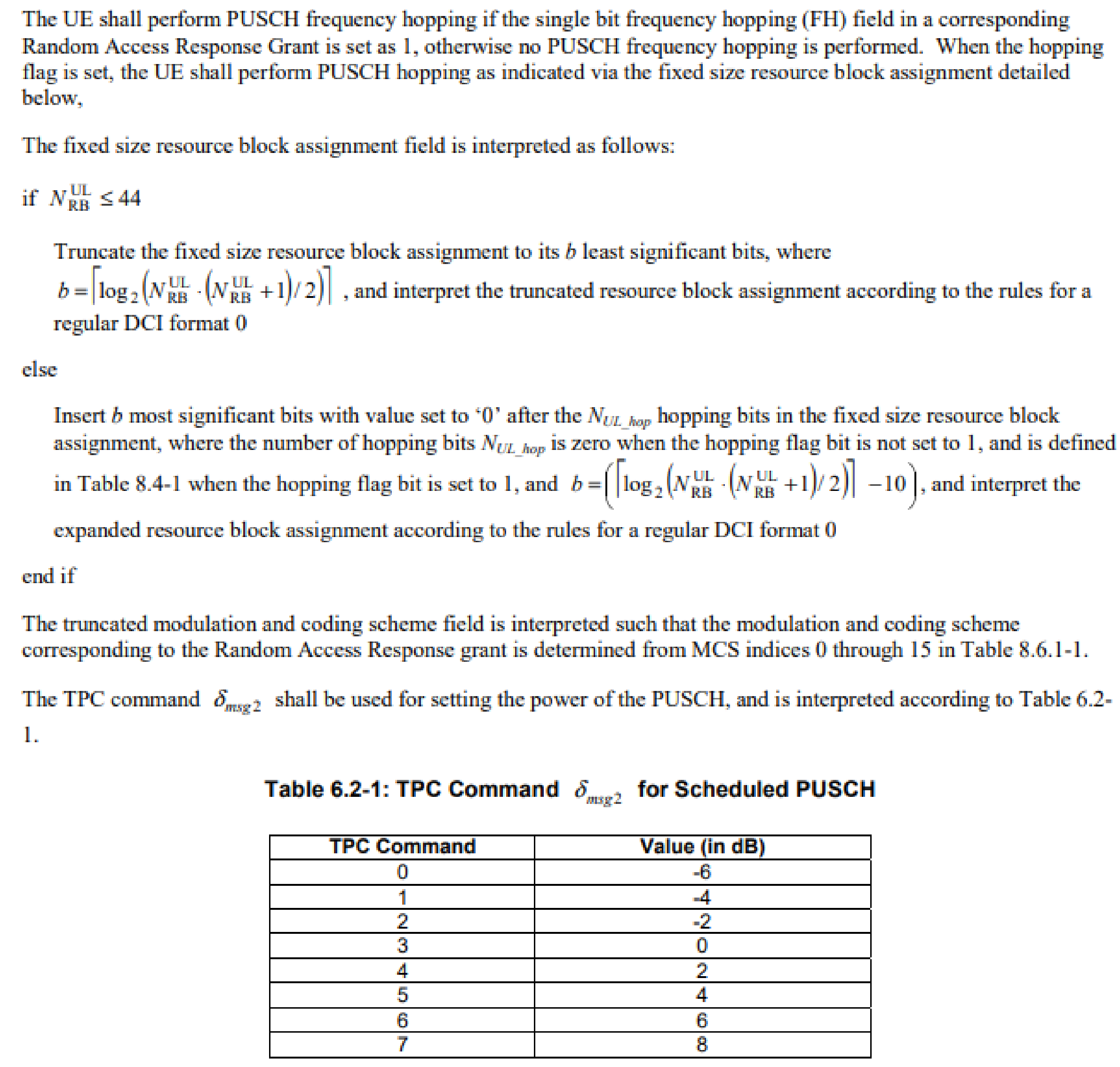
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
"wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information"

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of GM's Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

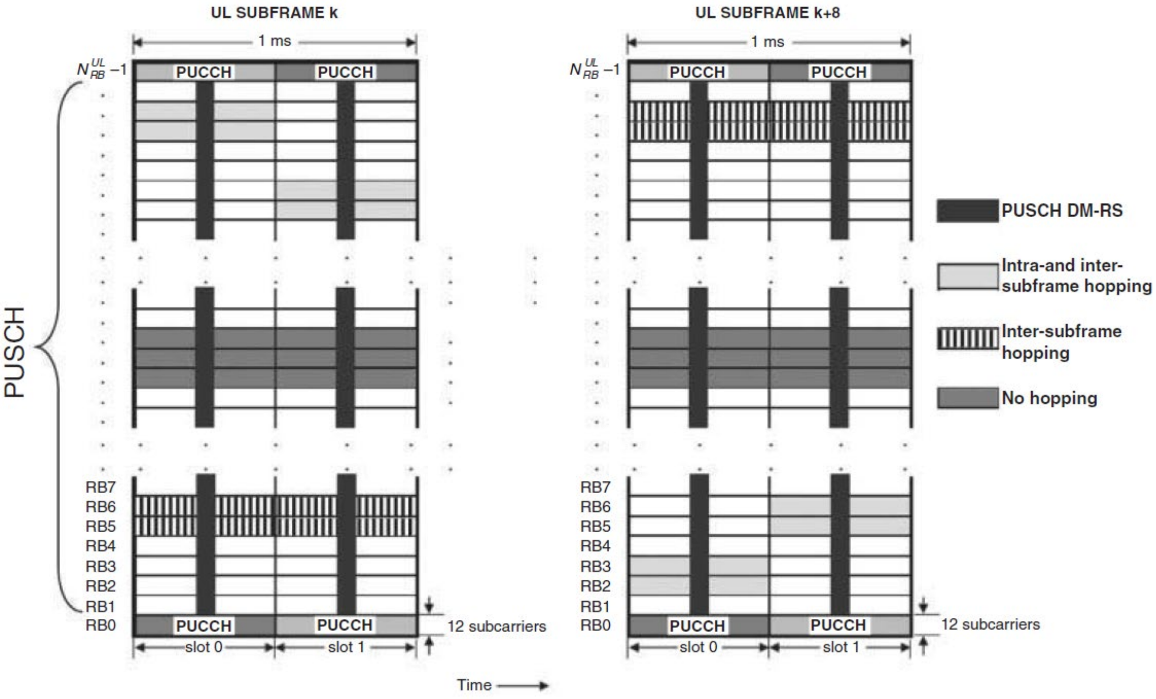
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

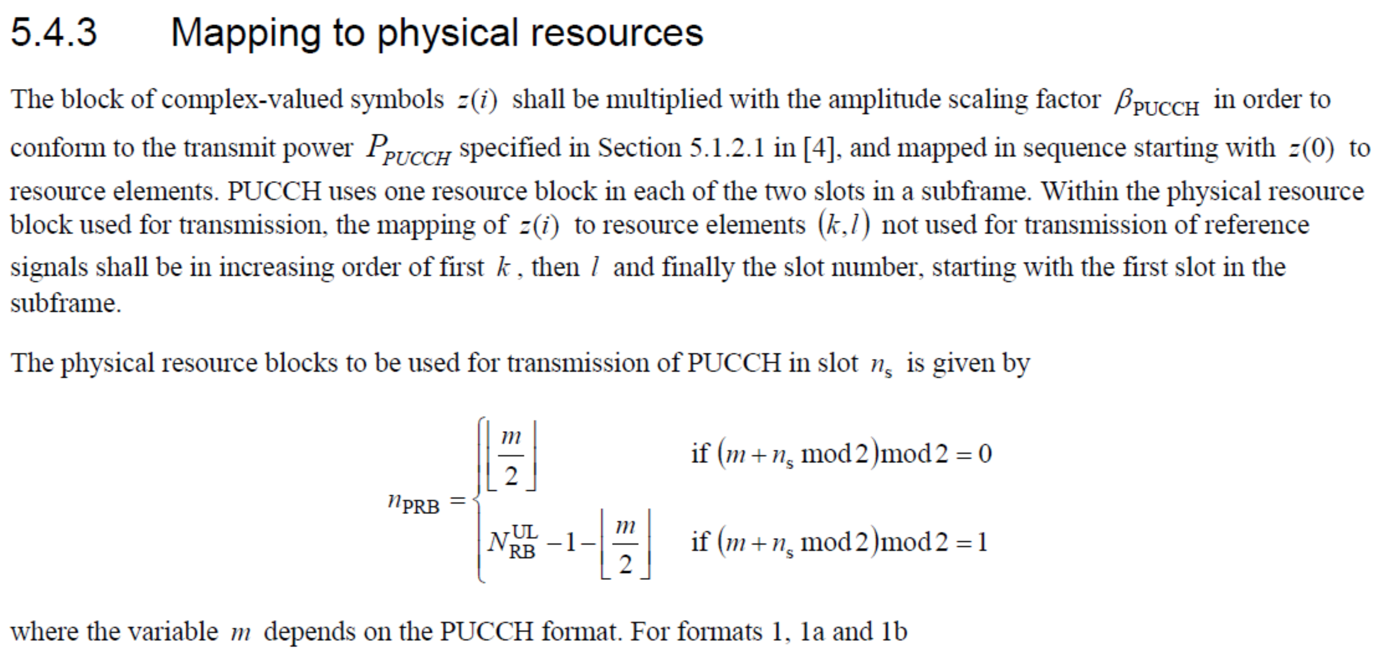
US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of GM's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure"). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

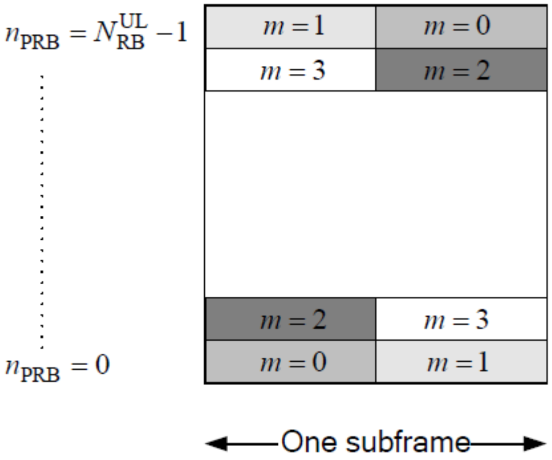


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

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For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is

defined as $n_{PRB}^{RA} = n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

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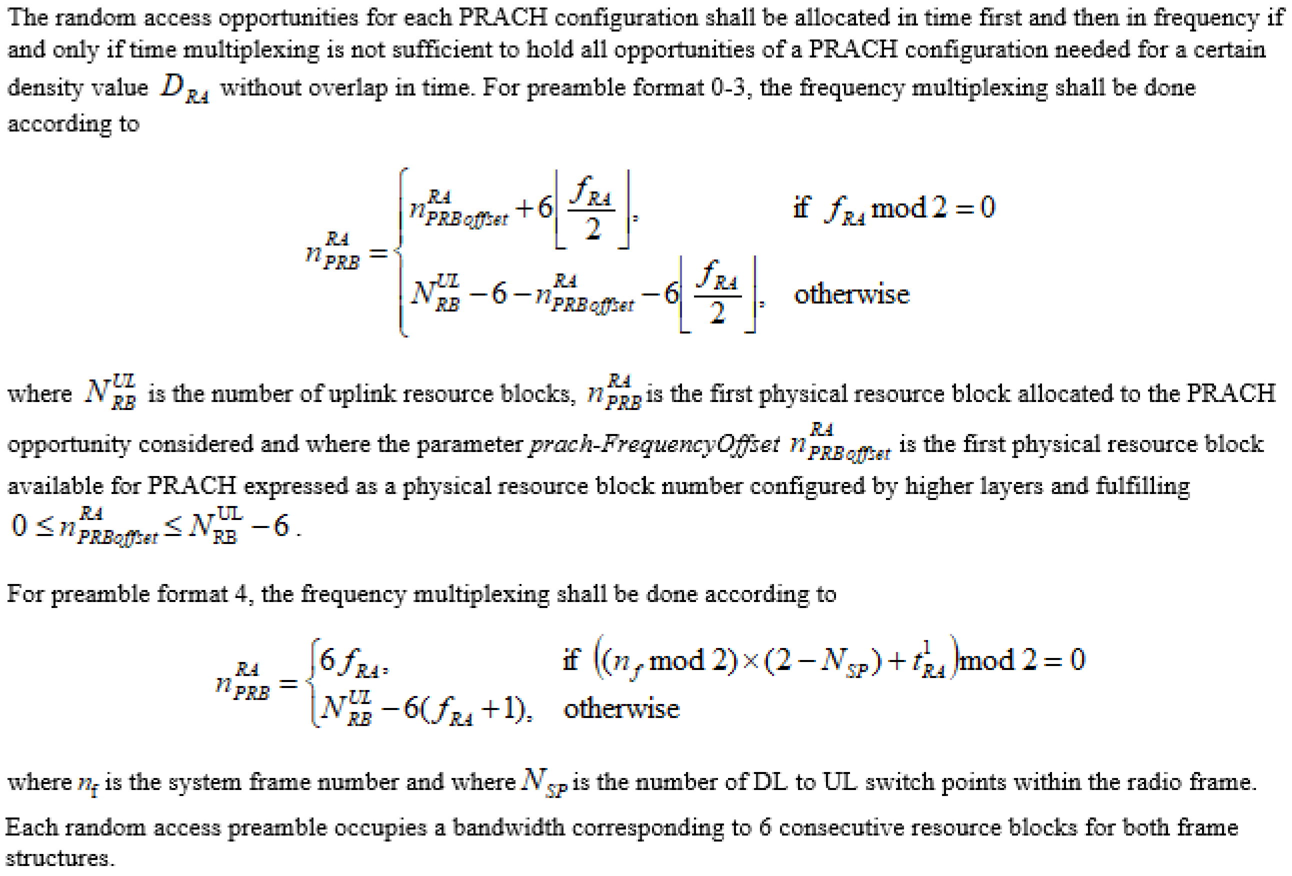
US Patent No. 10,833,908: Claim 4
“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^0, t_{RA}^1, t_{RA}^2)$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^0 = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^1 = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^2 is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^2 is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_s$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	**UL/DL configuration (See Table 4.2-2)**						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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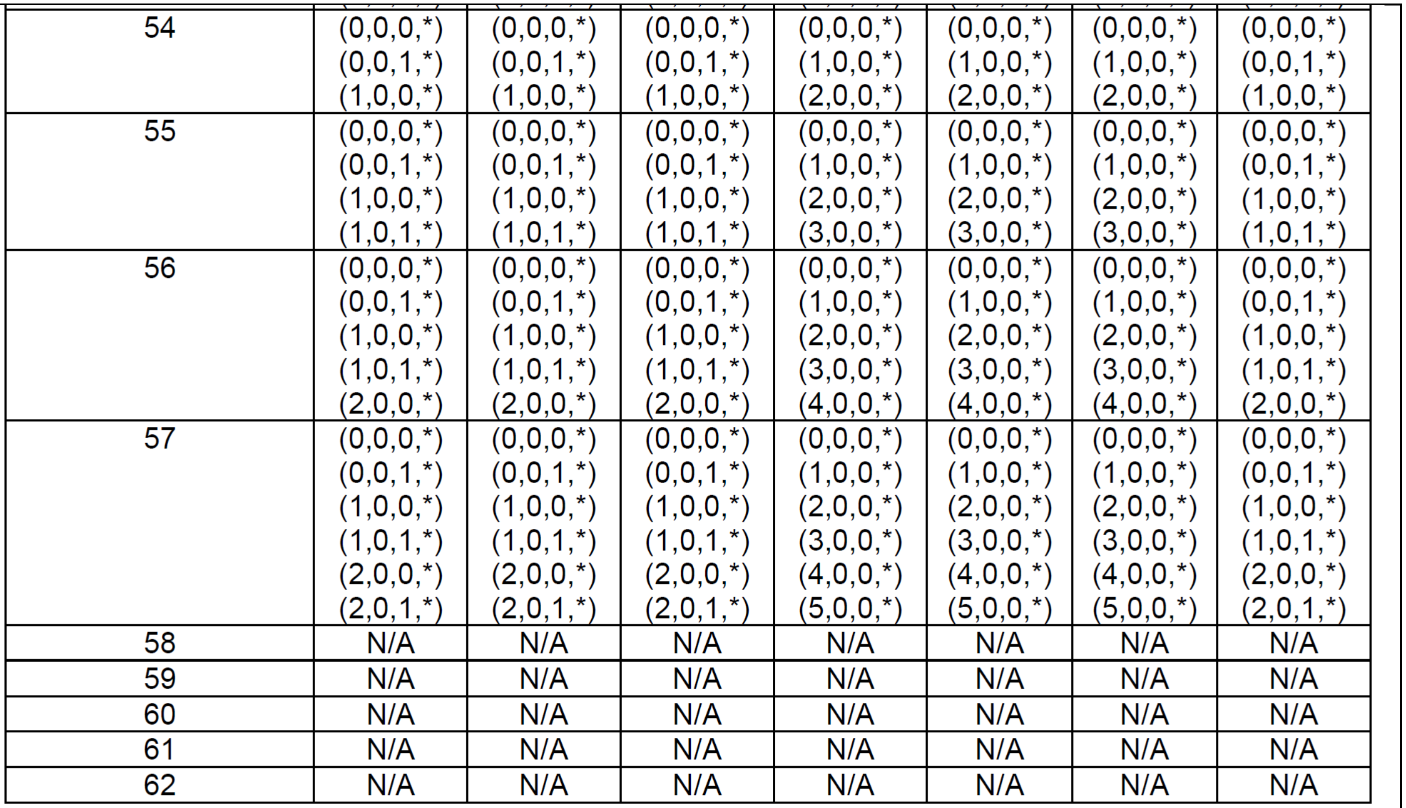
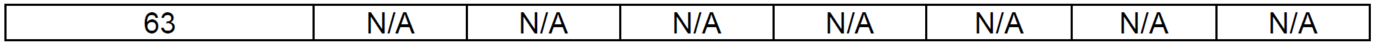
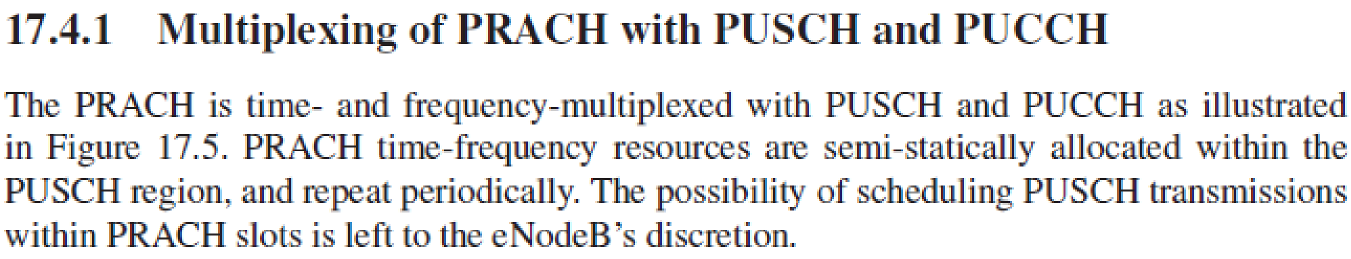


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A



63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

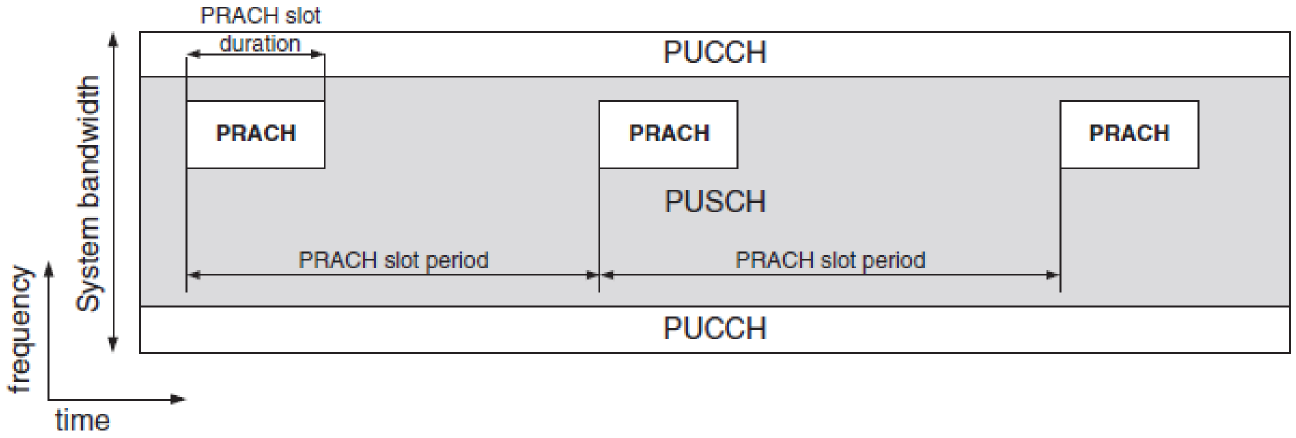


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

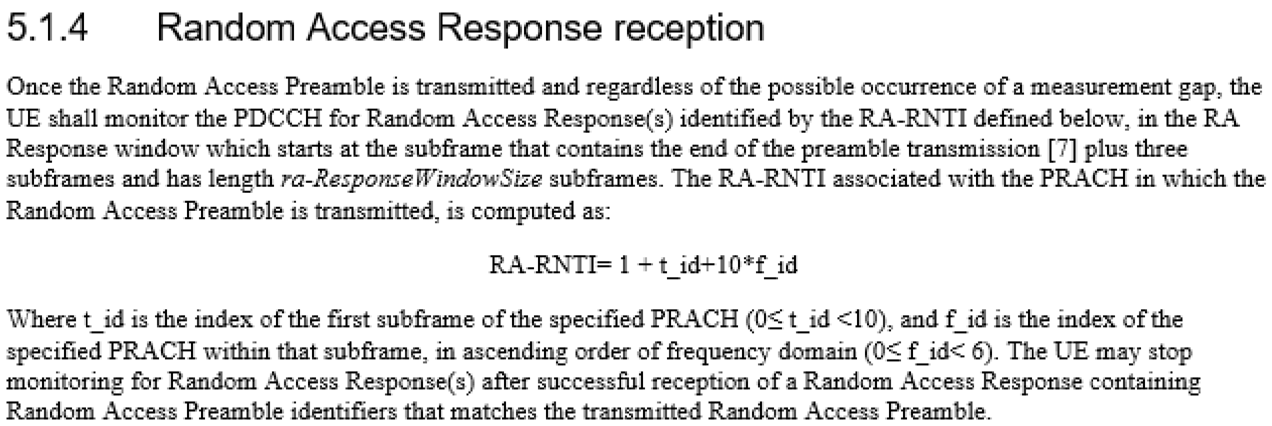
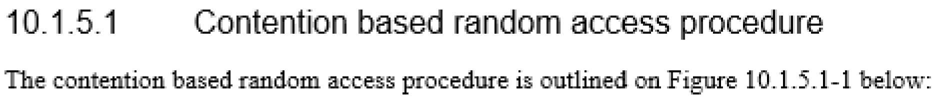
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of GM’s Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$ Where t_id is the index of the first subframe of the specified PRACH $(0 \le t\_id < 10)$, and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain $(0 \le f\_id < 6)$. The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

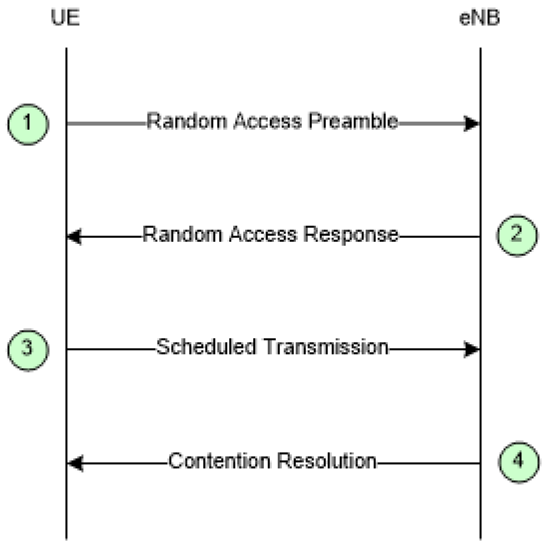


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

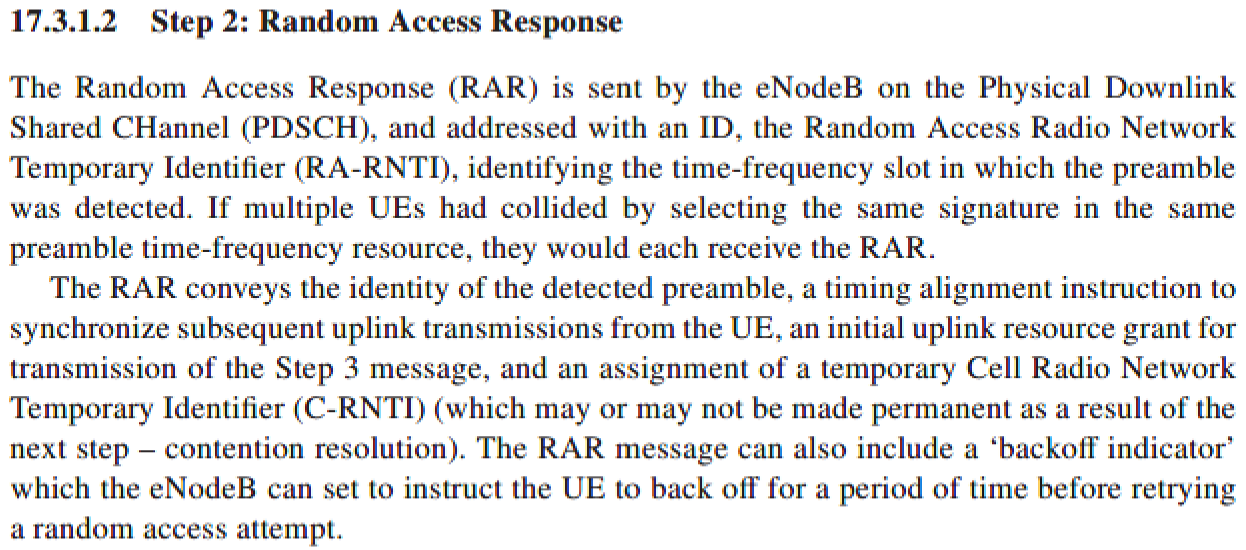
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

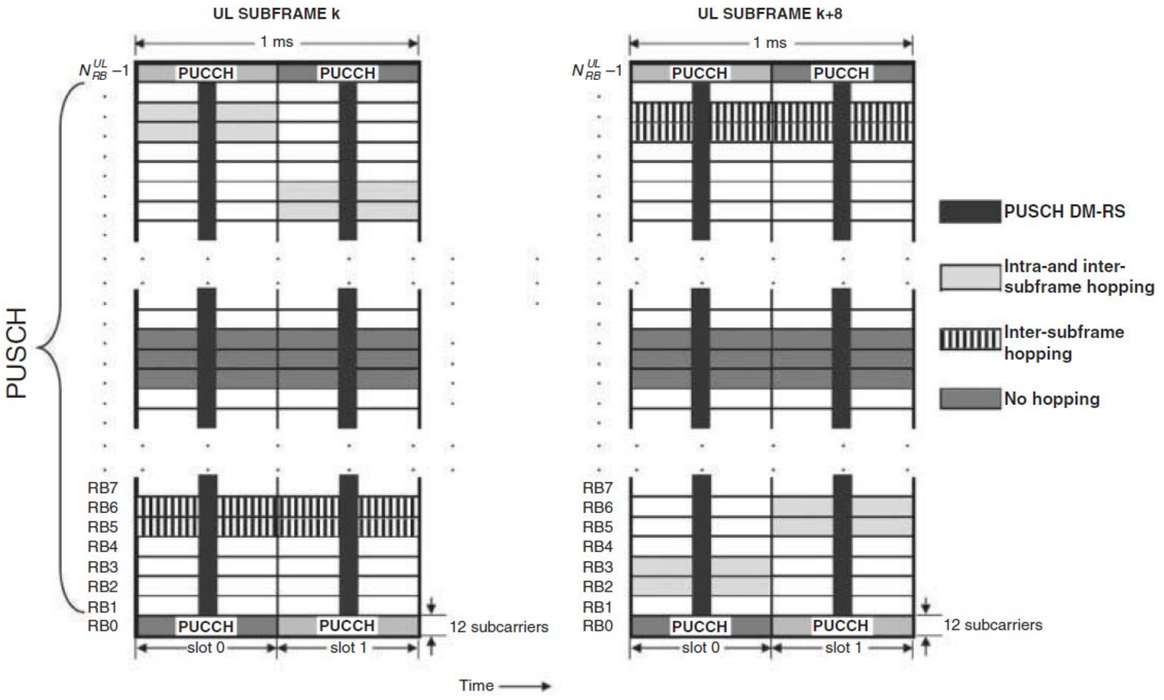
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 6
"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with GM's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

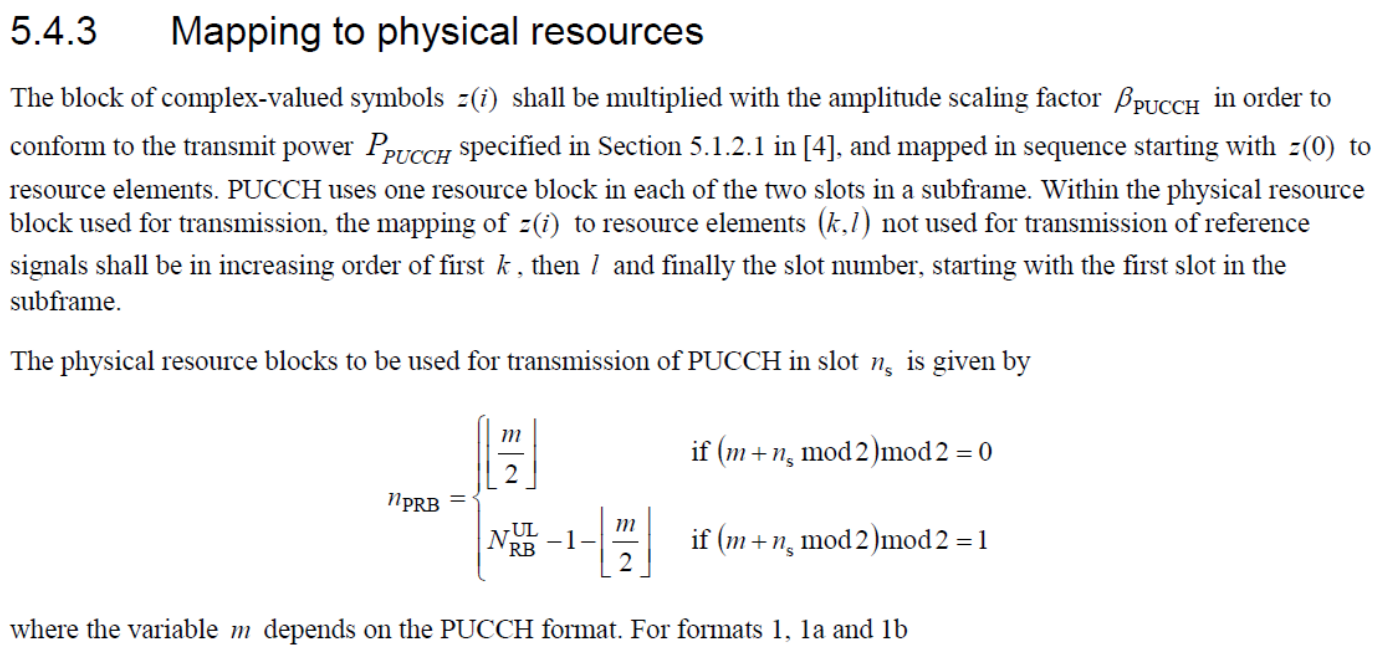
US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with GM's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

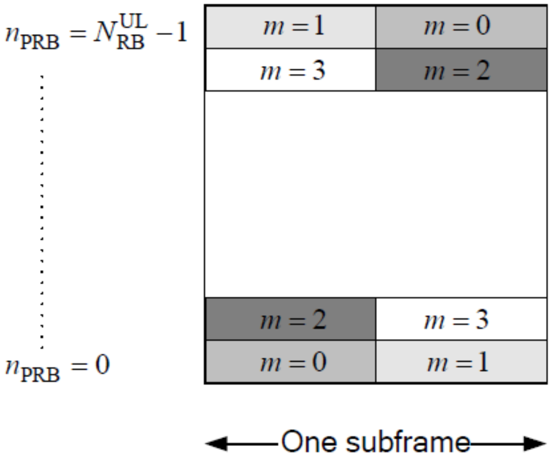
US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7

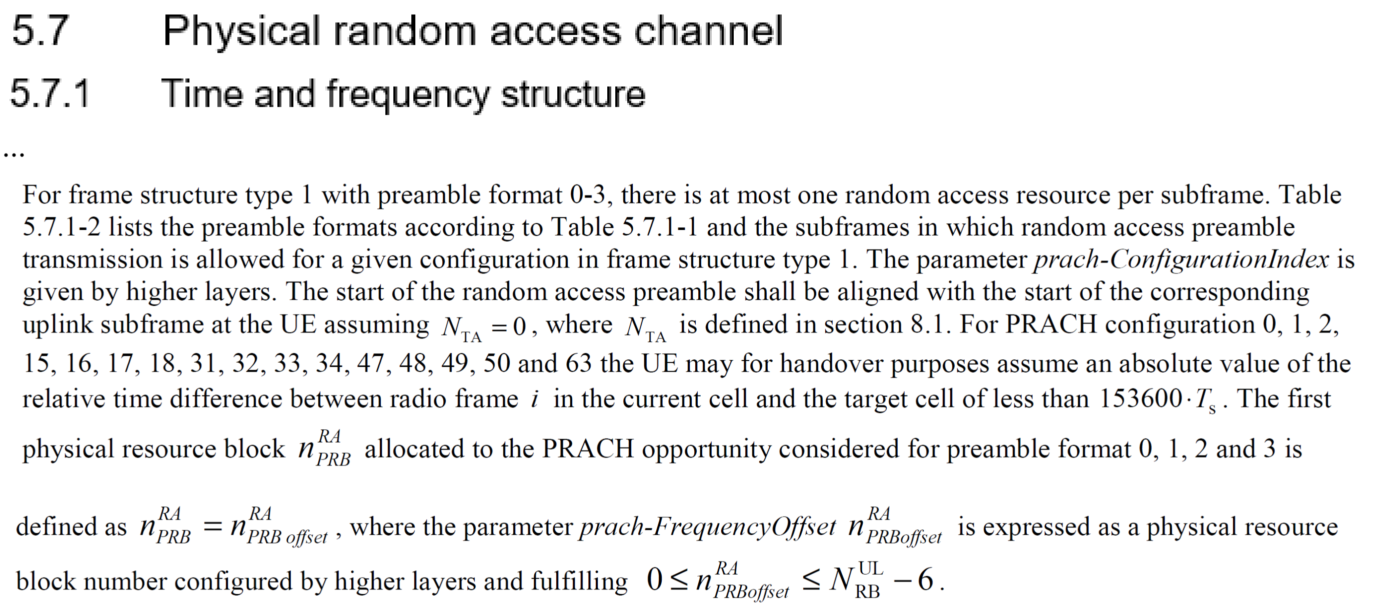
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$ $c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$ and for formats 2, 2a and 2b $m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$ Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1. In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.  **Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21. The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

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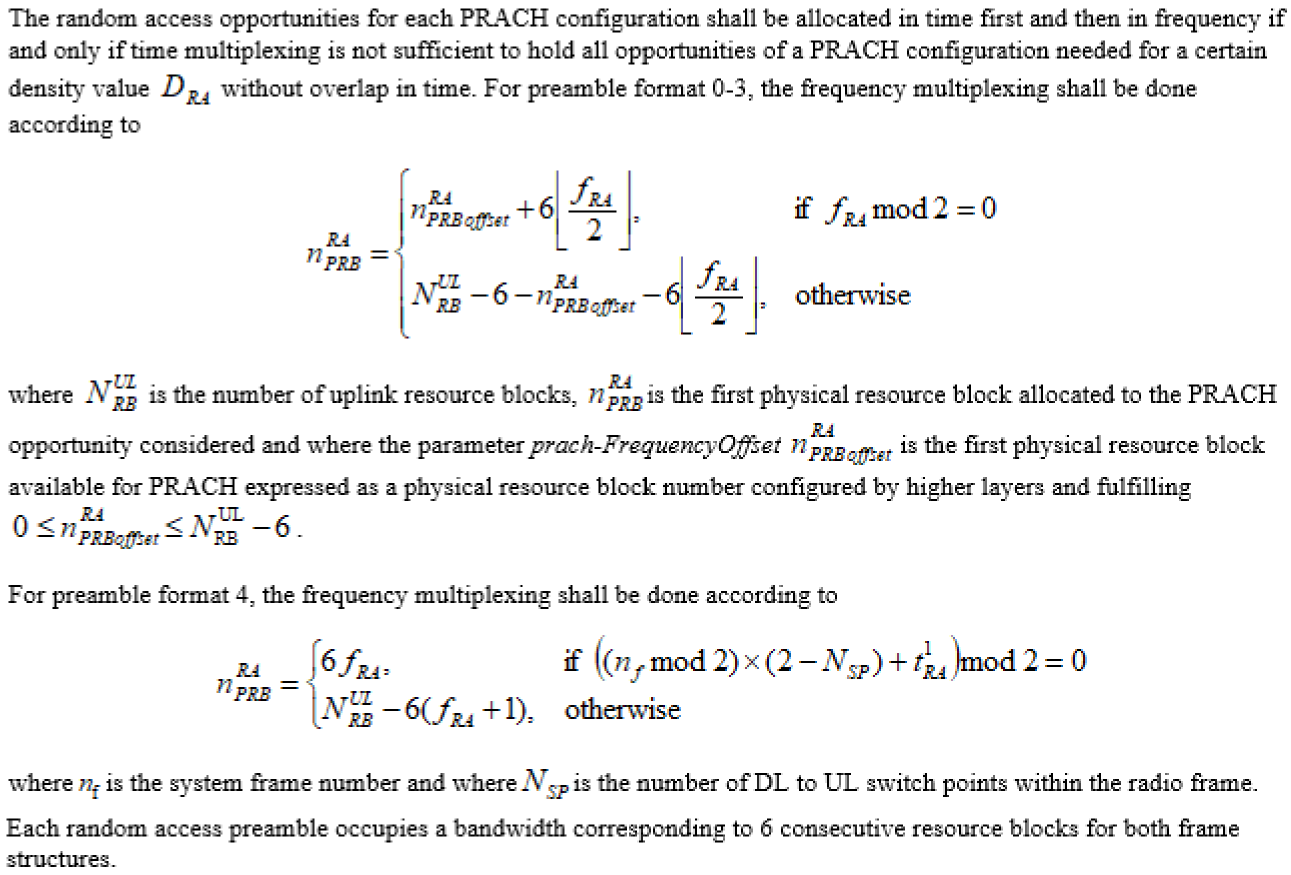
For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

...

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

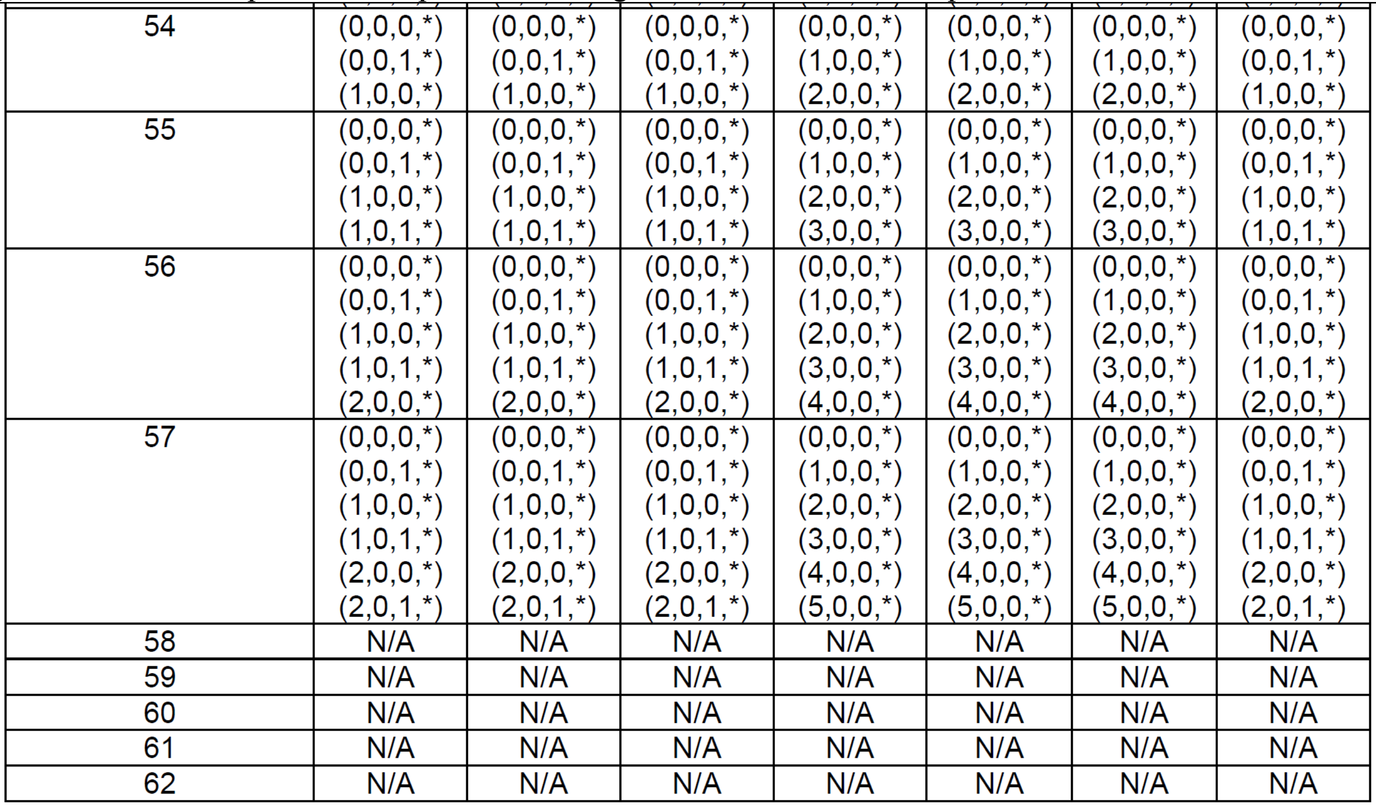
.

.

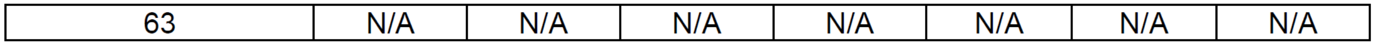
.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

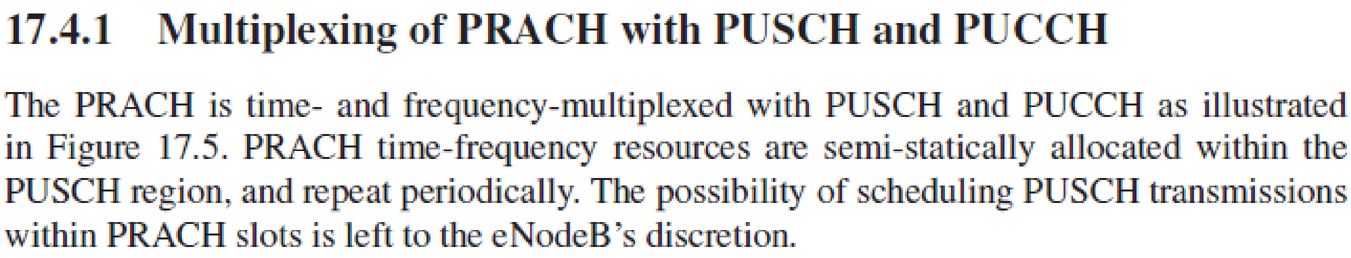


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A



63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

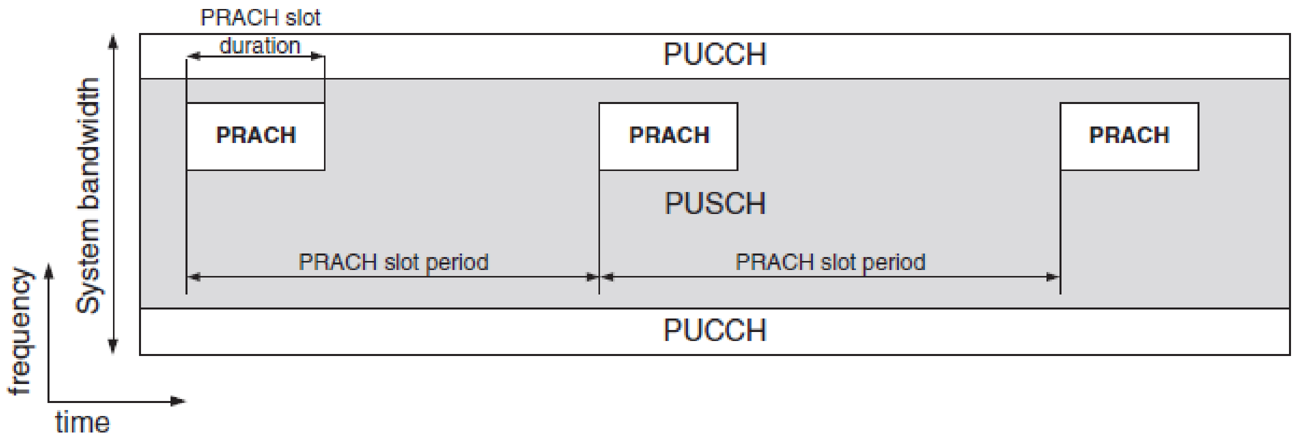


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

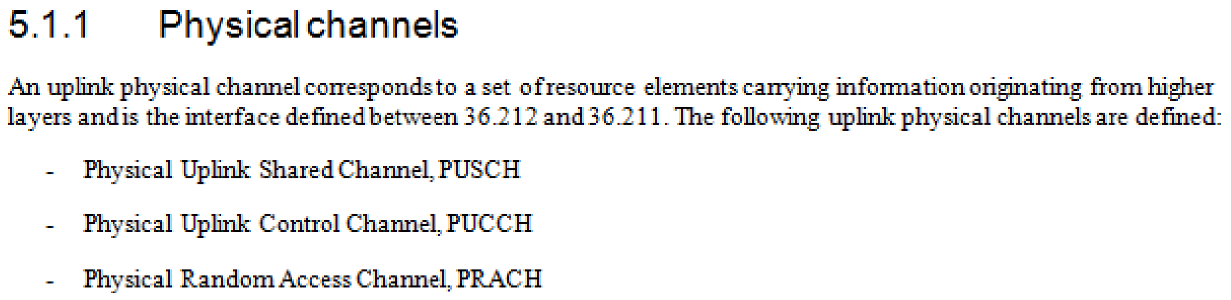
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 7

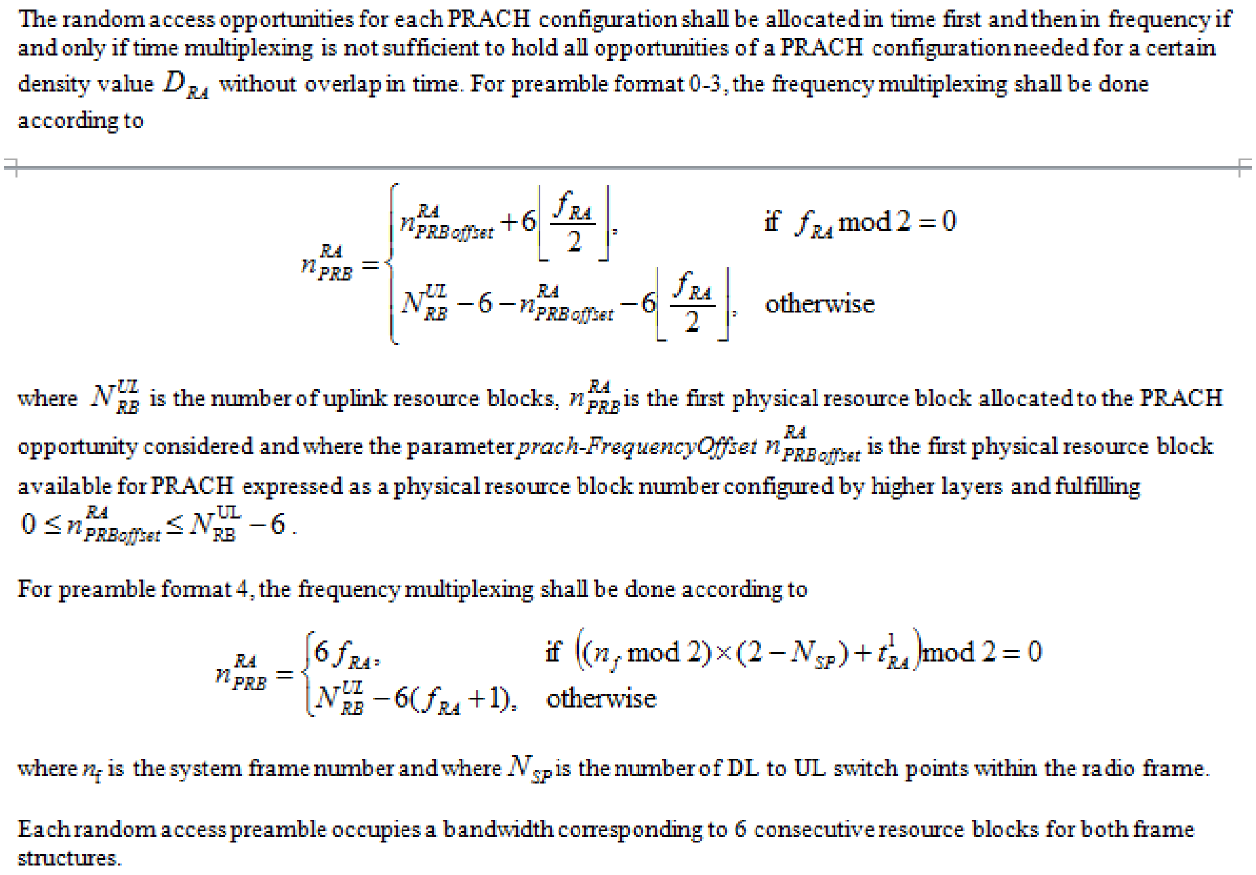
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

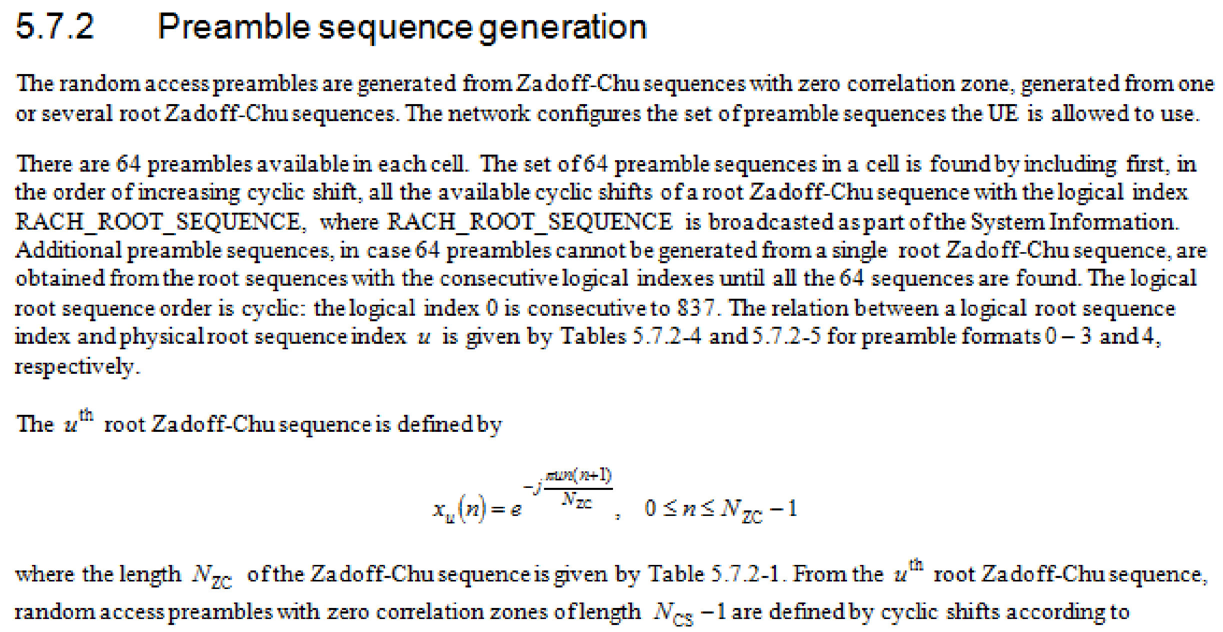
US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with GM’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}},\quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

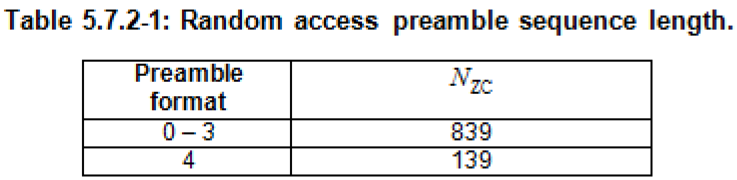
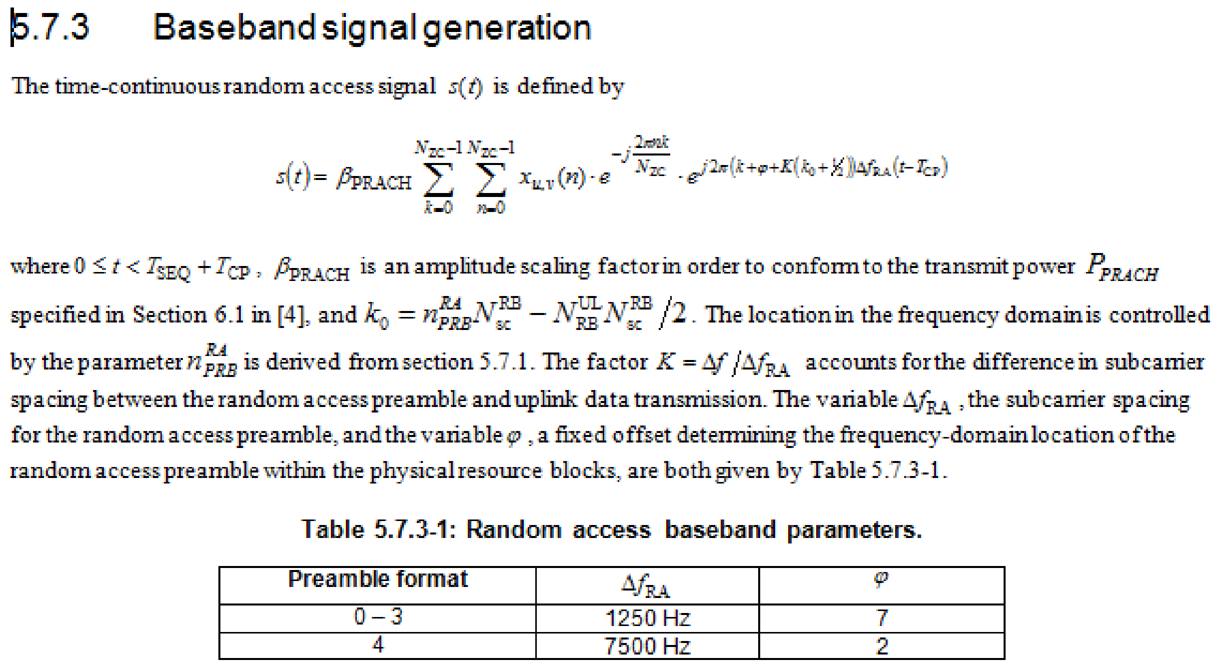


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

where $0\leq t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

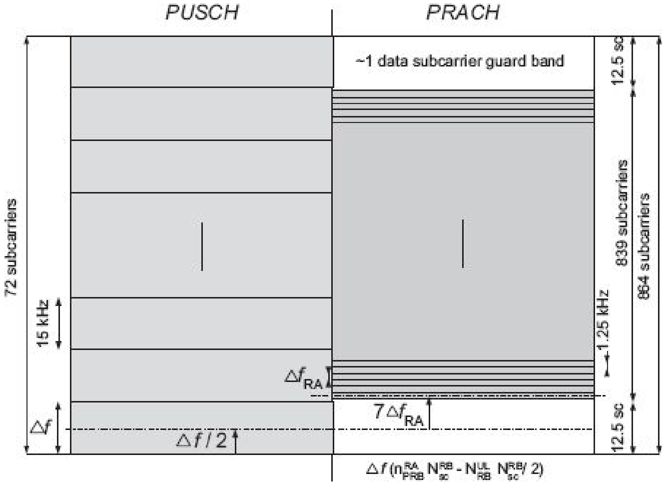
Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

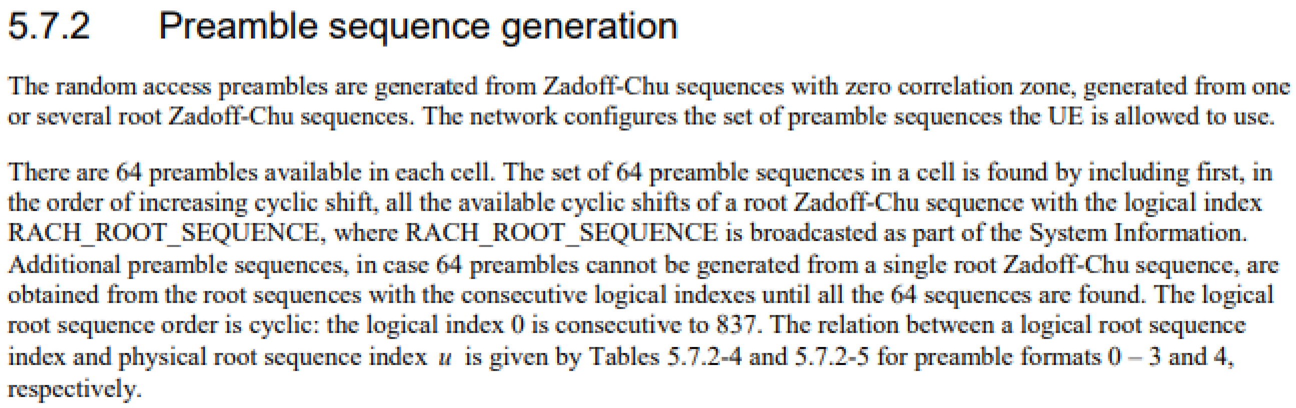
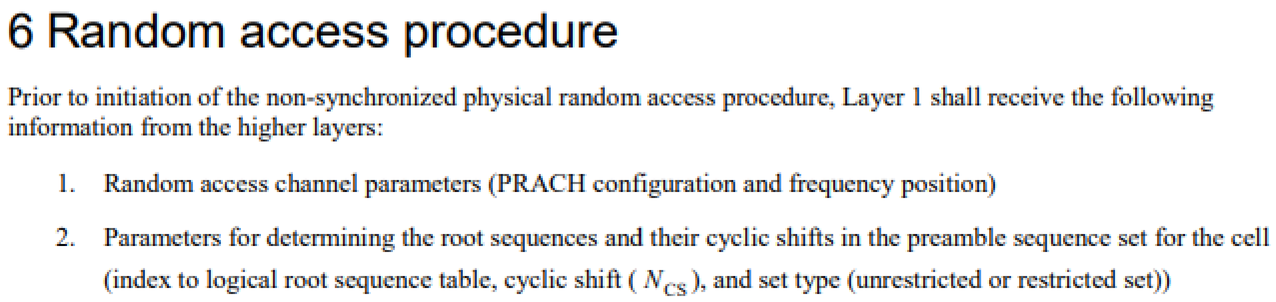
Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.



See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 9
“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of GM’s Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

US Patent No. 10,833,908: Claim 9
“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

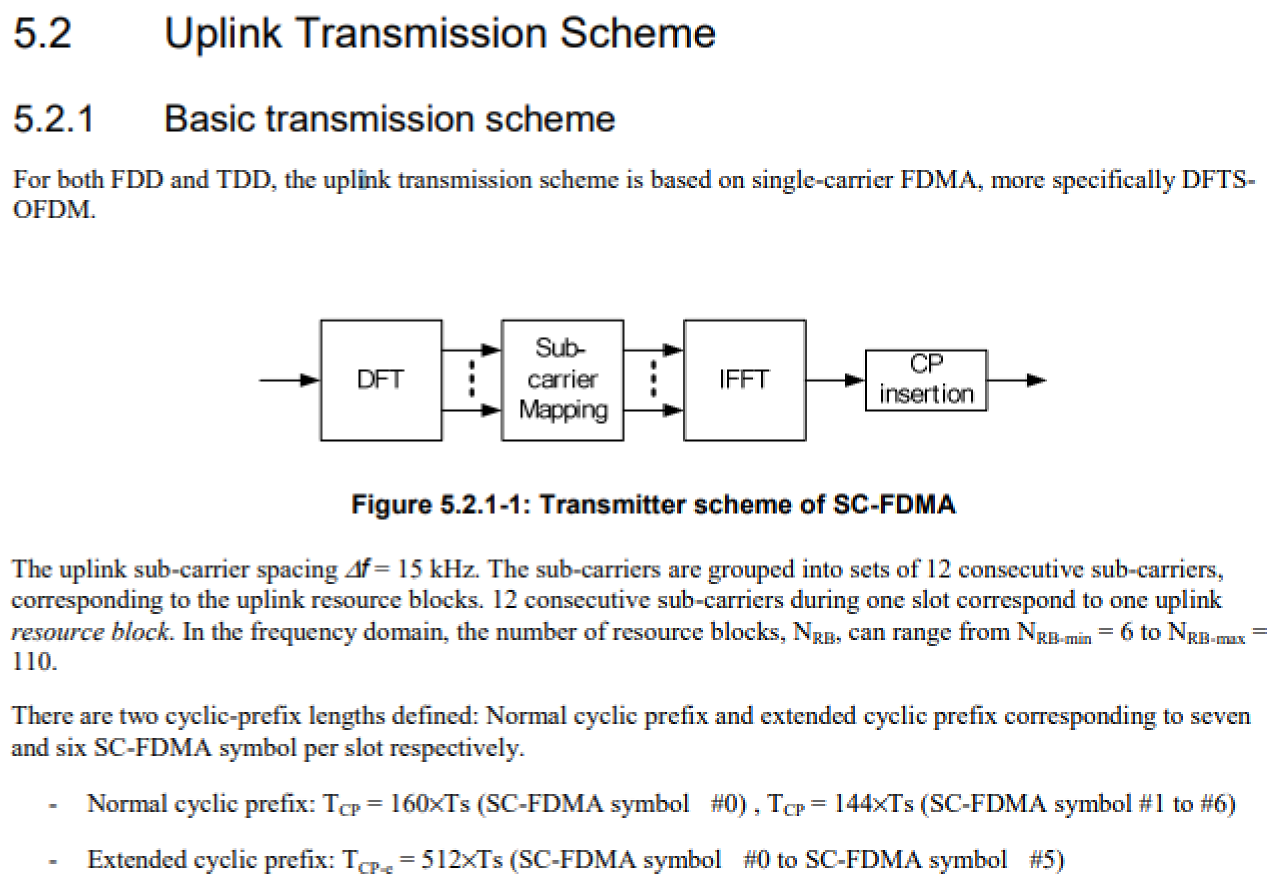
```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

US Patent No. 10,833,908: Claim 10

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 1. GM's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* GM's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

“The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

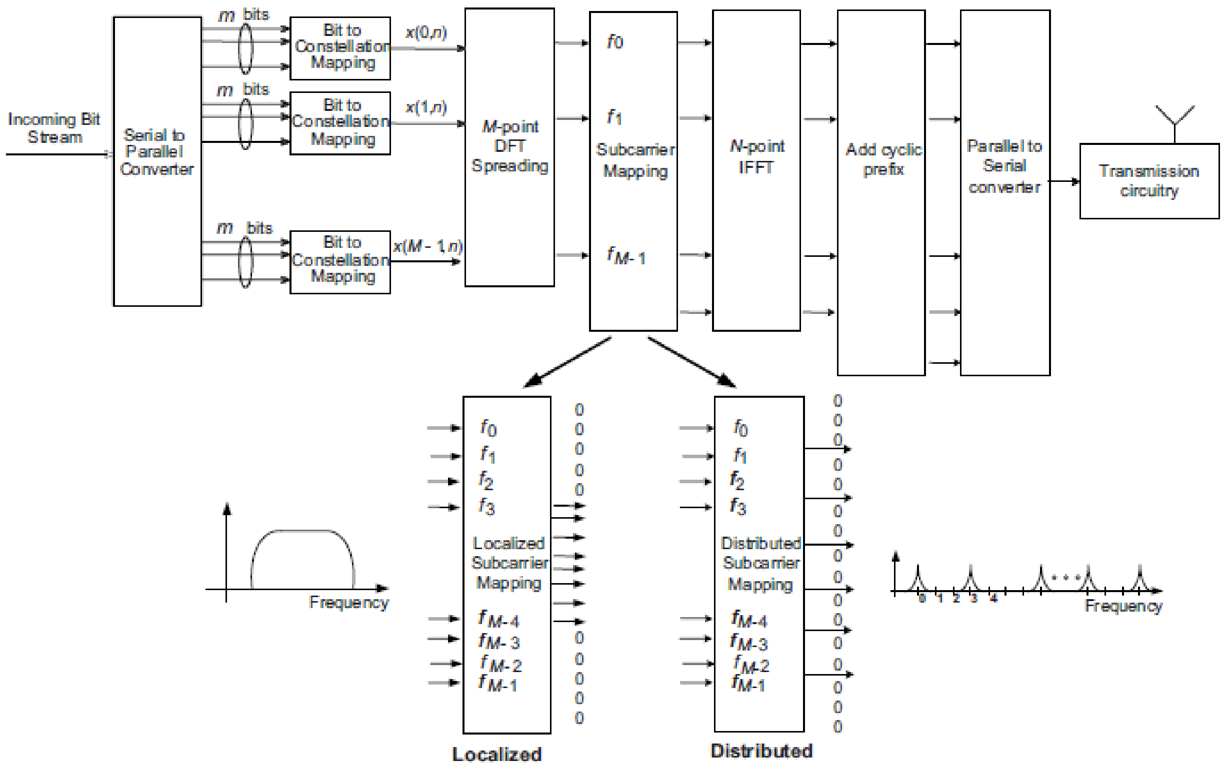
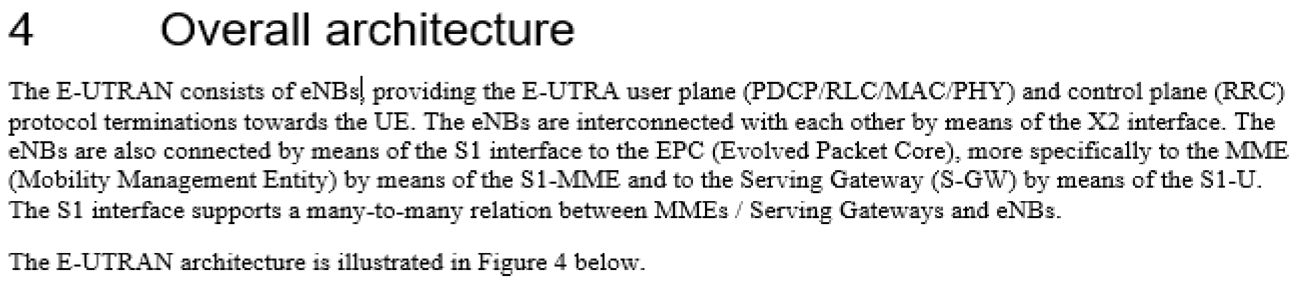


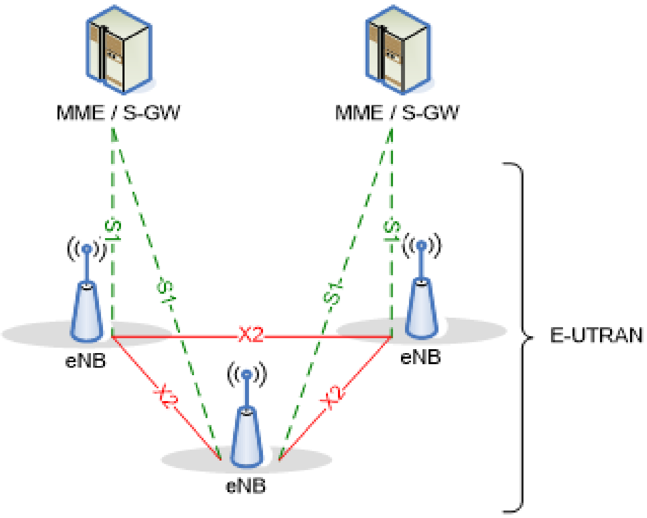
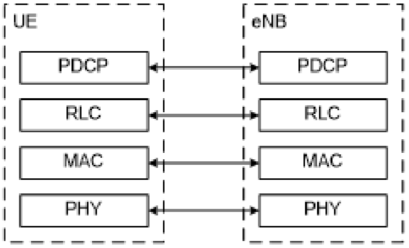
Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, GM's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* GM's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, GM offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

	 **Figure 4-1: Overall Architecture** See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15. 4.3.1 User plane The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;  **Figure 4.3.1-1: User-plane protocol stack** See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	GM’s Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

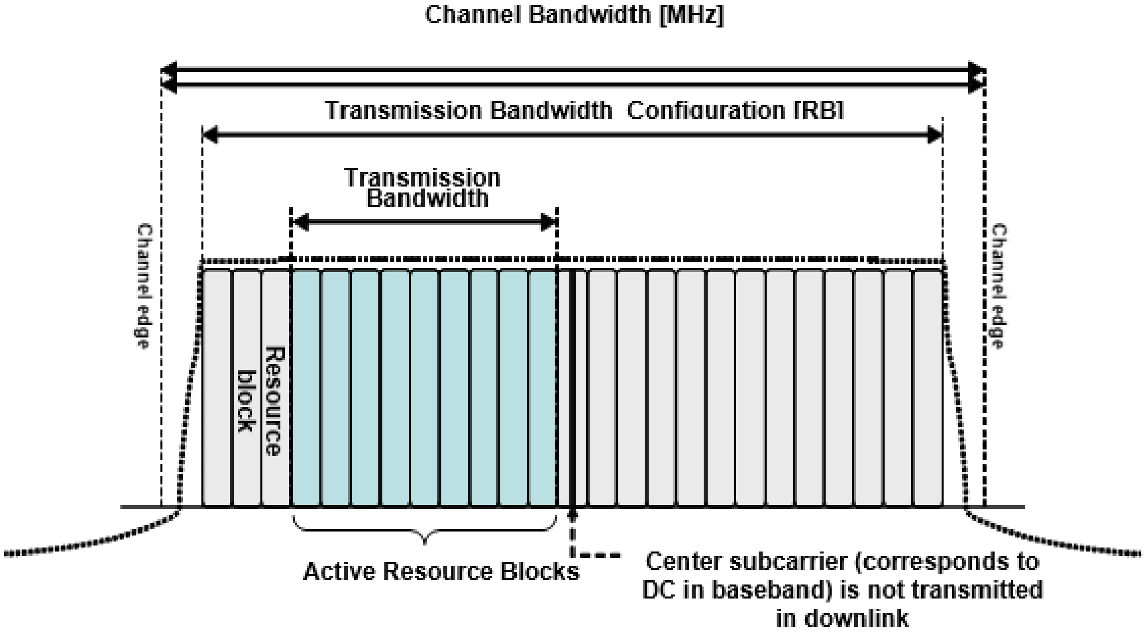
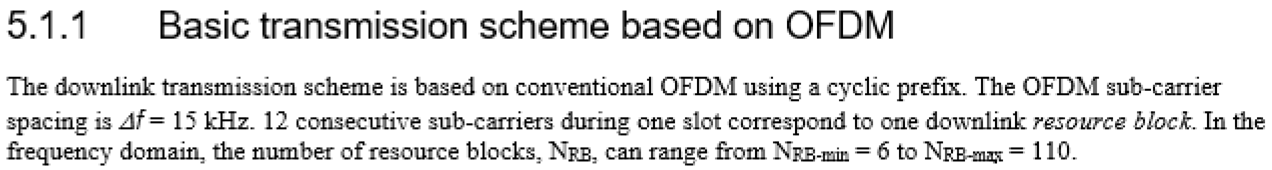


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

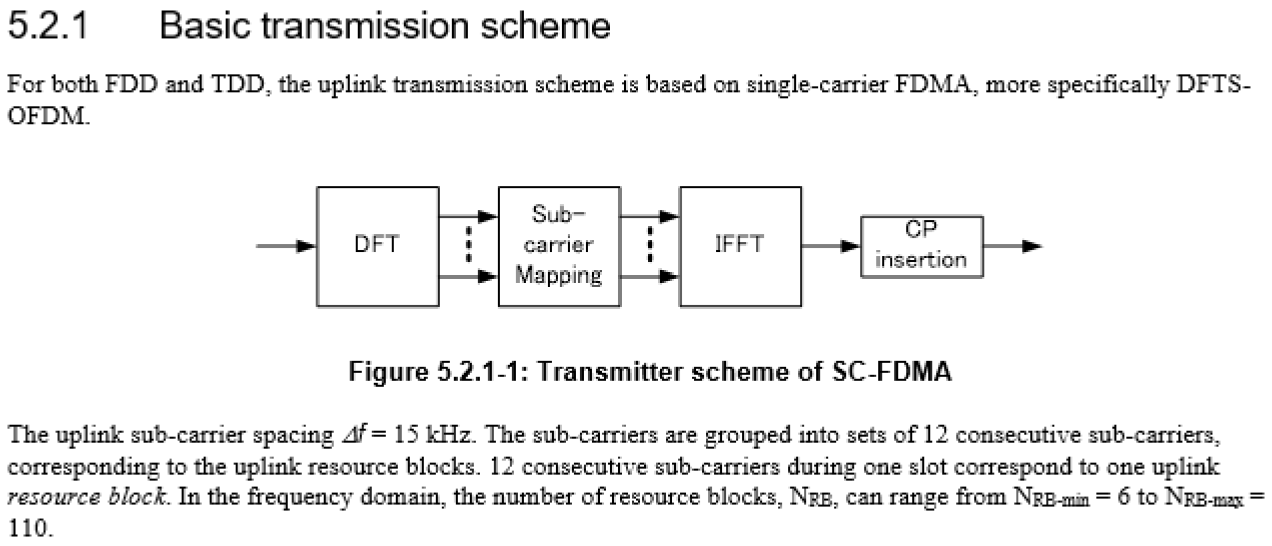
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

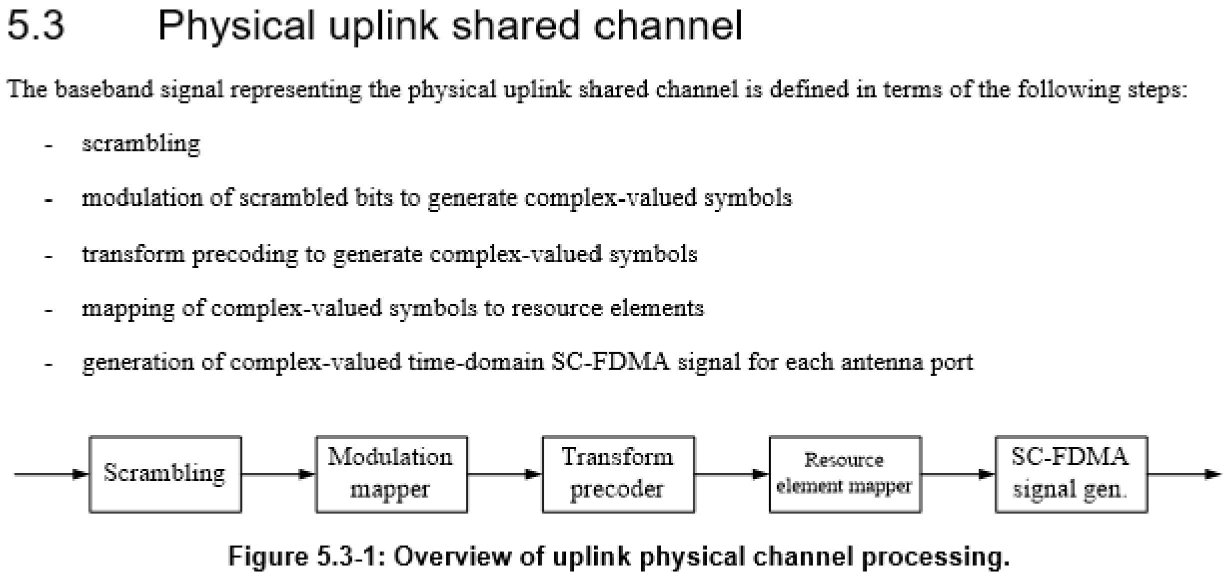
The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

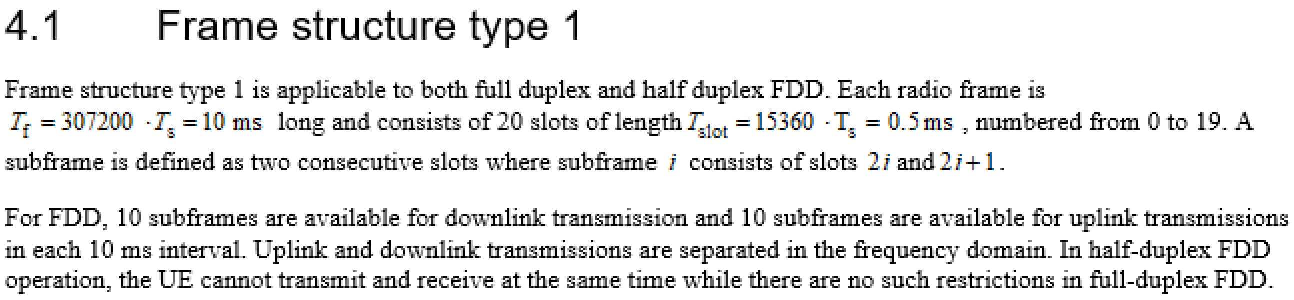
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

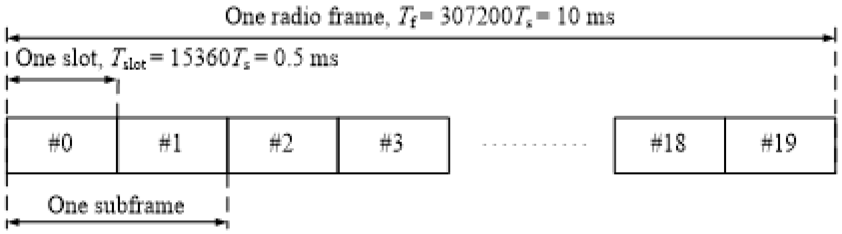
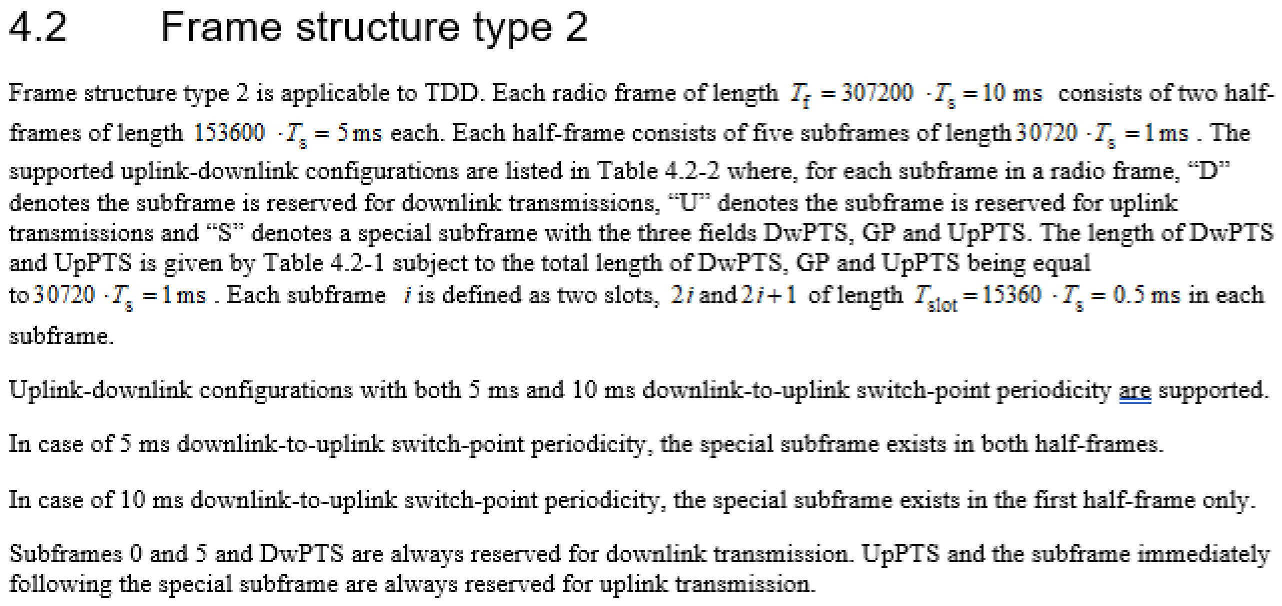


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

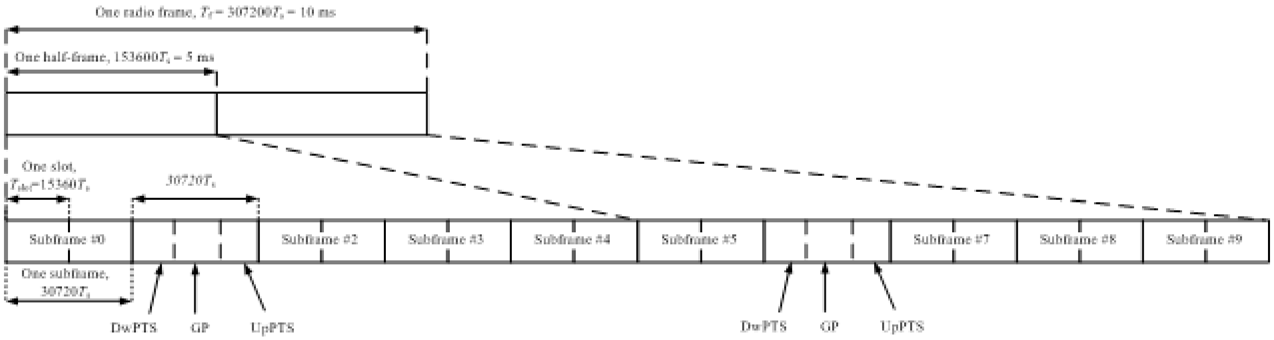
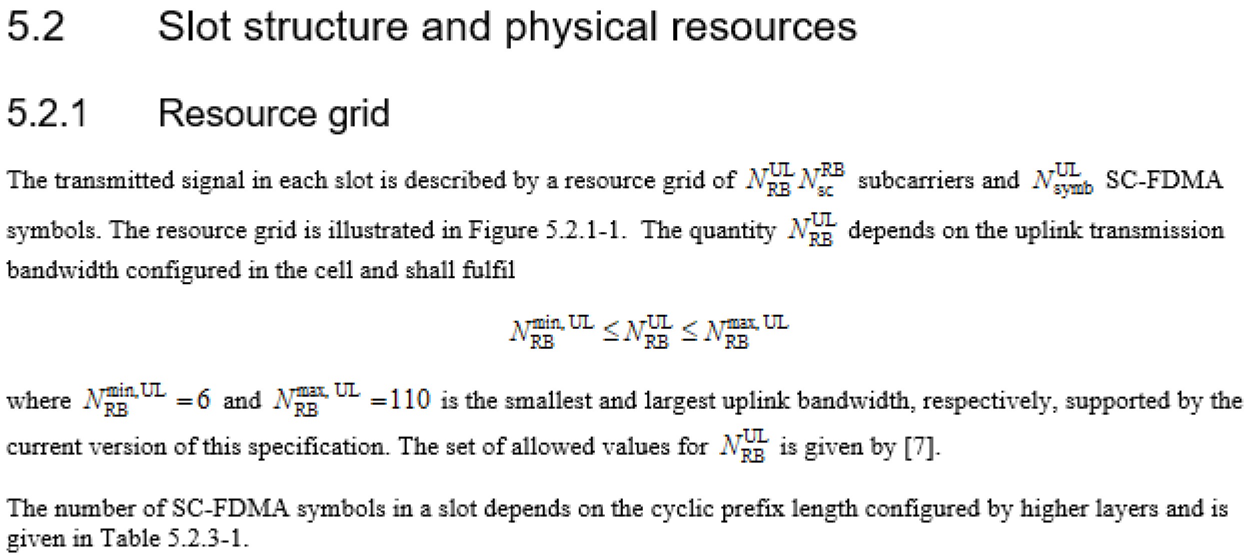


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

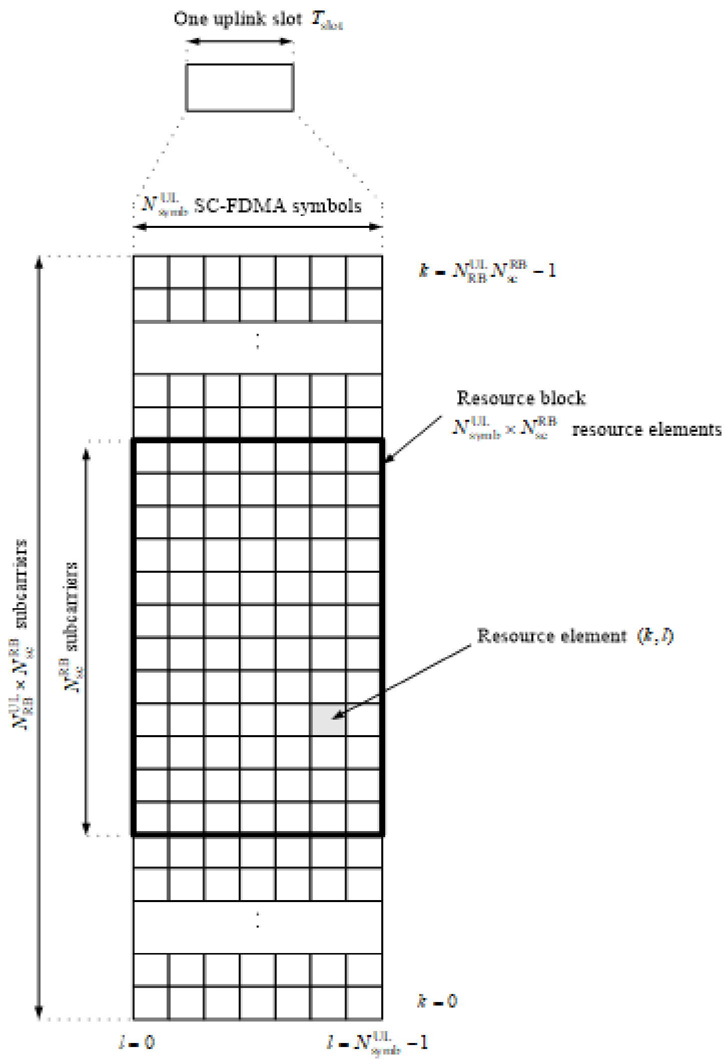
$$N_{\mathrm{RB}}^{\min,\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$$

where $N_{\mathrm{RB}}^{\min,\mathrm{UL}} = 6$ and $N_{\mathrm{RB}}^{\max,\mathrm{UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

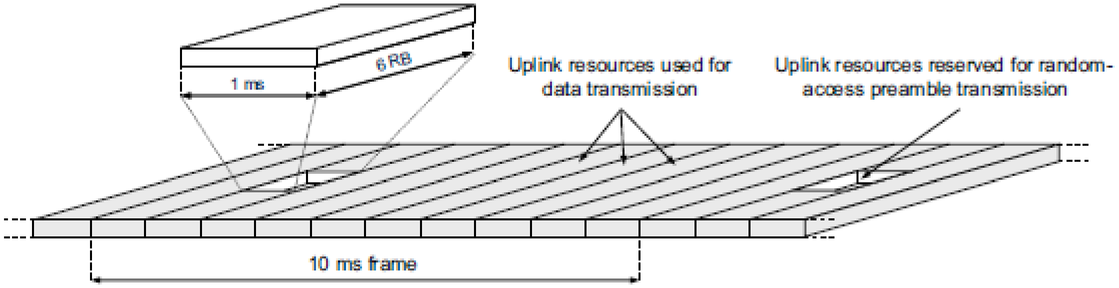
The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

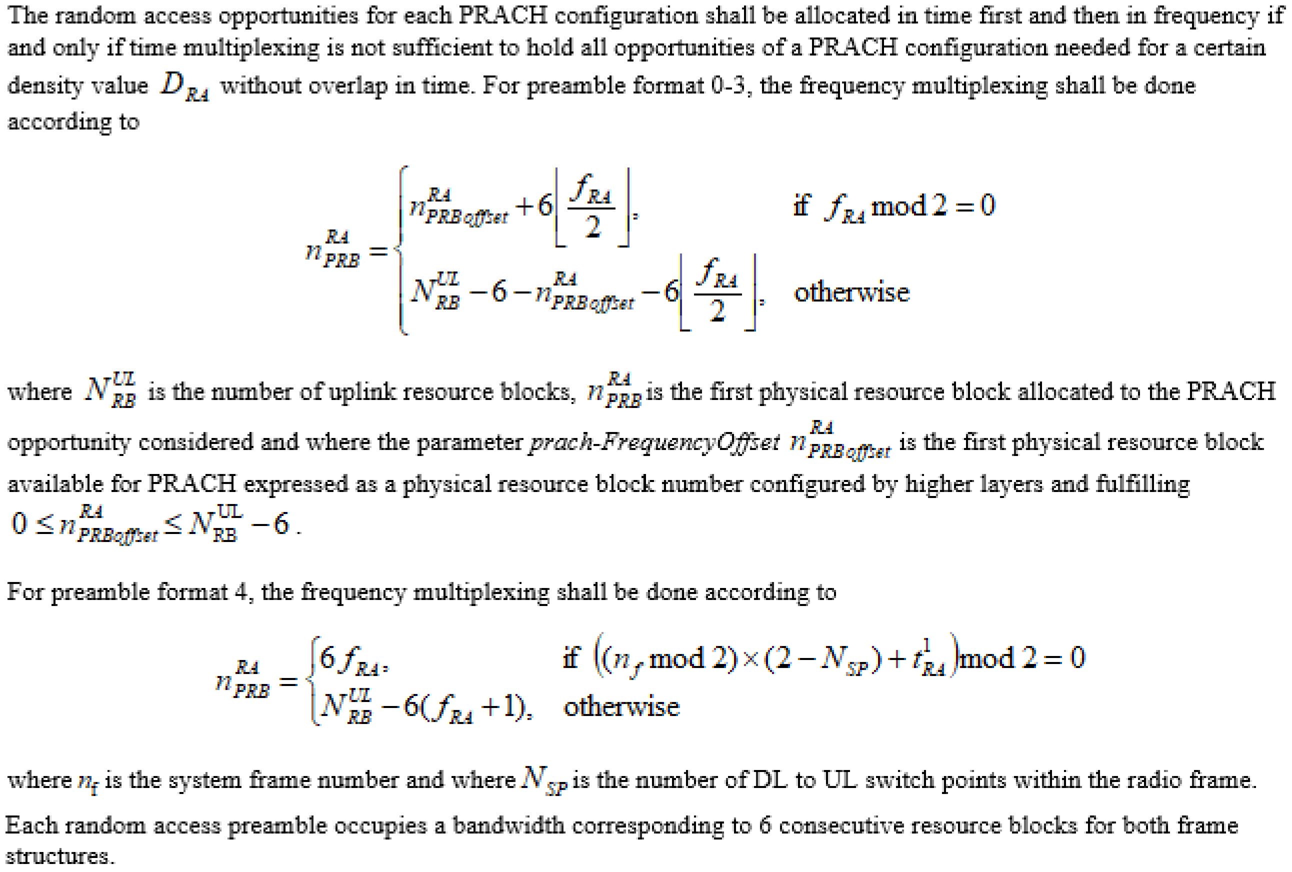
US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

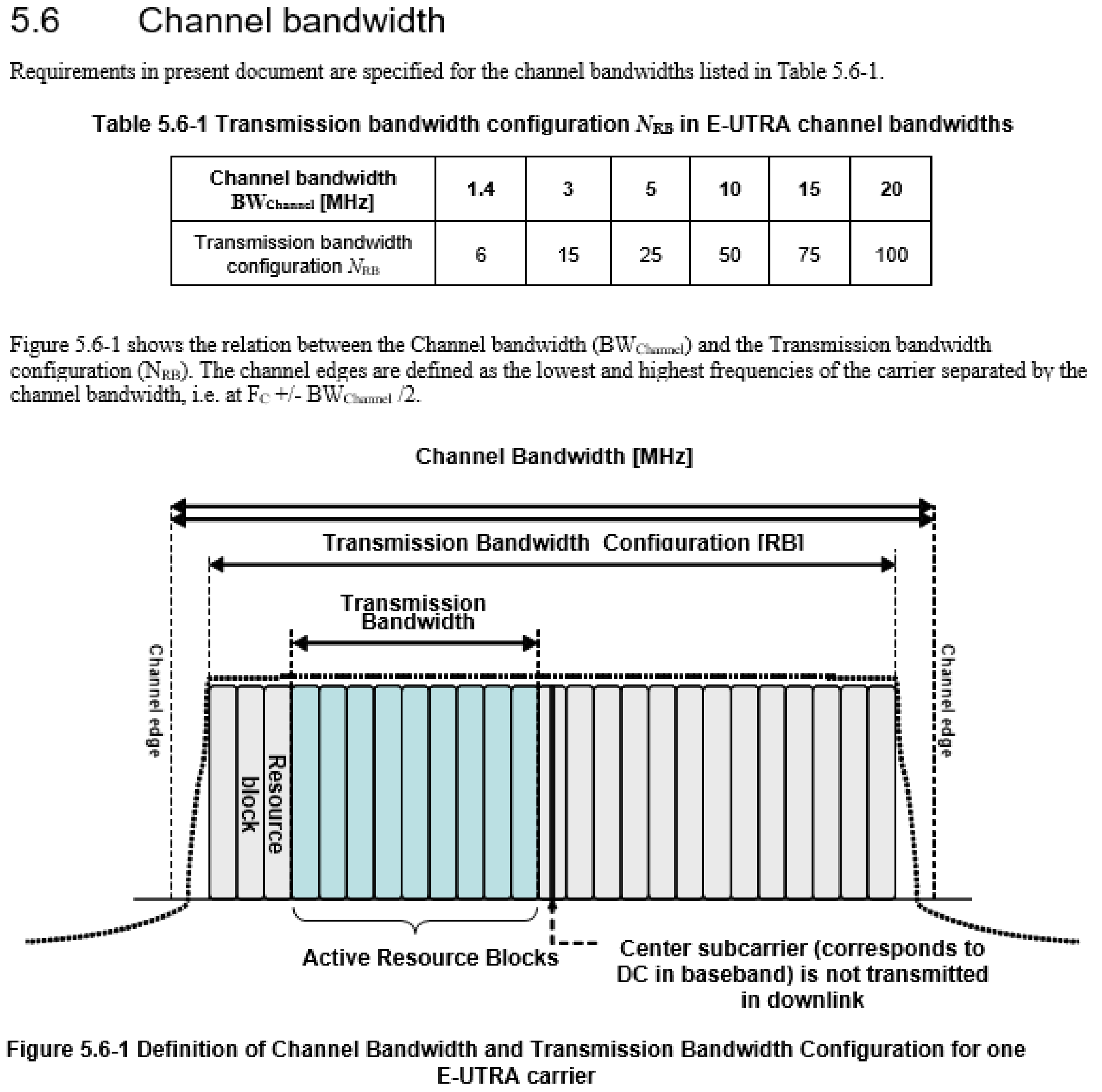
US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	GM's Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

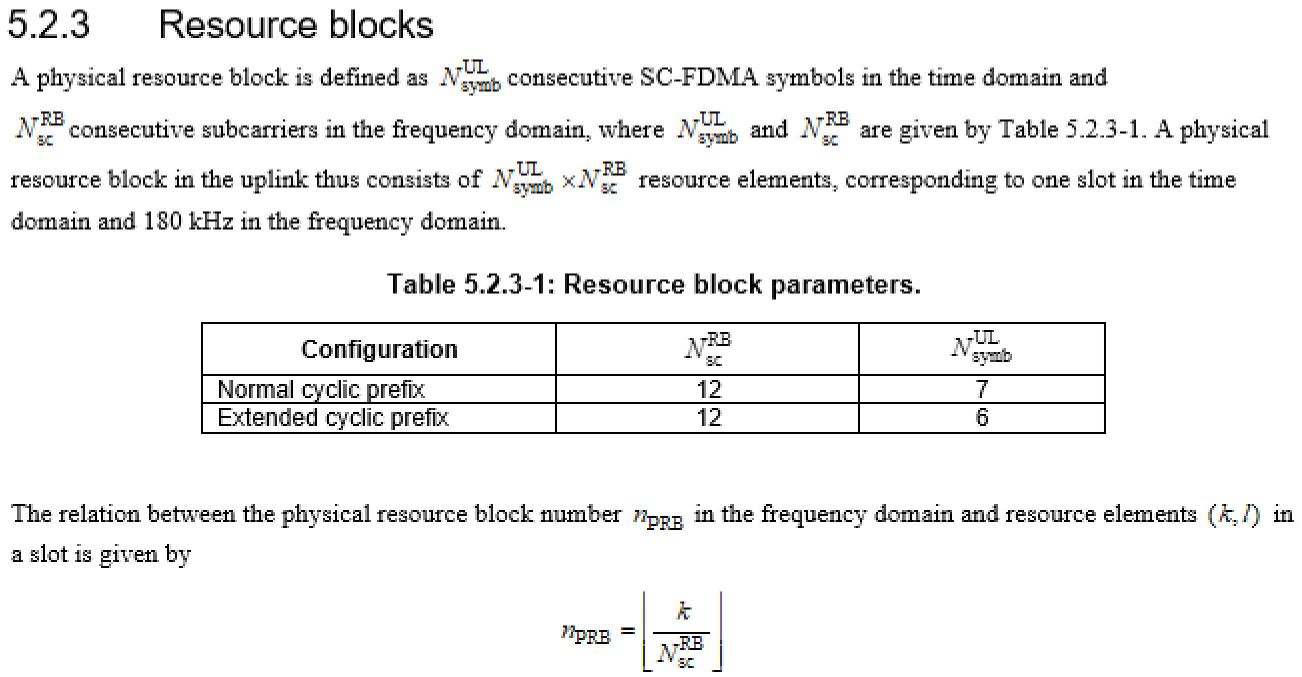
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

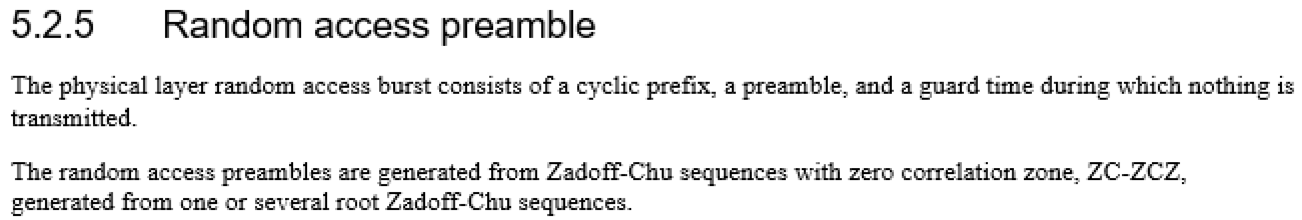
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

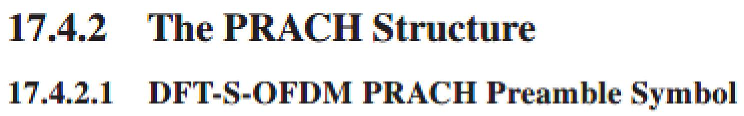


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

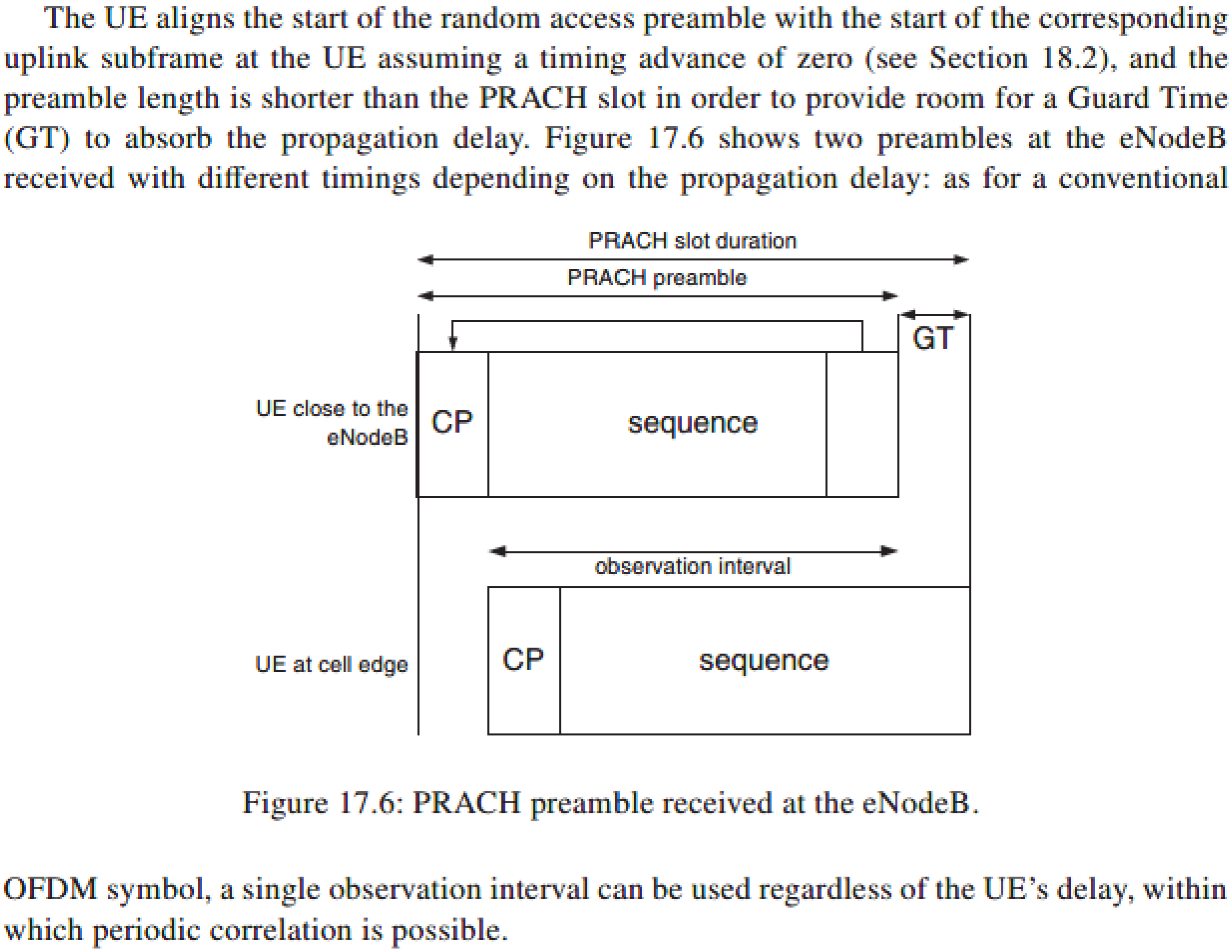
See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.



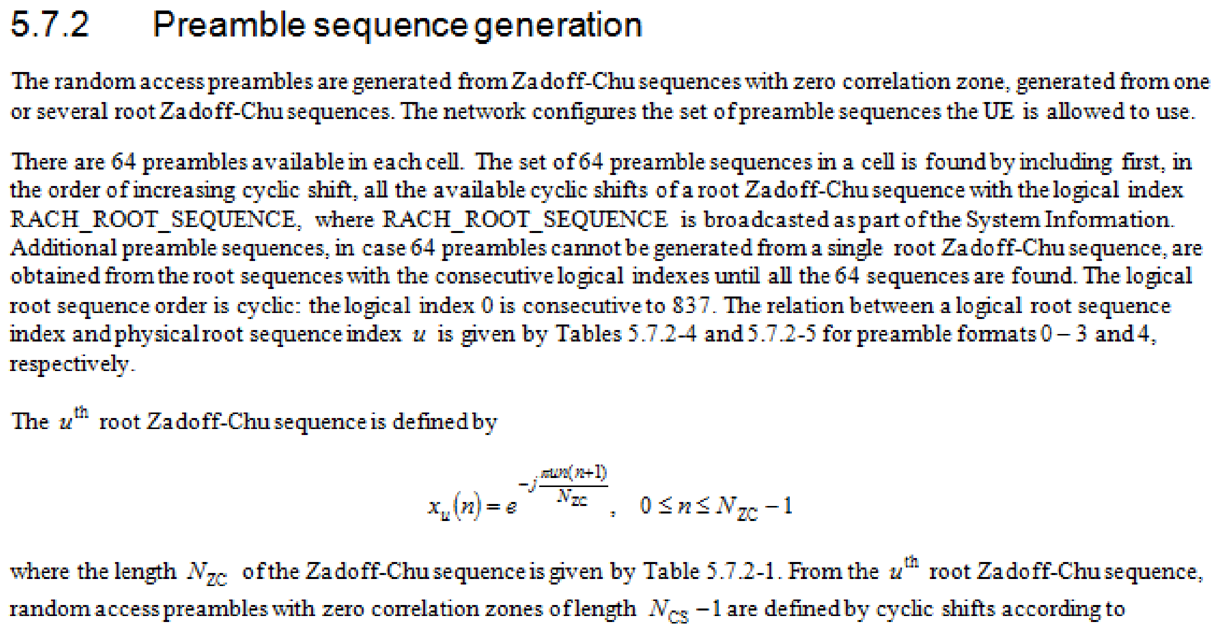
17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

...

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE's delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

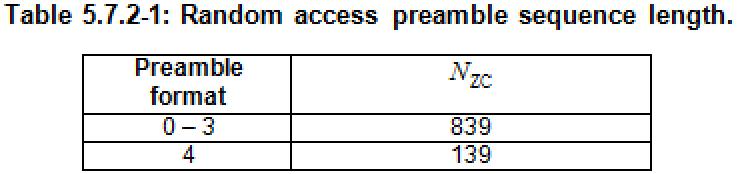
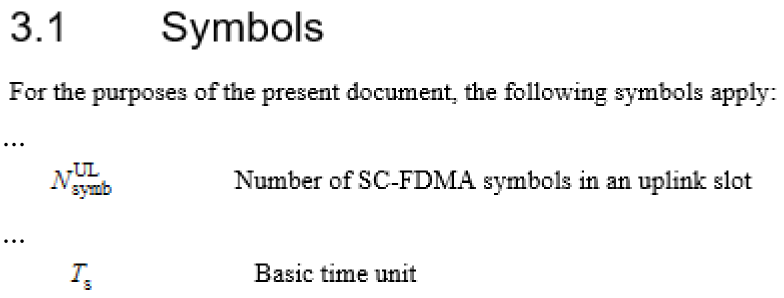
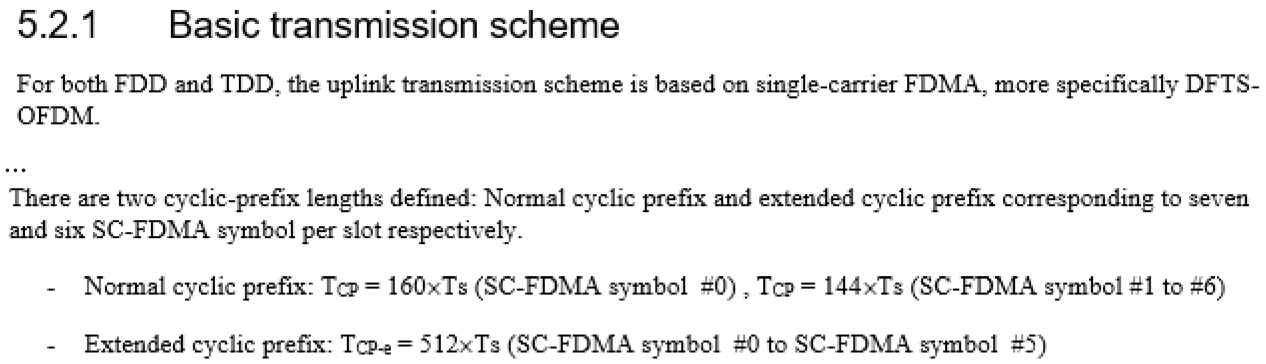


Table 5.7.2-1: Random access preamble sequence length.

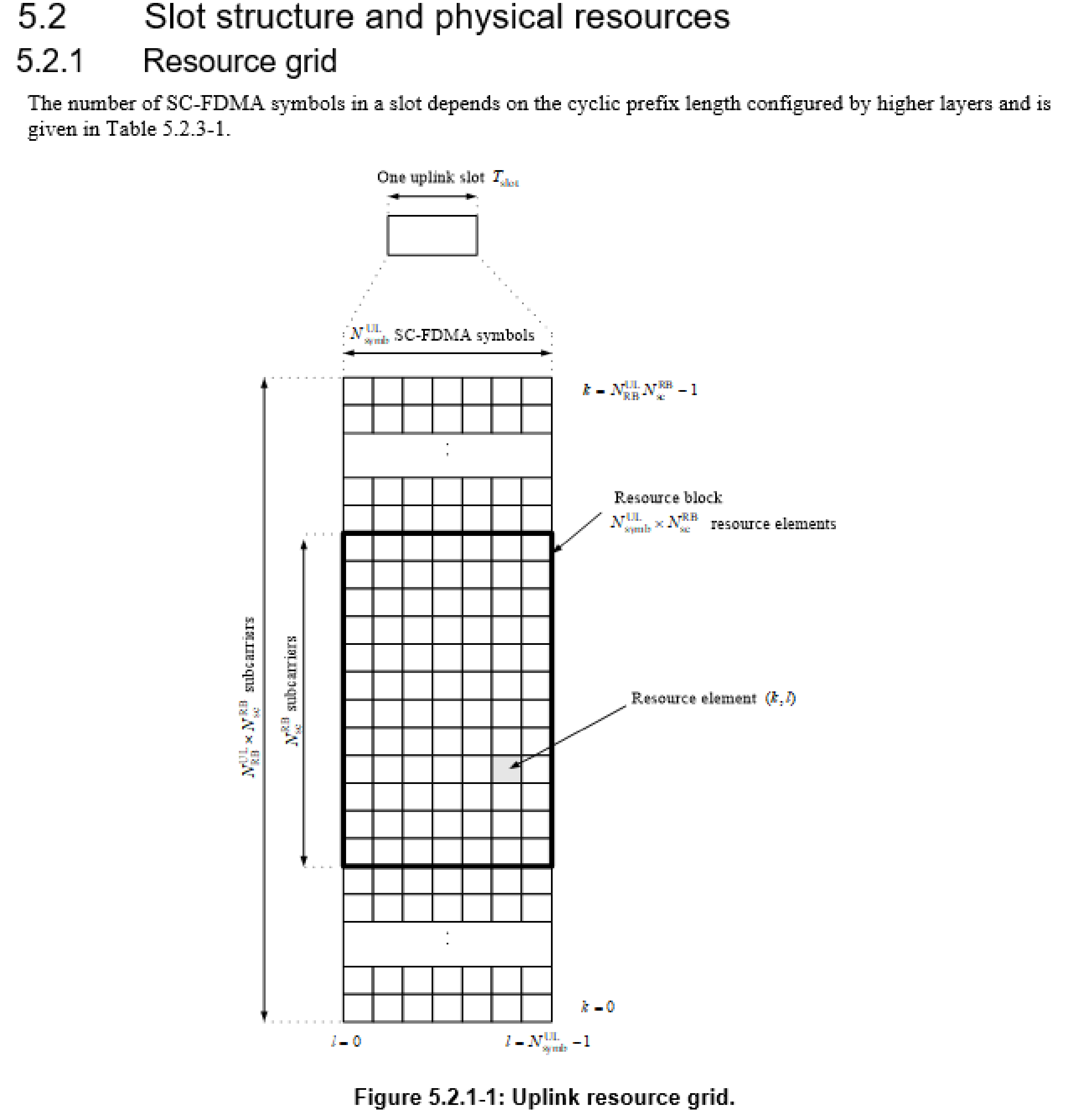
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using GM's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”



5.2 Slot structure and physical resources

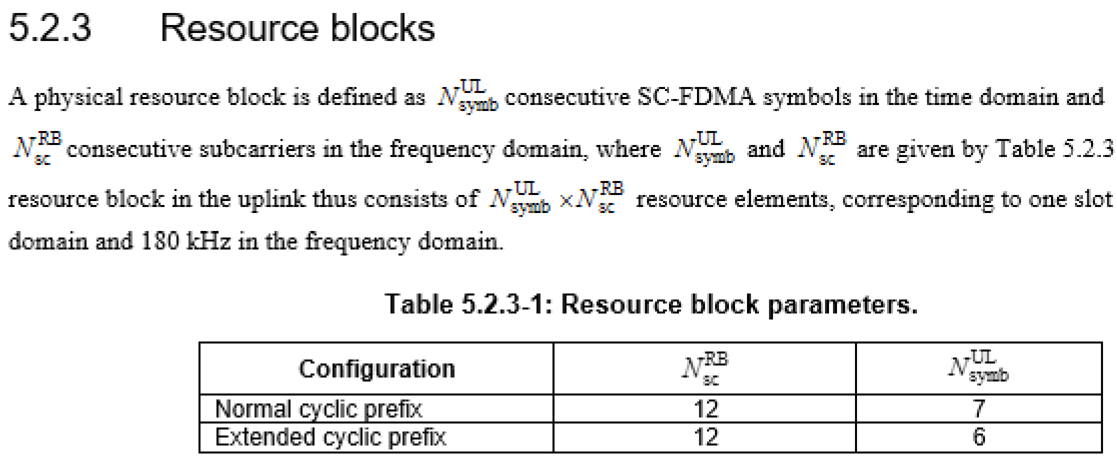
5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

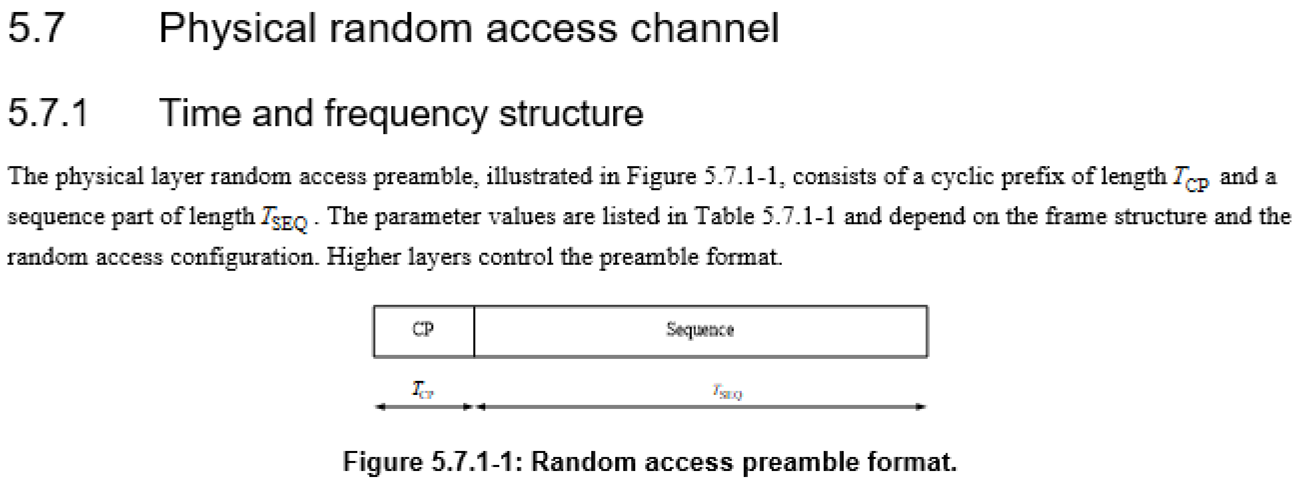
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

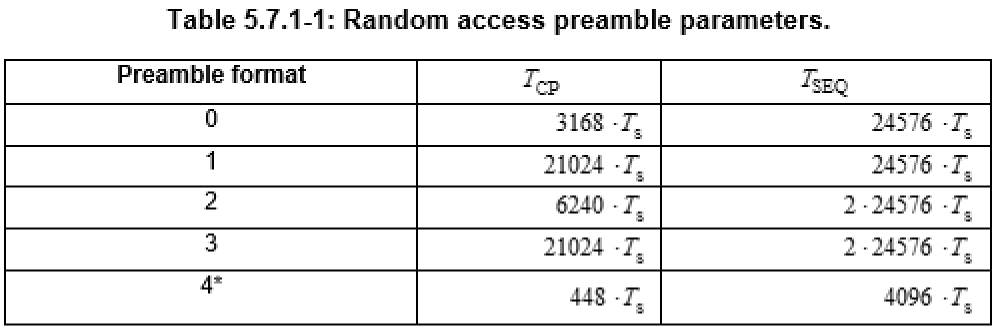
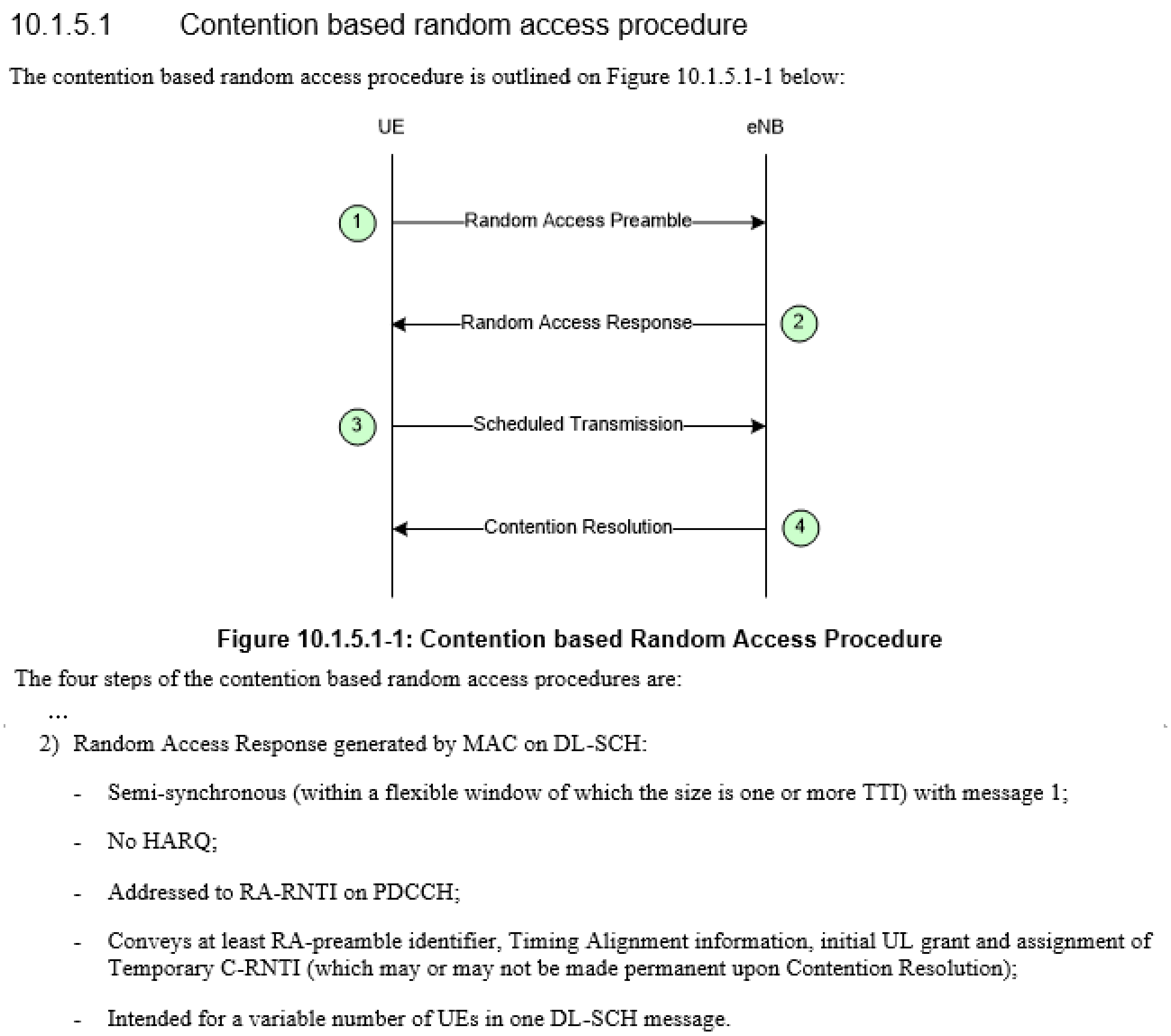


Table 5.7.1-1: Random access preamble parameters.

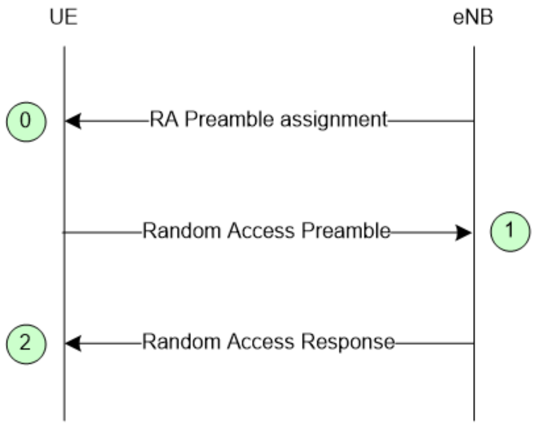
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

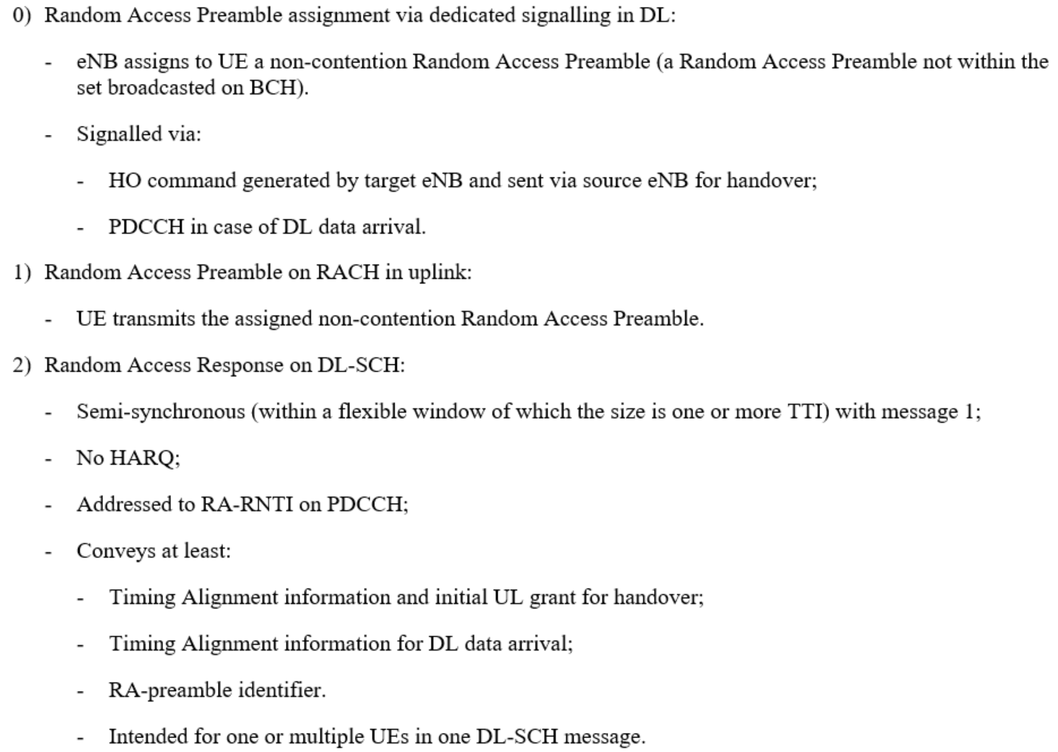
US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

receiving, from the base station, a response message. ;	GM's Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53. 10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

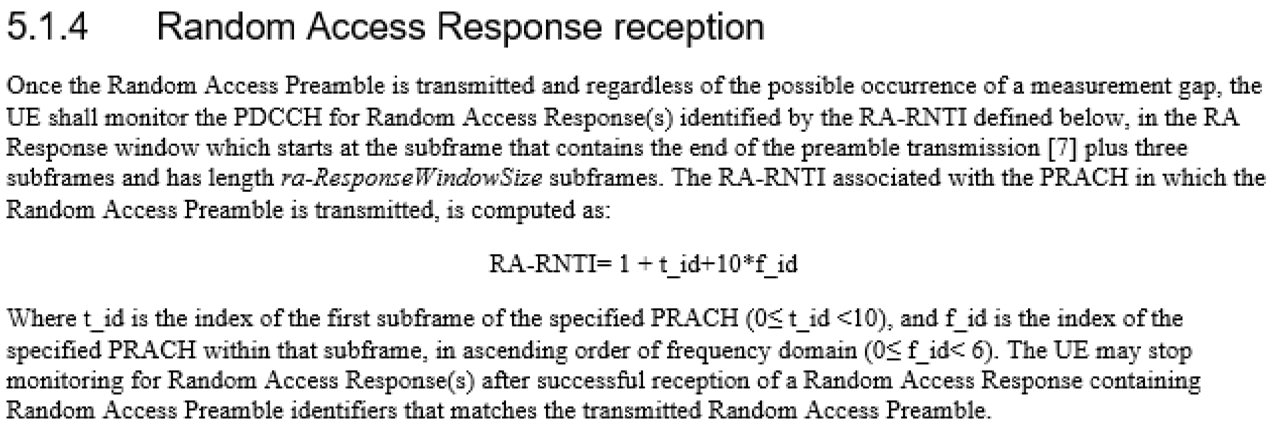


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

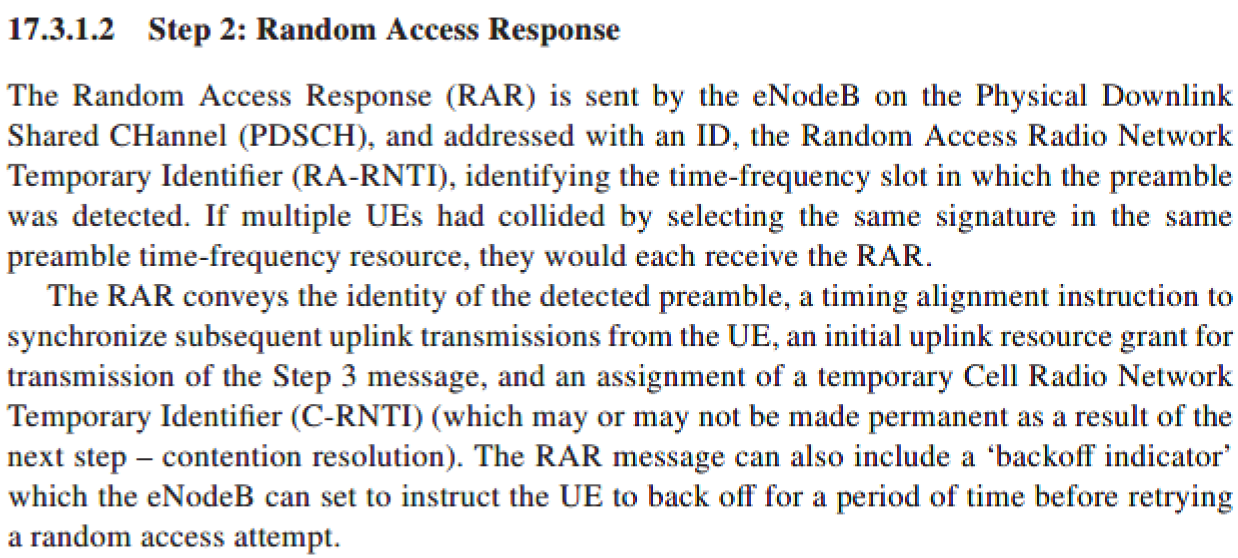
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

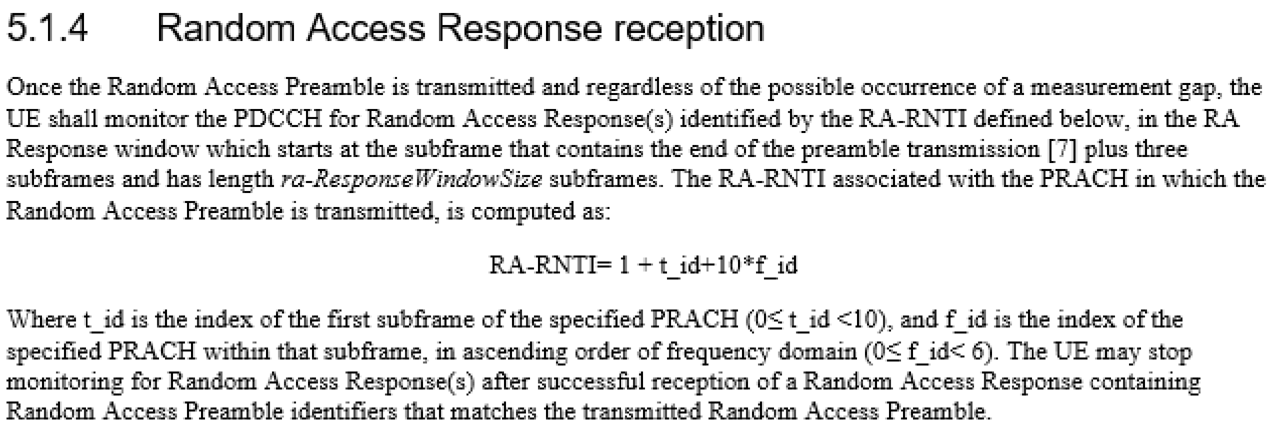
US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

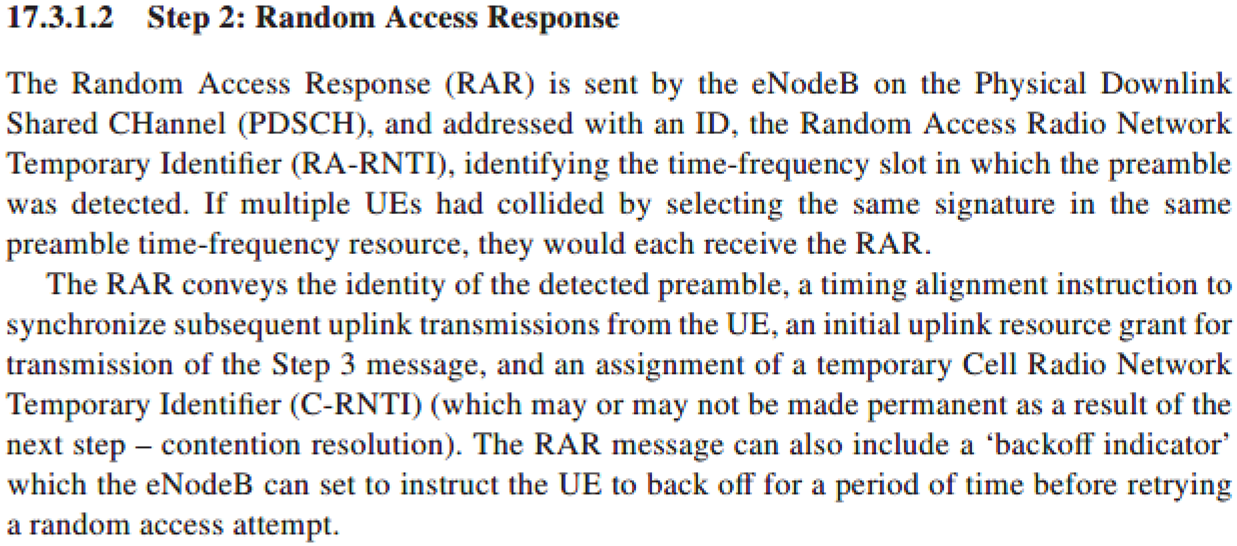
US Patent No. 10,833,908: Claim 12(a)
"The method claim 11, further comprising:"

12. The method claim 11, further comprising:	*See* Claim 11.

US Patent No. 10,833,908: Claim 12(b)
"determining if the response message identifies the sequence associated with the base station in the random access signal; and"

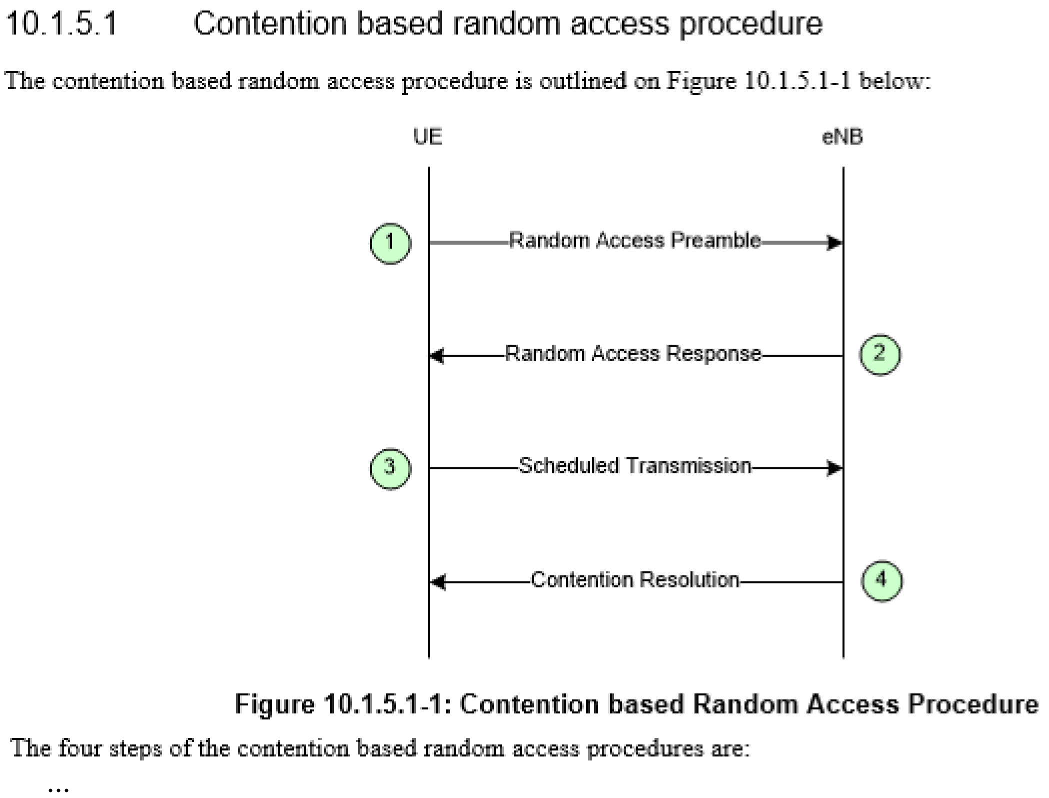
determining if the response message identifies the sequence associated with the base station in the random access signal; and	GM's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(b)
"determining if the response message identifies the sequence associated with the base station in the random access signal; and"

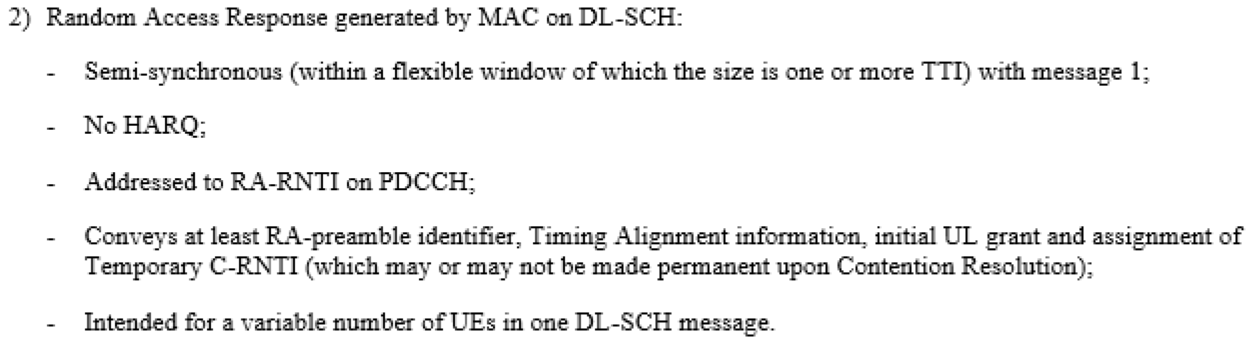
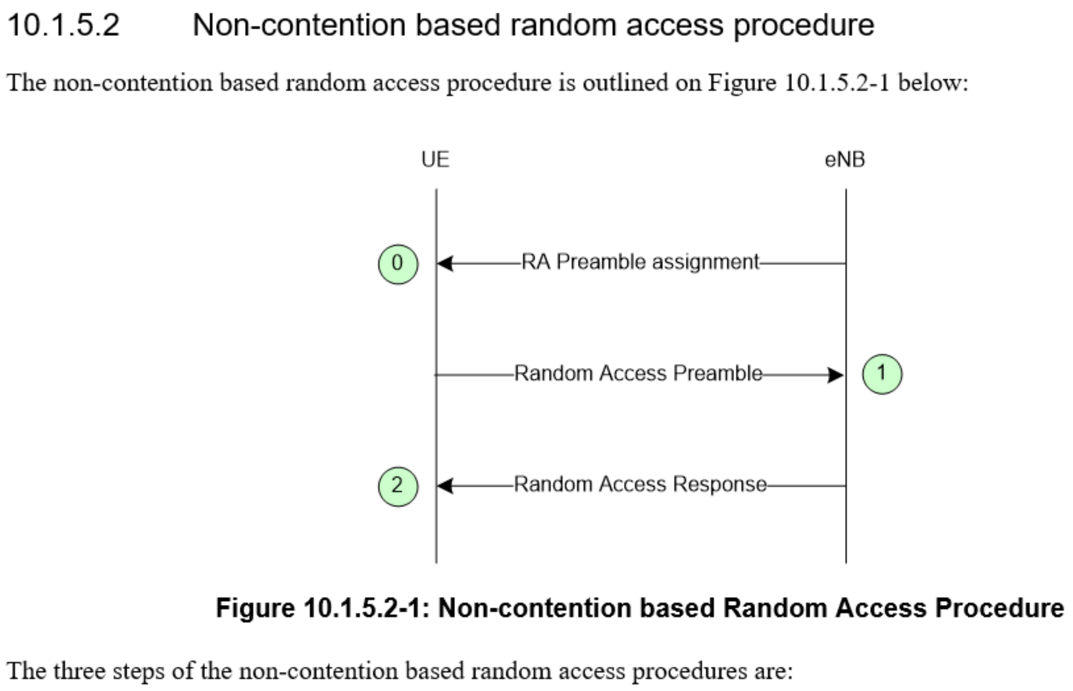
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 12(c)

“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

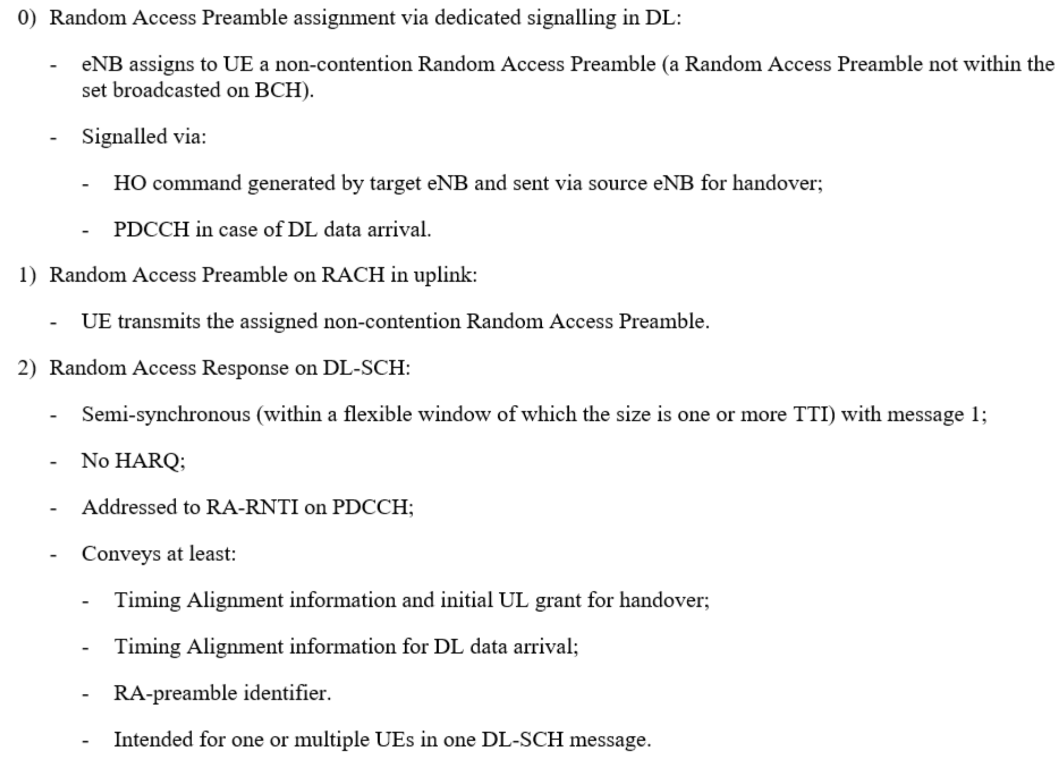
on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, GM’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 12(c)

“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

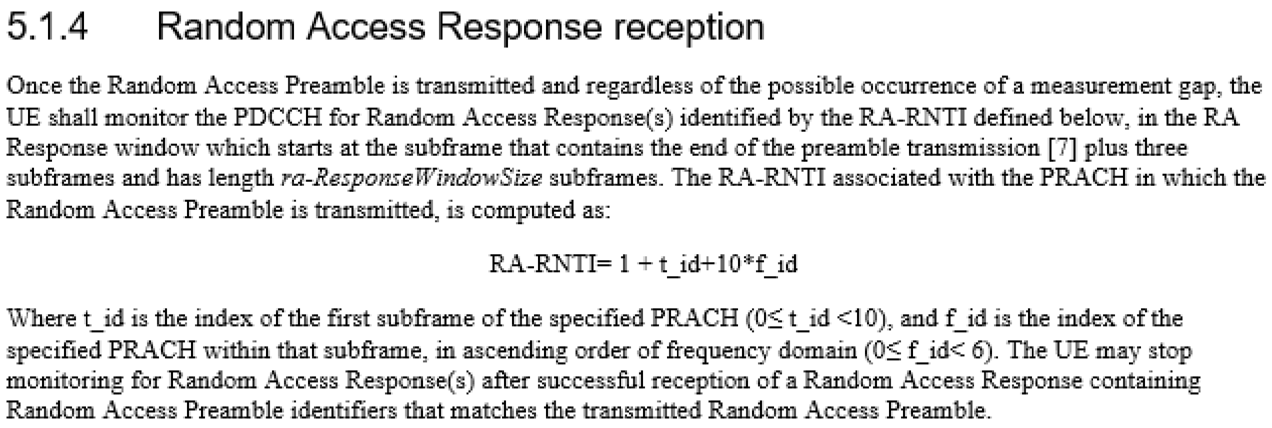
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

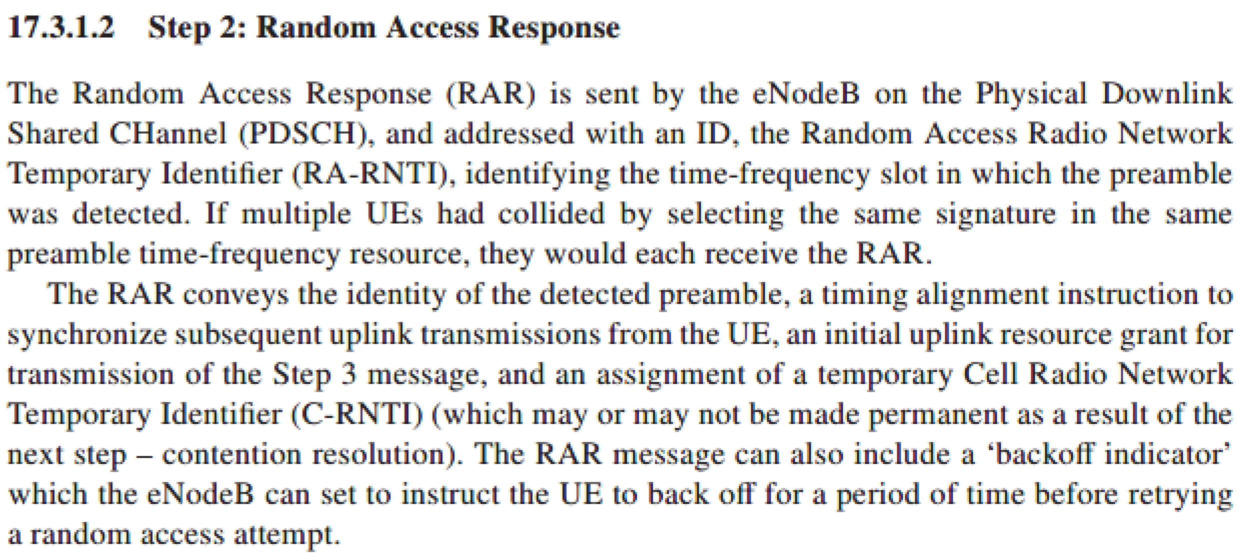
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

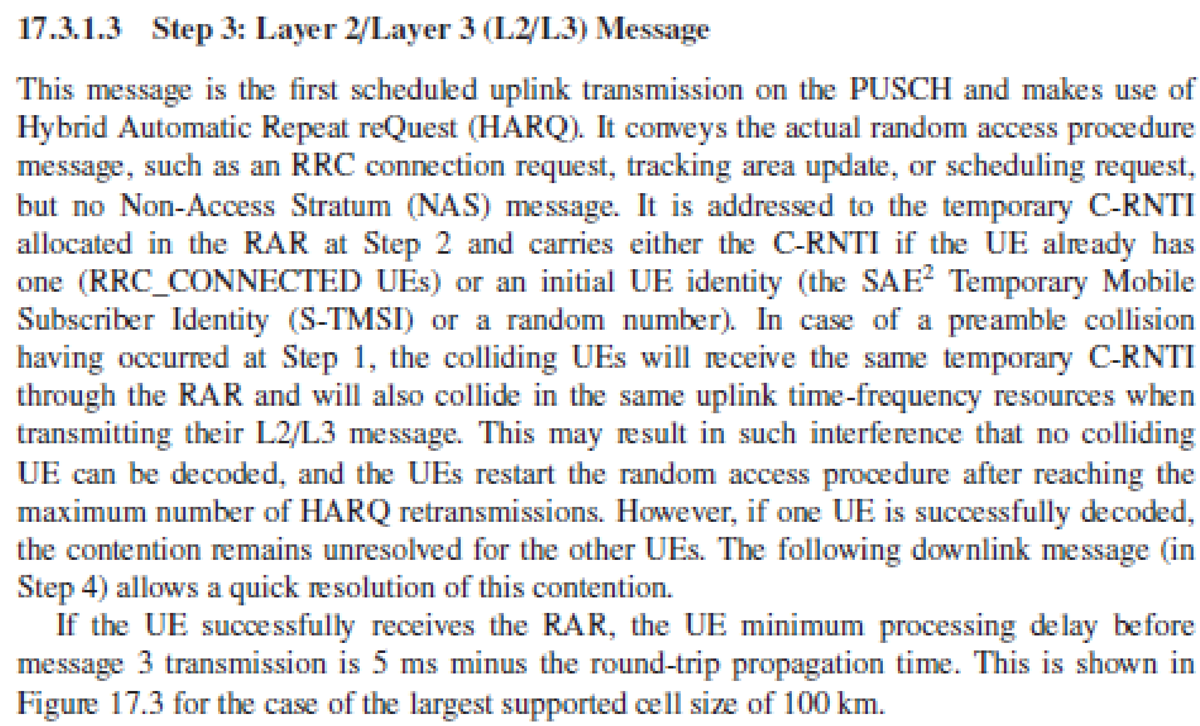
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

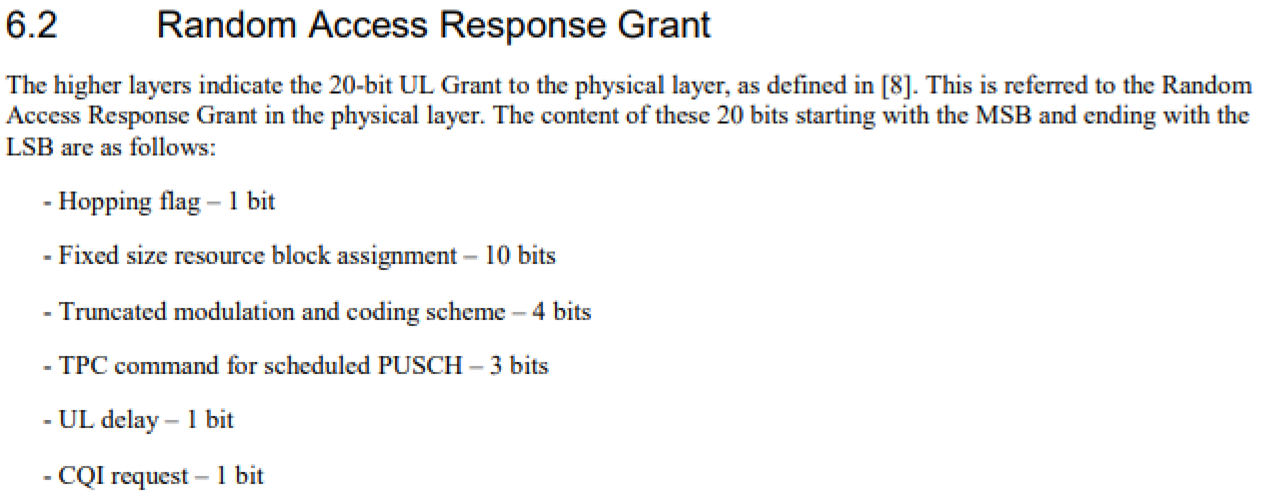
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

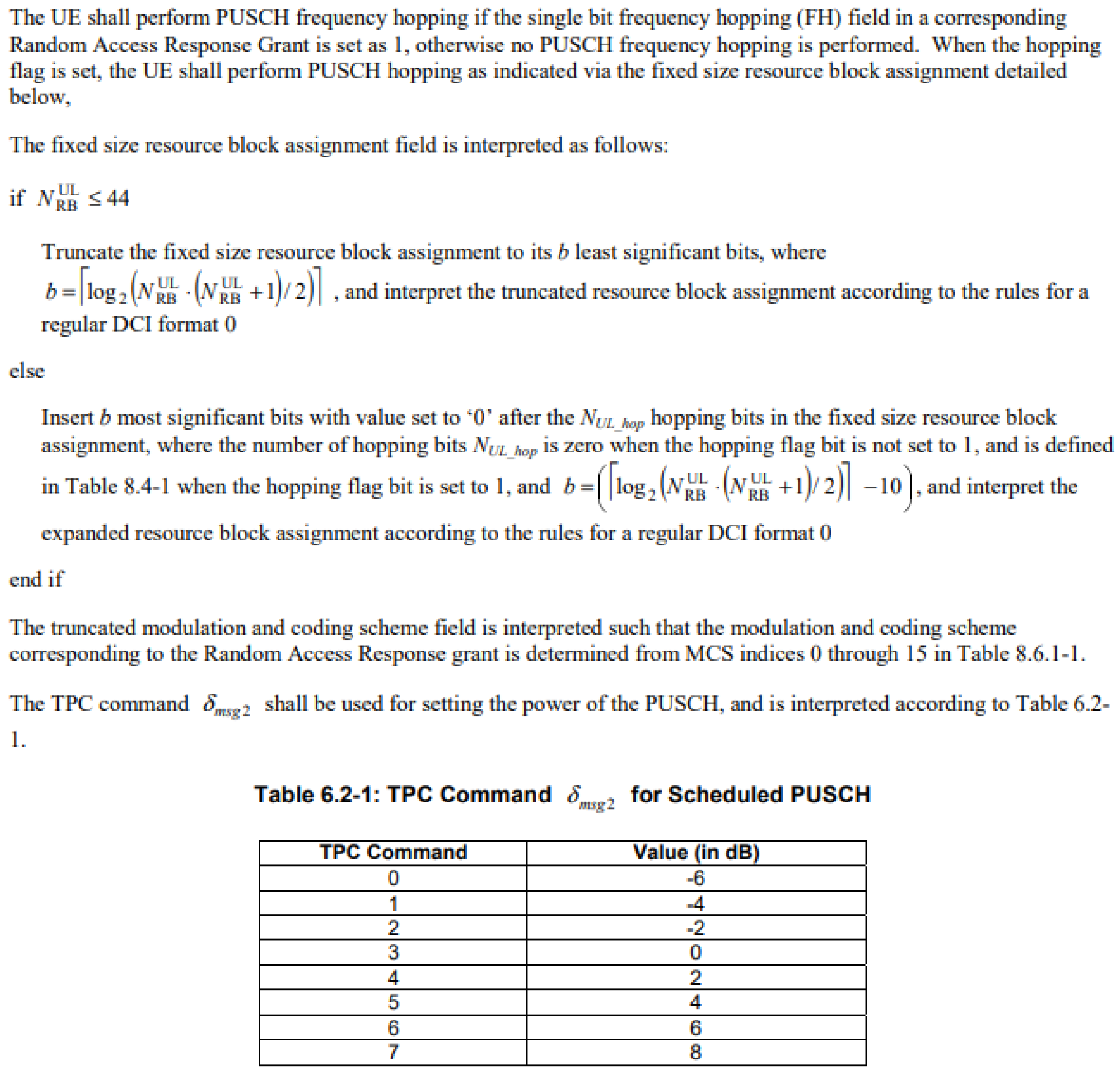
	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 13(a)
"The method of claim 12, wherein the response message includes power adjustment information and"

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by GM's Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)

"The method of claim 12, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

```
if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$
    Truncate the fixed size resource block assignment to its $b$ least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0
else
    Insert $b$ most significant bits with value set to '0' after the $N_{UL\_hop}$ hopping bits in the fixed size resource block assignment, where the number of hopping bits $N_{UL\_hop}$ is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0
end if
```

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

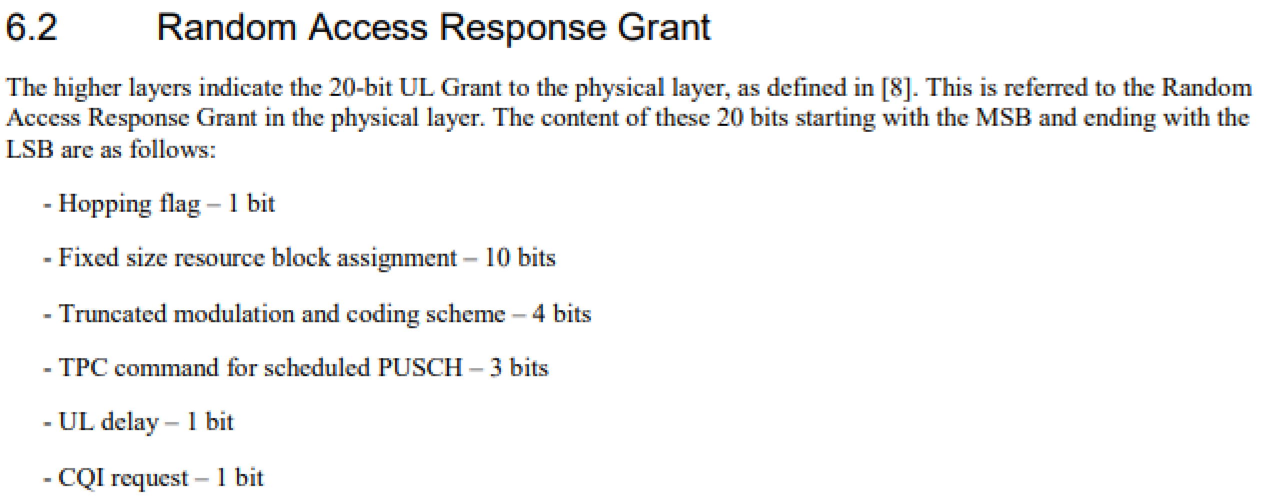
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

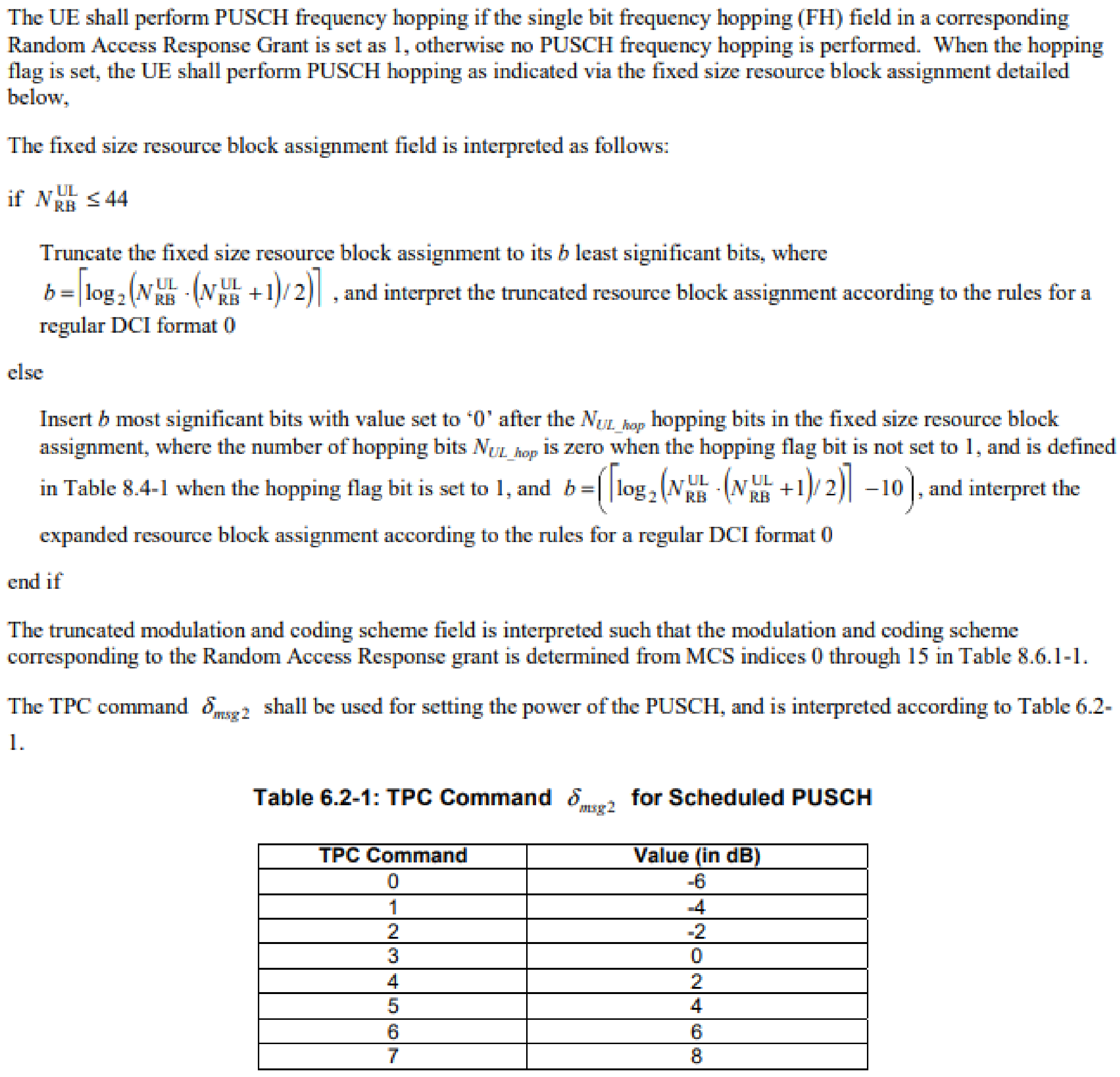
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the second uplink signal is transmitted according to the power adjustment information.	GM's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

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3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

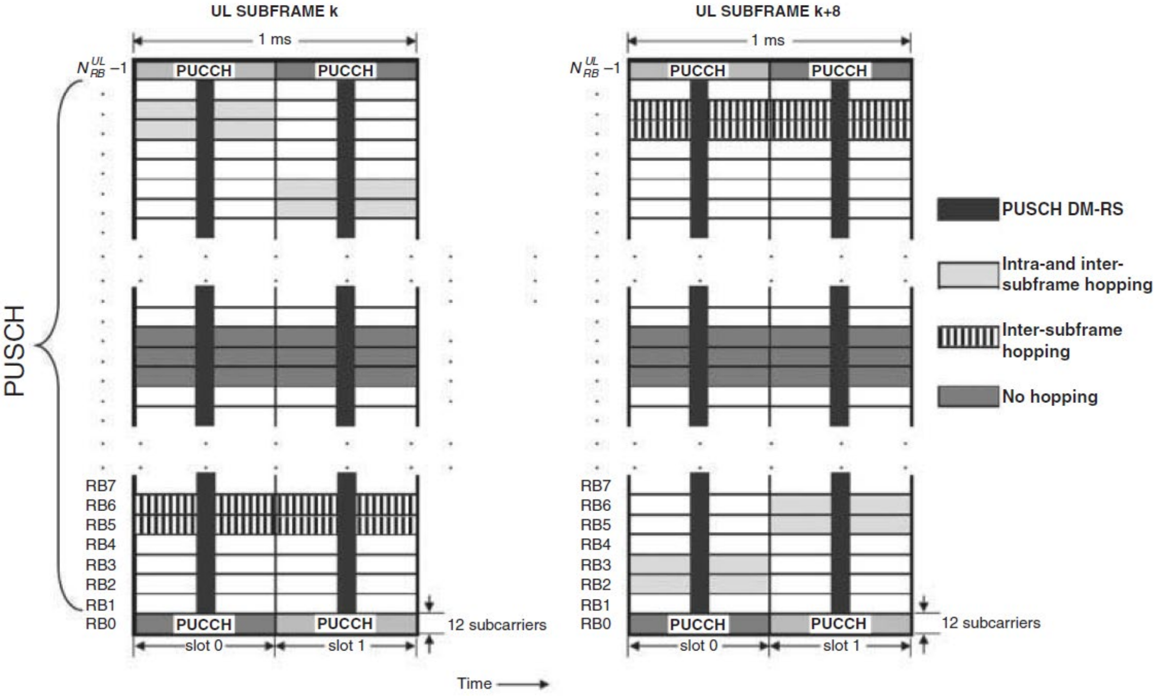
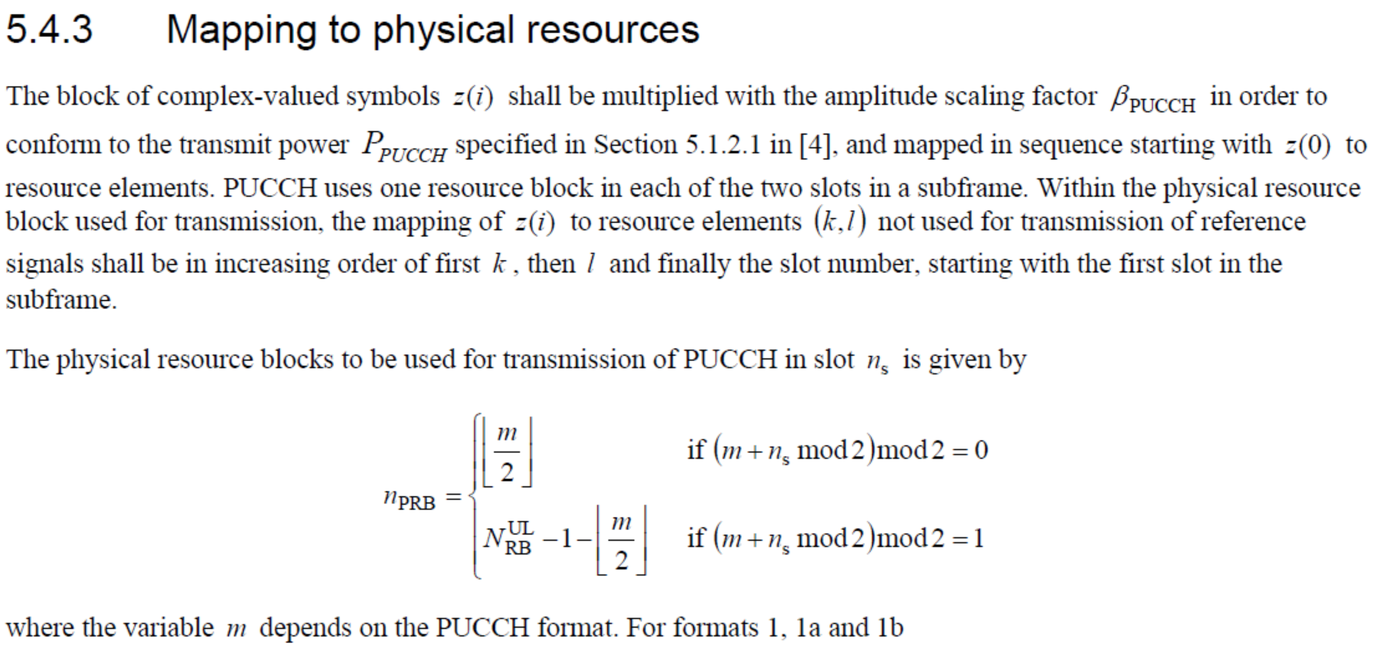
<table>
<tr><td>14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.</td><td>The portion of the frequency band used for transmission of the random access signal by GM's Accused Instrumentalities does not include control channels. *E.g.,*
See Claim 11.
The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.


Figure 16.3: Uplink physical data channel processing.
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").</td></tr>
</table>

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

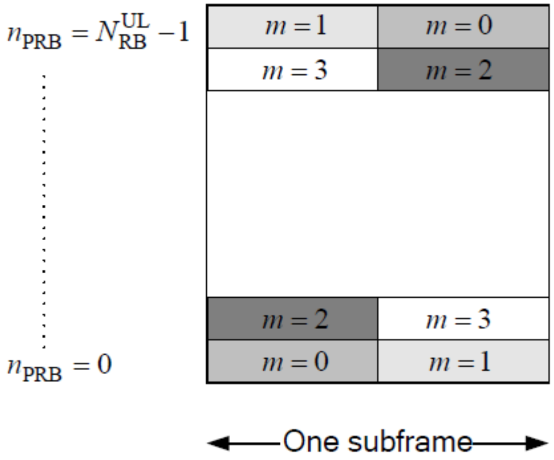


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

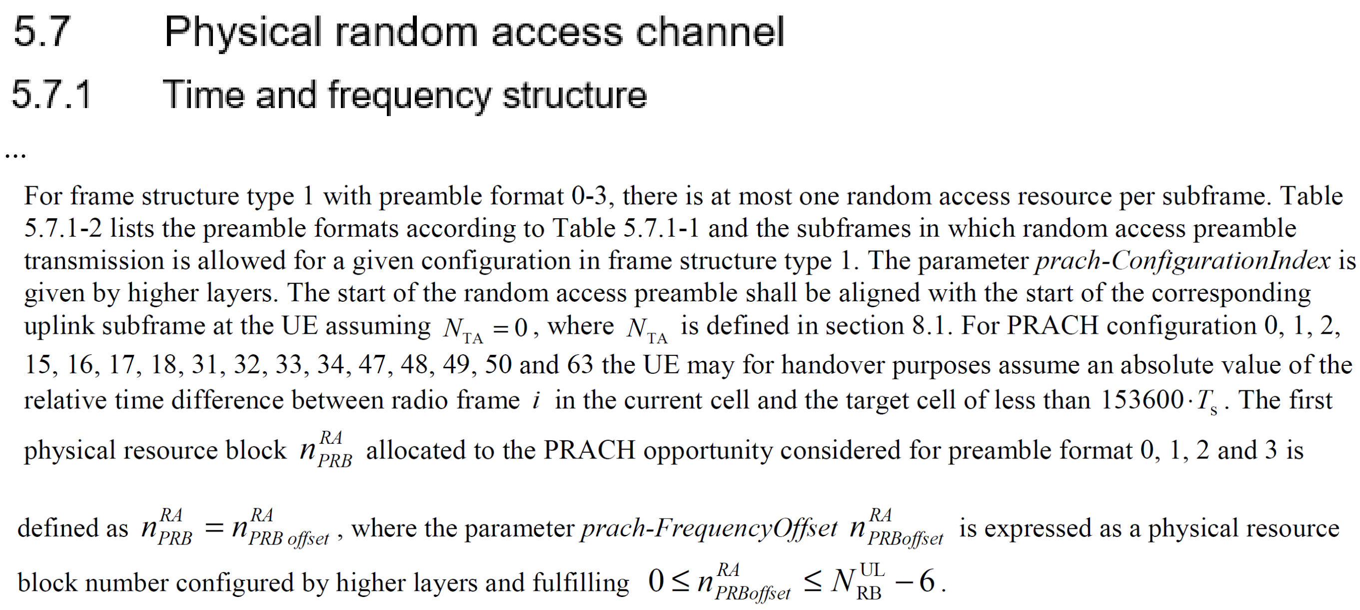
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\mathrm{RA}}_{\mathrm{PRBoffset}}$. For FDD, the parameter directly determines

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

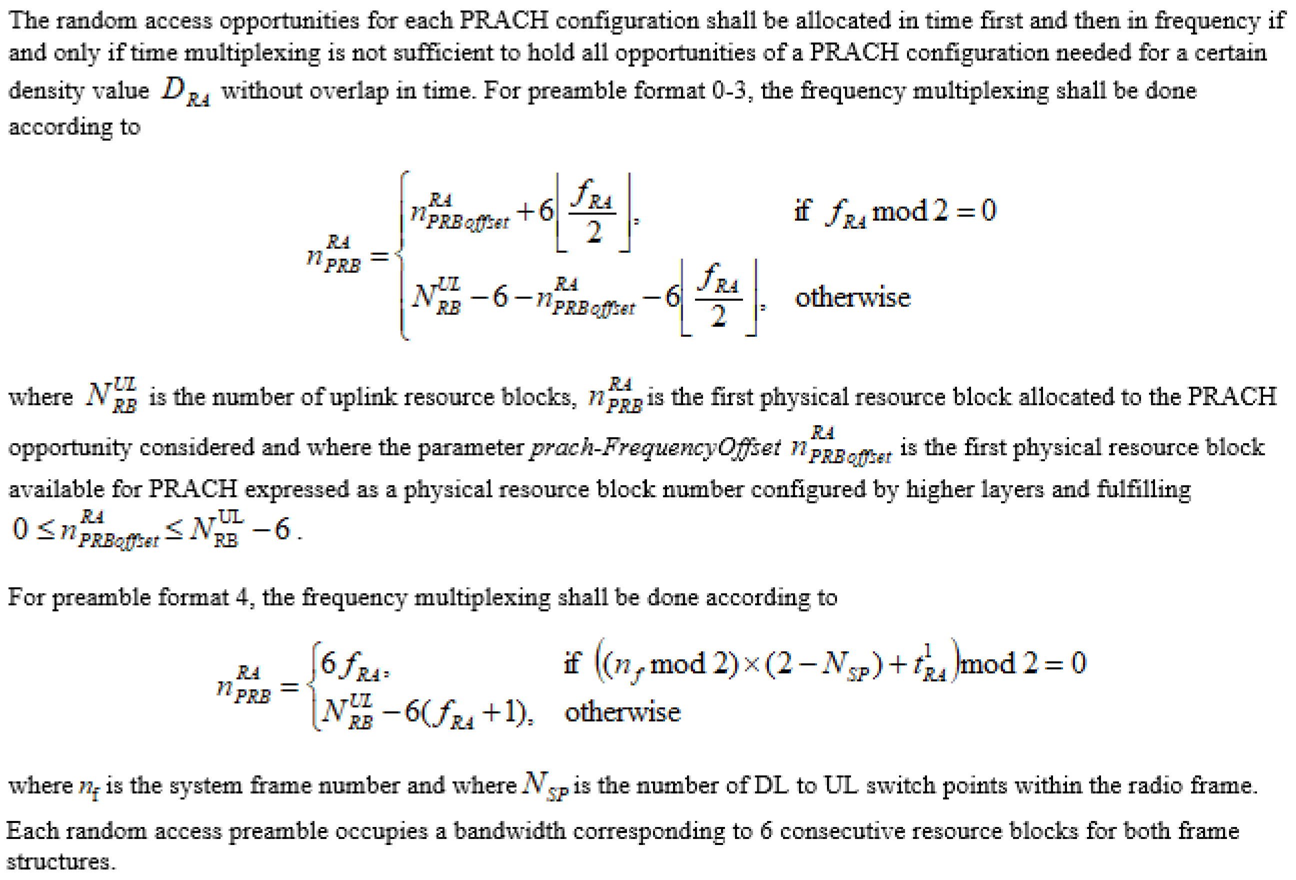
…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\,offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

…

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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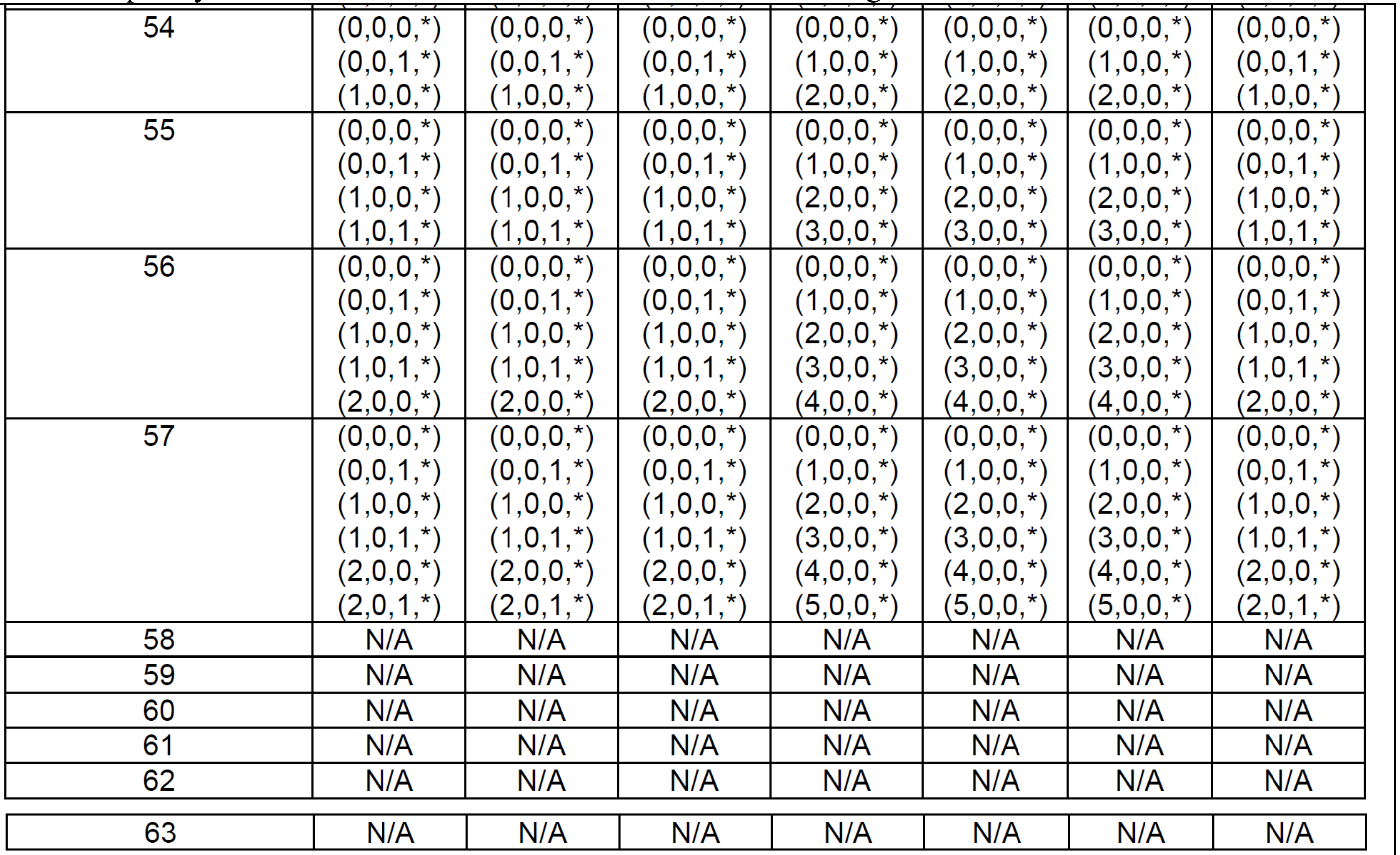
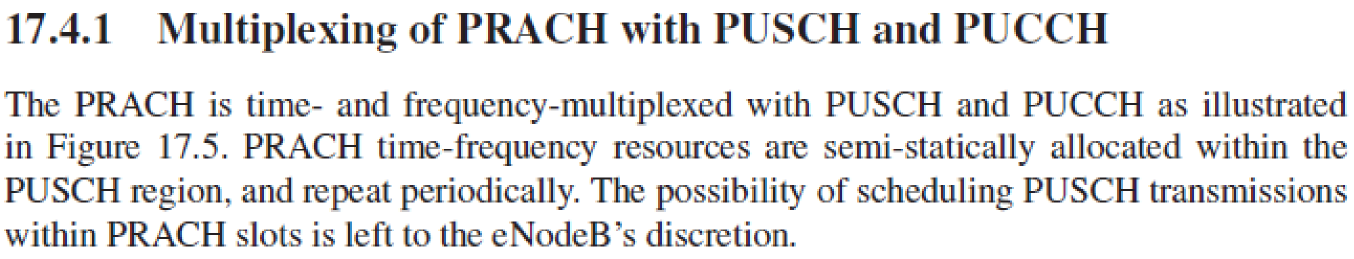
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

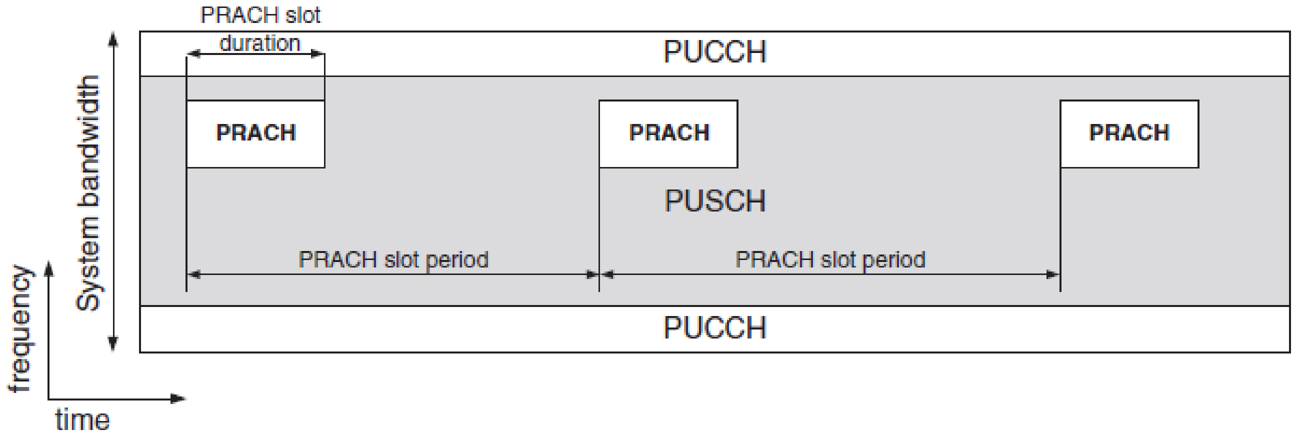
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

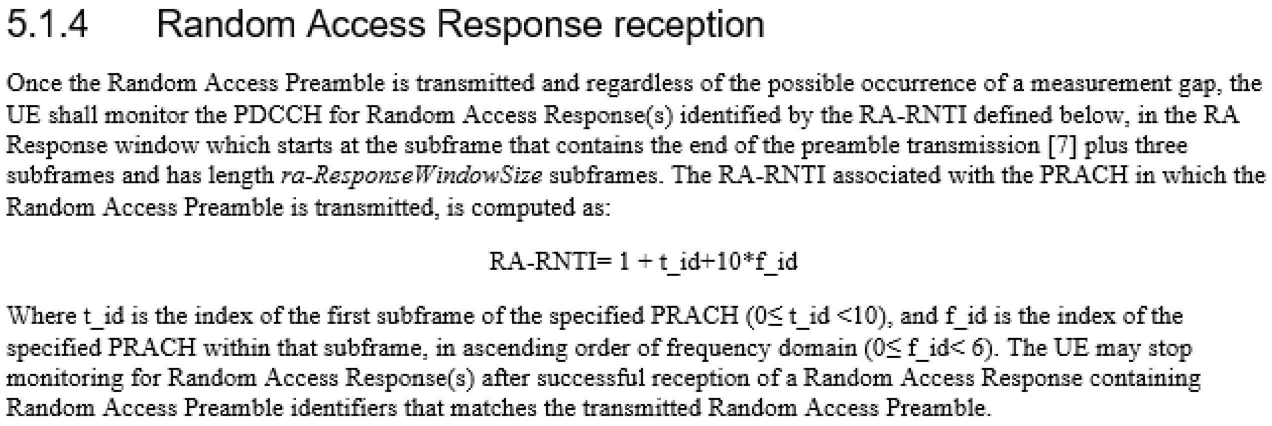
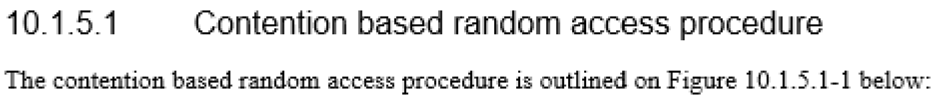
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of GM's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $$\text{RA-RNTI}= 1 + \text{t\_id}+10*\text{f\_id}$$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le \text{t\_id} < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le \text{f\_id} < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15
"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

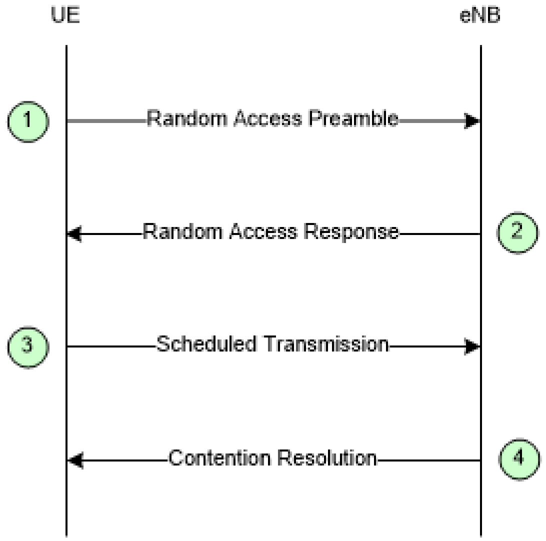
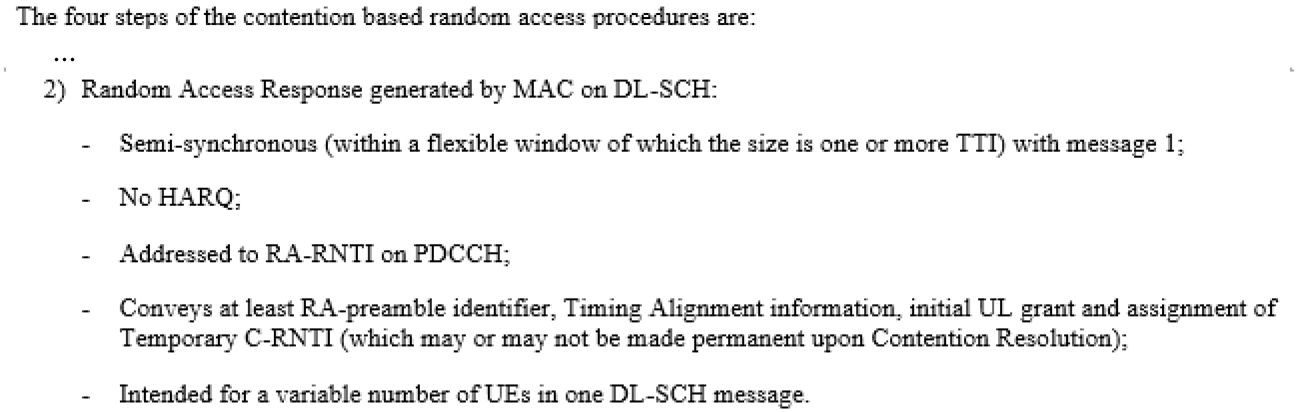


Figure 10.1.5.1-1: Contention based Random Access Procedure


The four steps of the contention based random access procedures are:

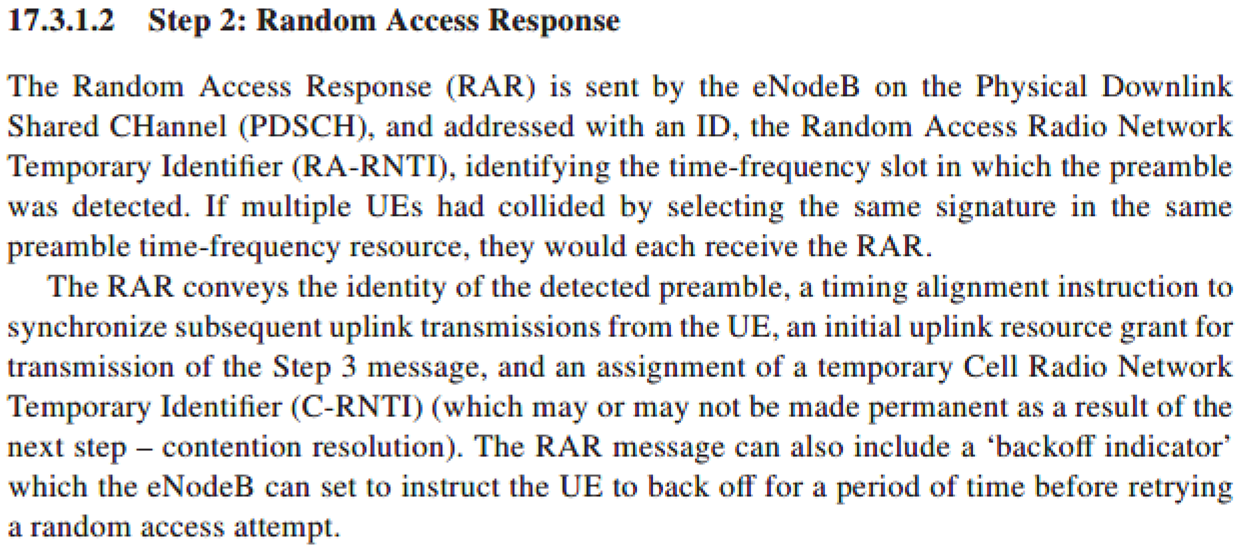
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15
“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

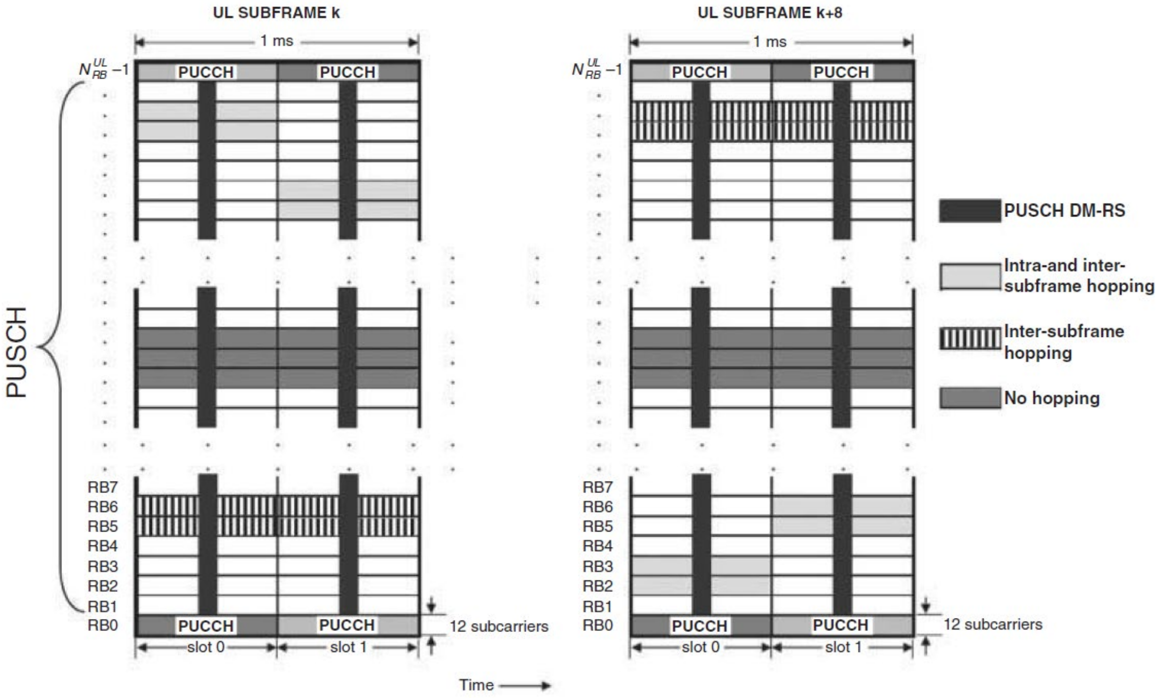
US Patent No. 10,833,908: Claim 16

"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with GM's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

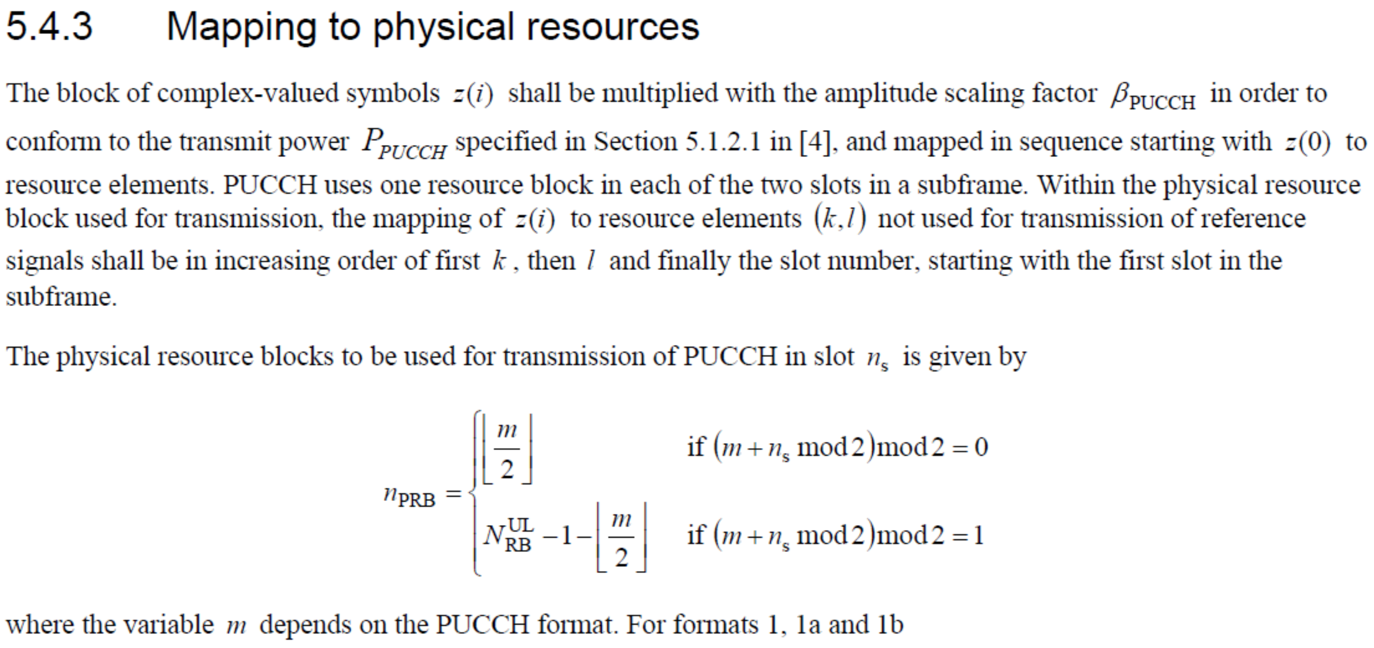
US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with GM's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

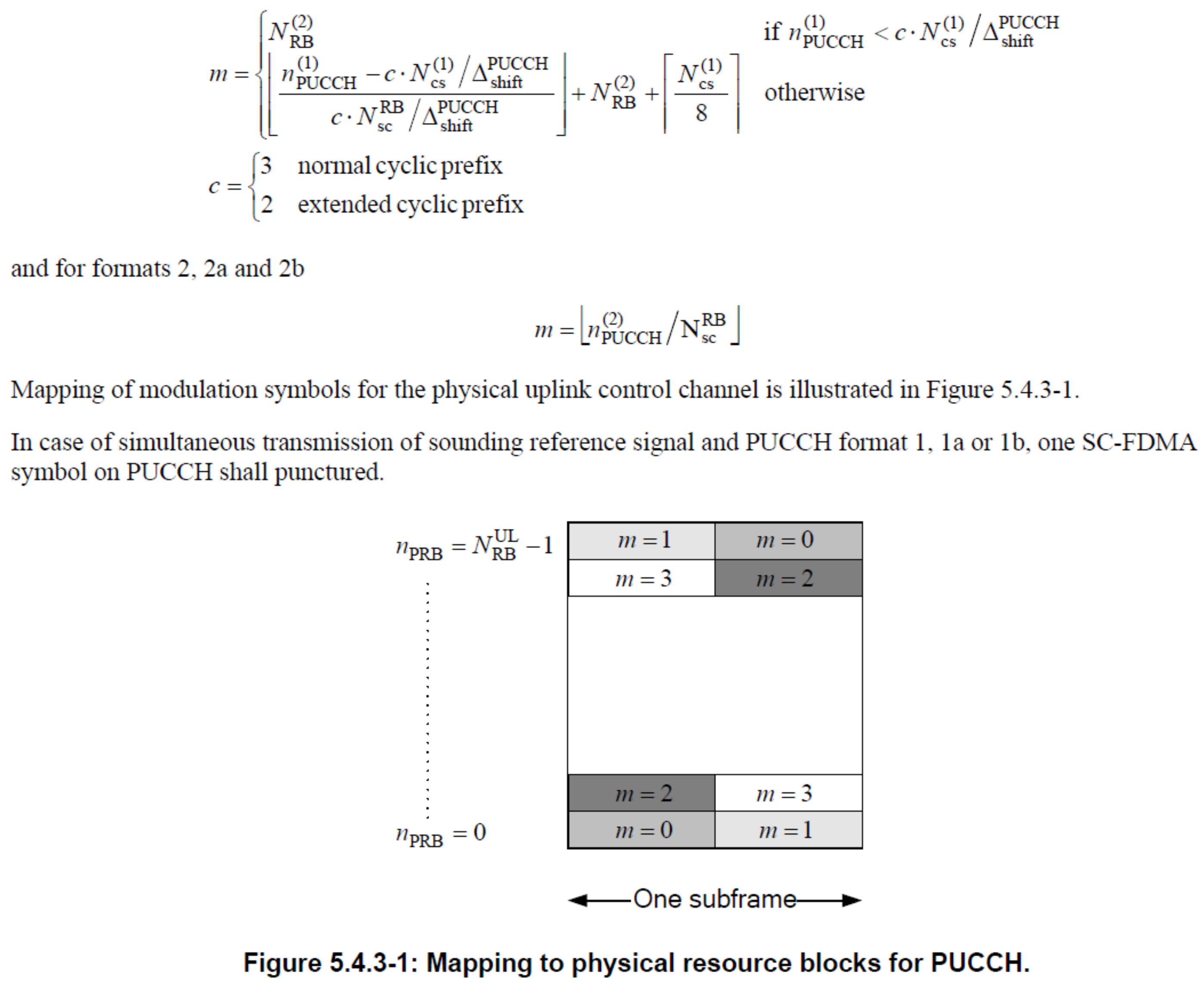
US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  **5.4.3 Mapping to physical resources** The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

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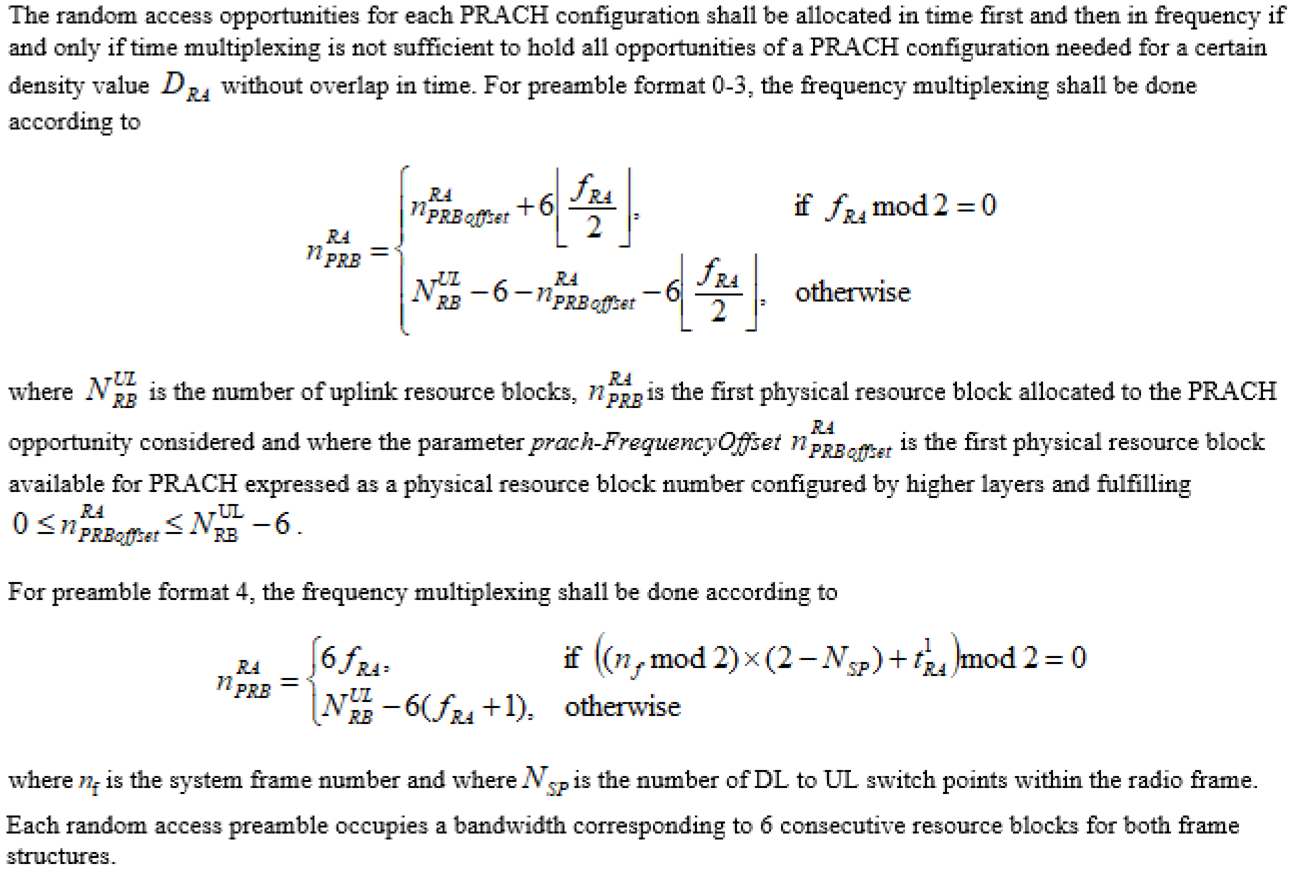
For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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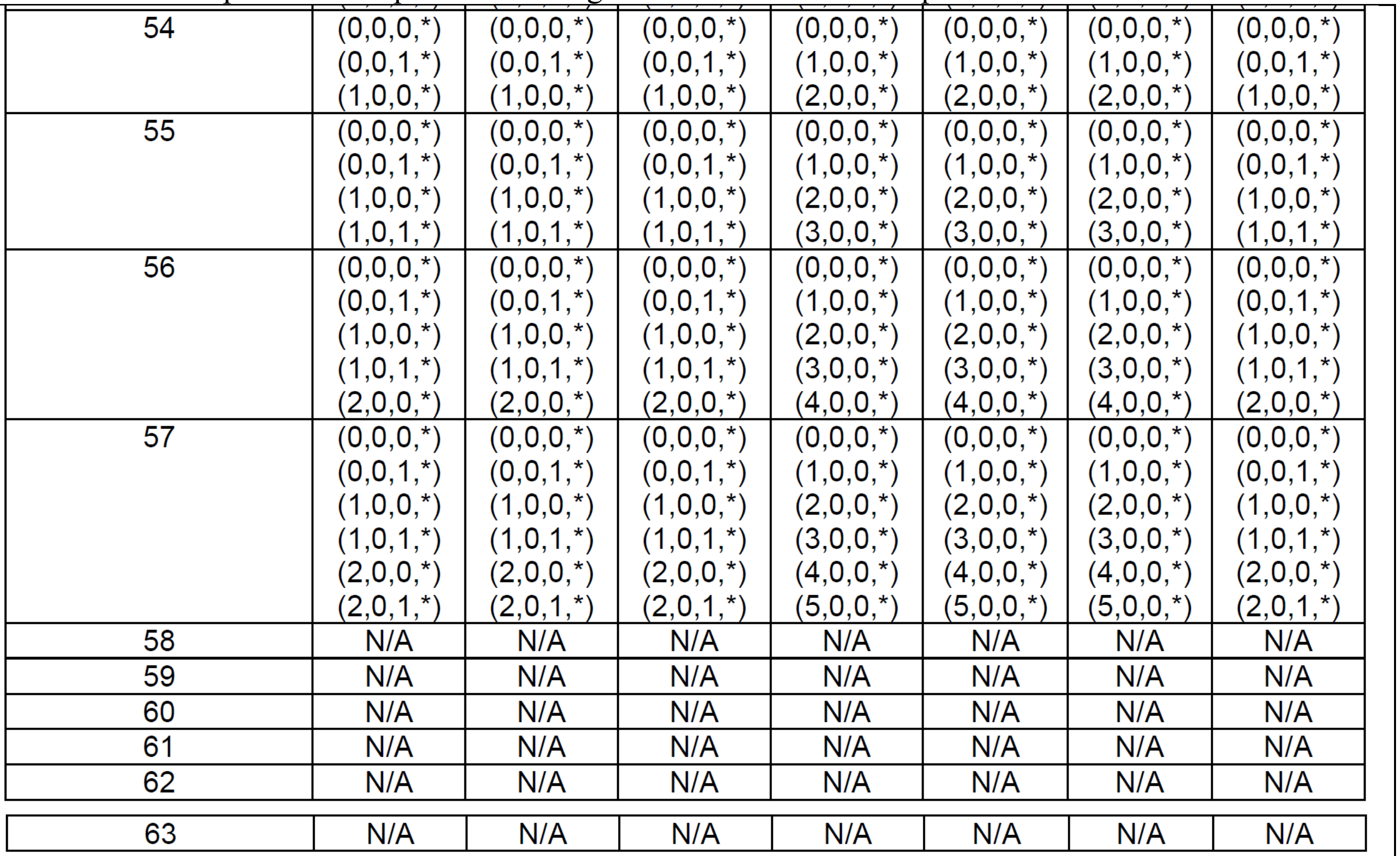
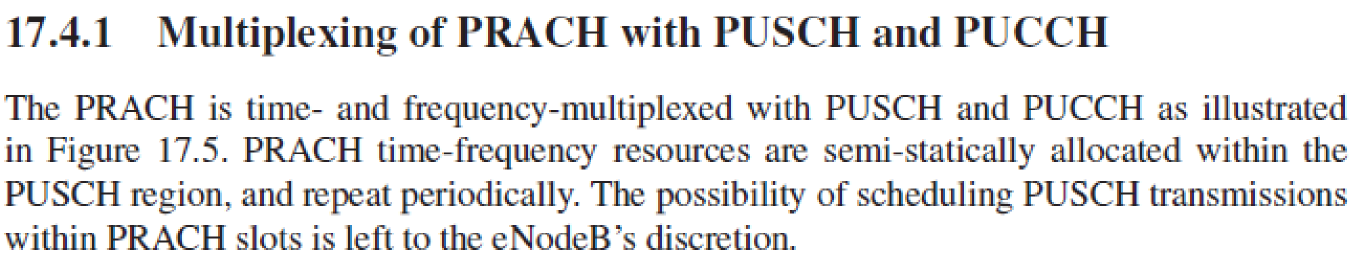
US Patent No. 10,833,908: Claim 17
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

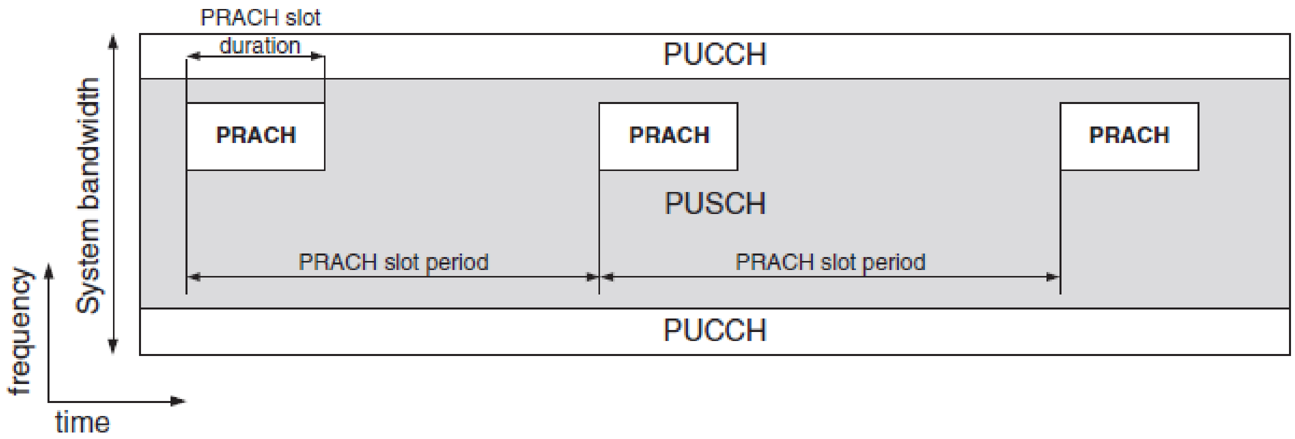
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



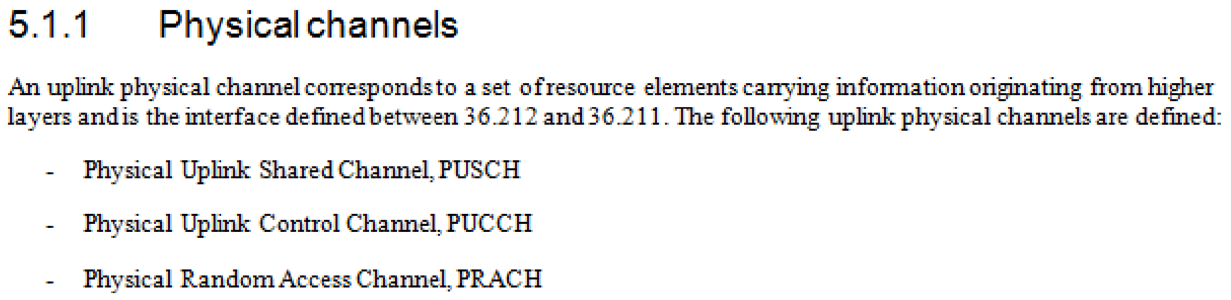
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

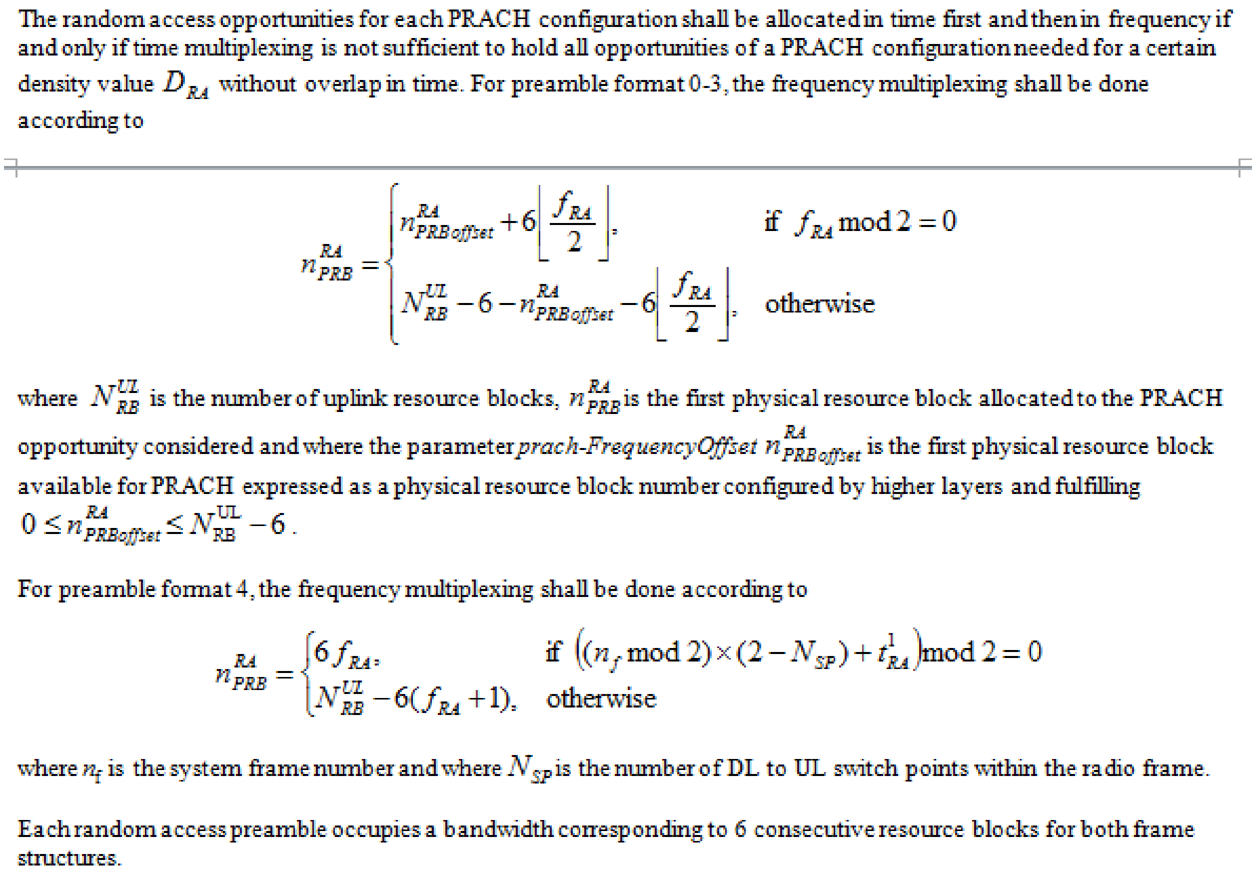
US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with GM's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

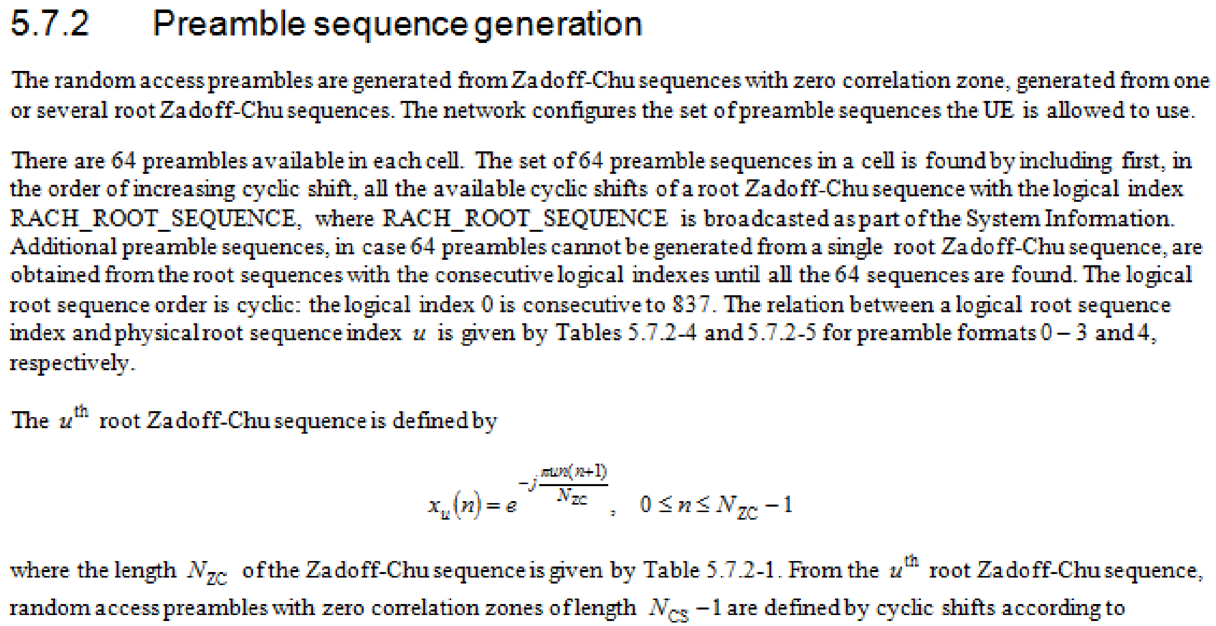
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

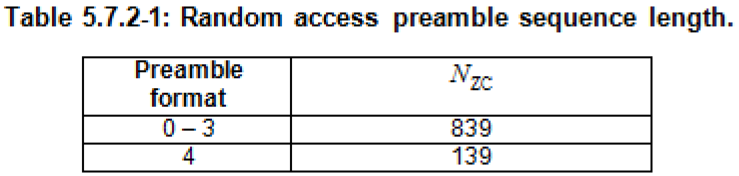
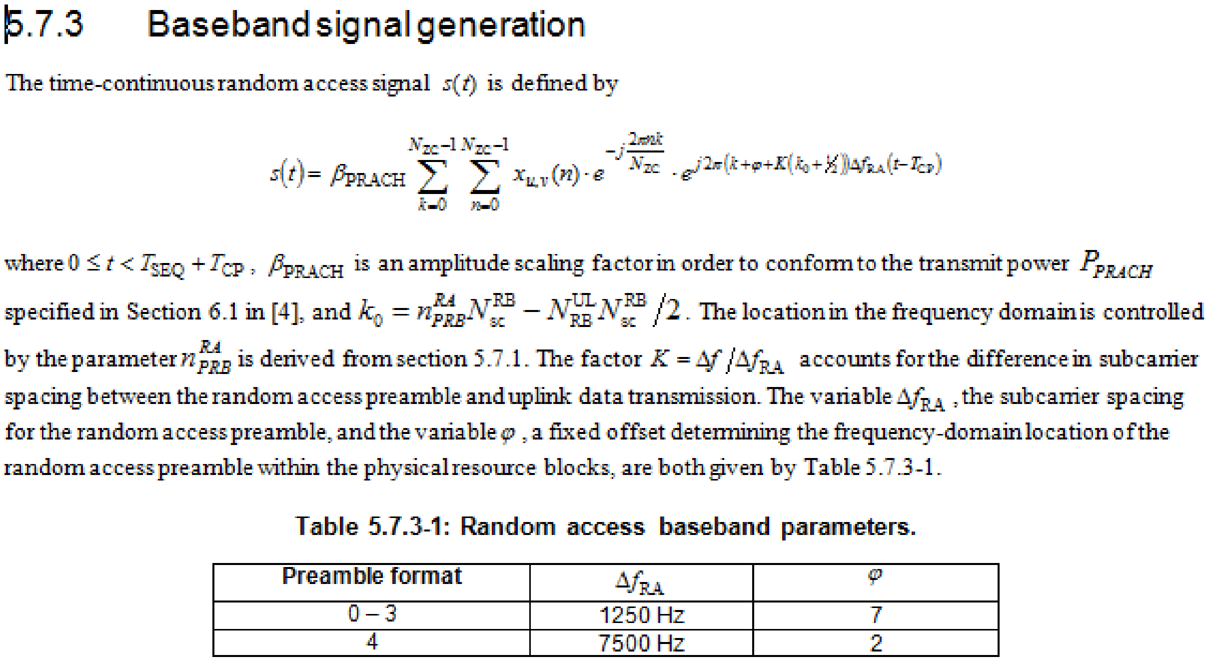


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

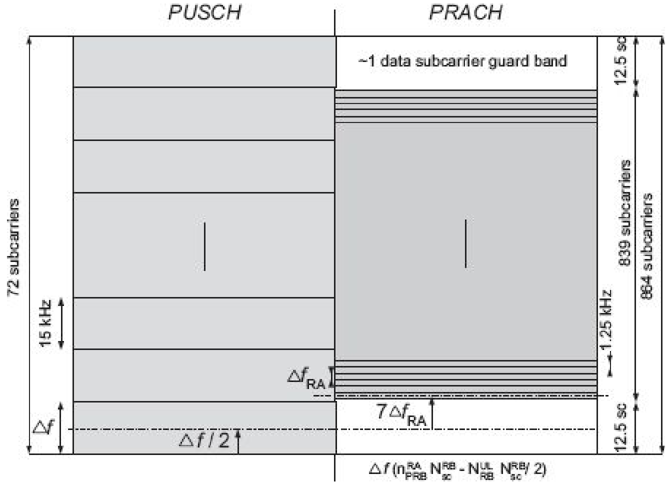
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

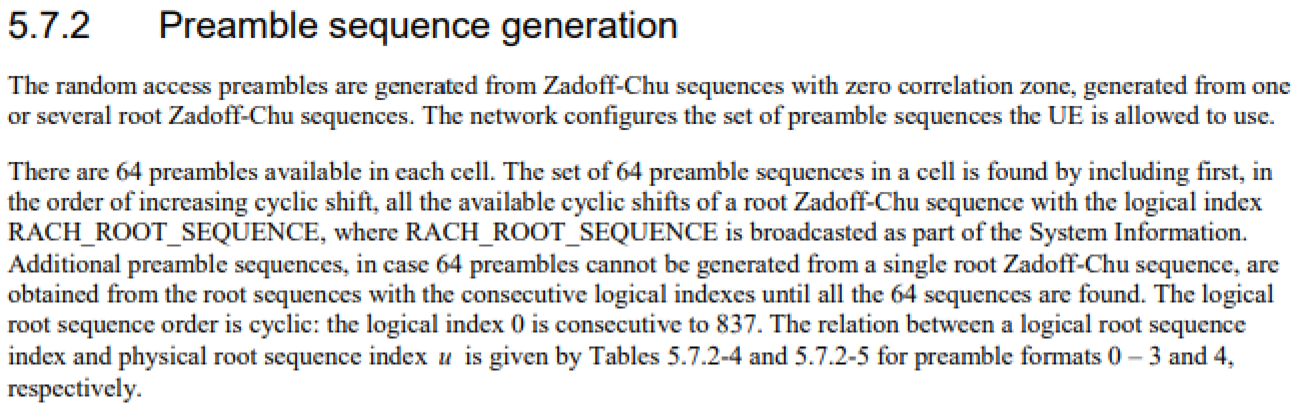
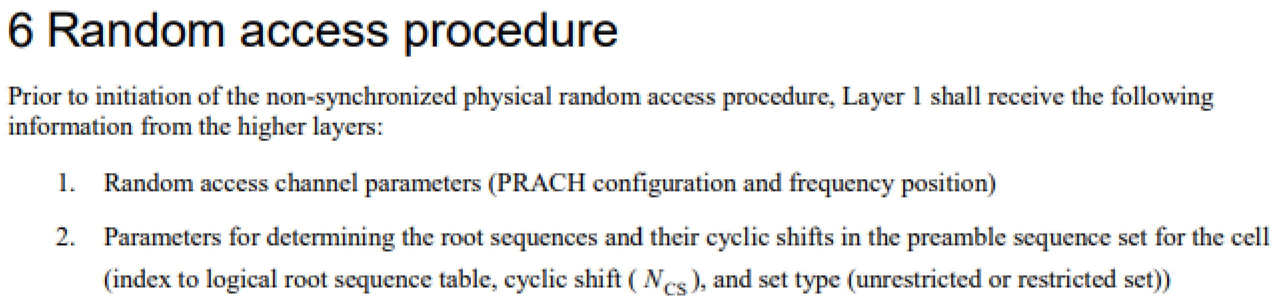
Figure 17.14: PRACH preamble mapping onto allocated subcarriers.



See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of GM's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

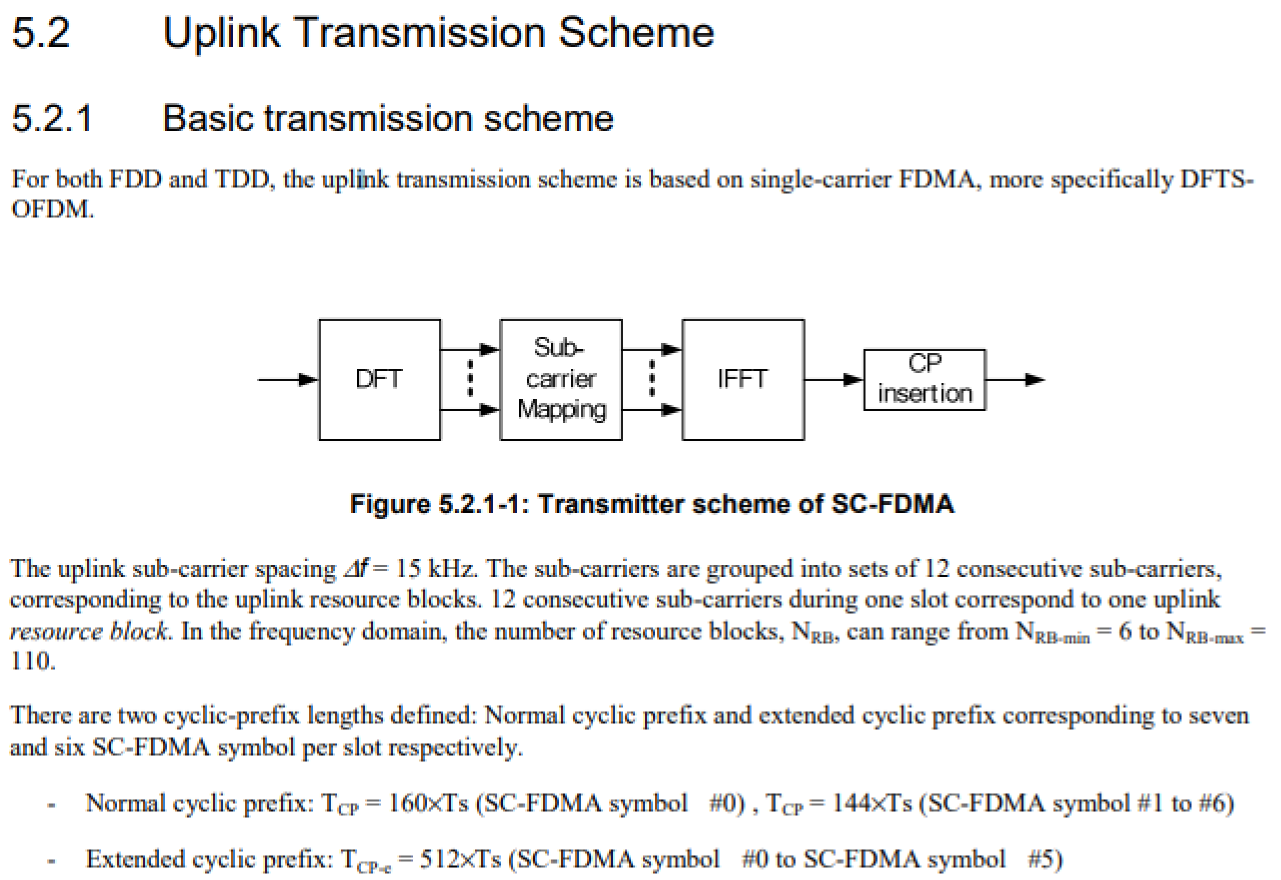
"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

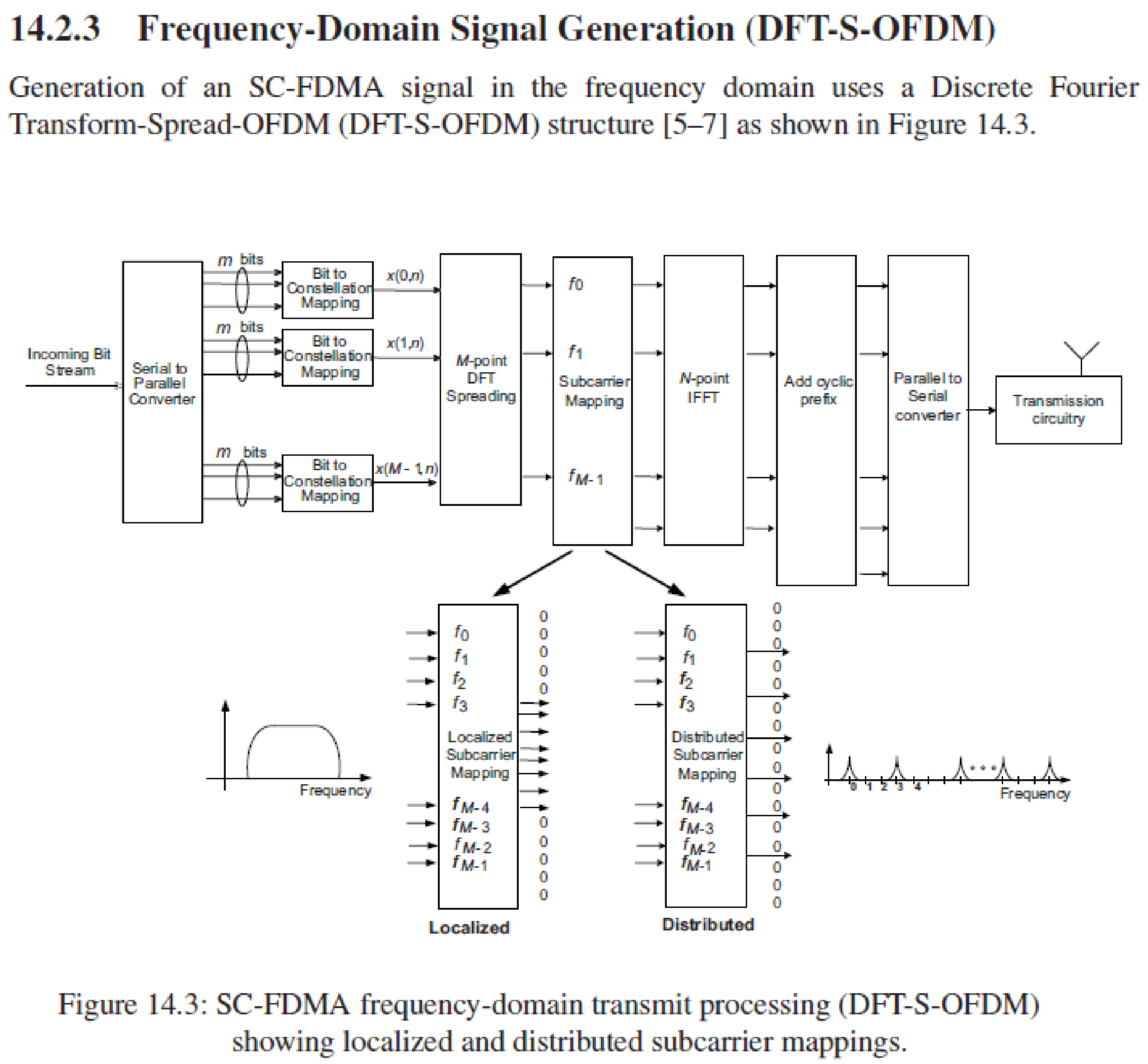
See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. GM's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,* GM's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

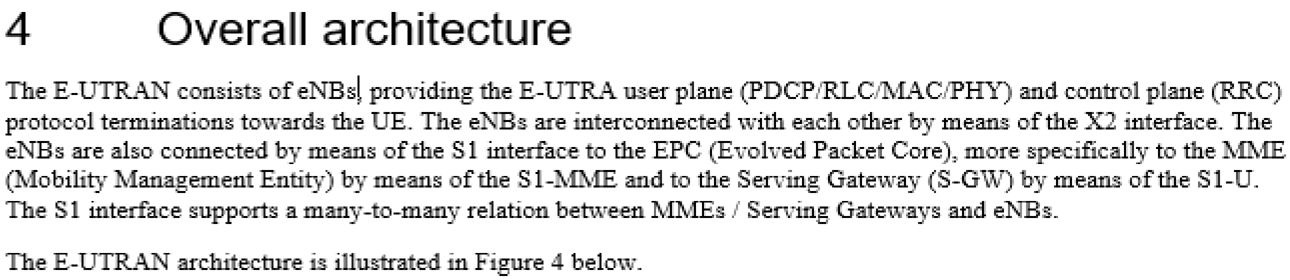
	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.  **14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)** Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3. Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20

"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

21. A mobile station comprising:	To the extent the preamble is considered a limitation, GM's Accused Instrumentalities meet the preamble of claim 21 of the '908 patent. *E.g.,* GM's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, GM offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

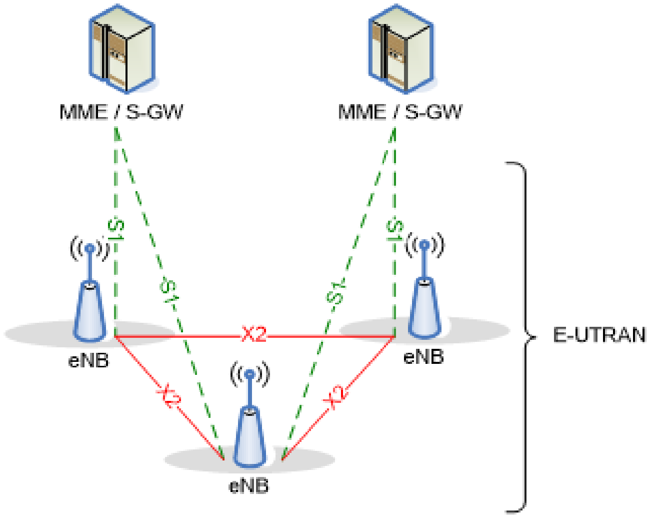


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

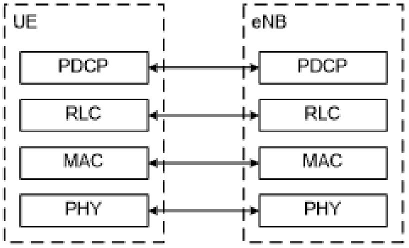


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	GM's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The GM Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

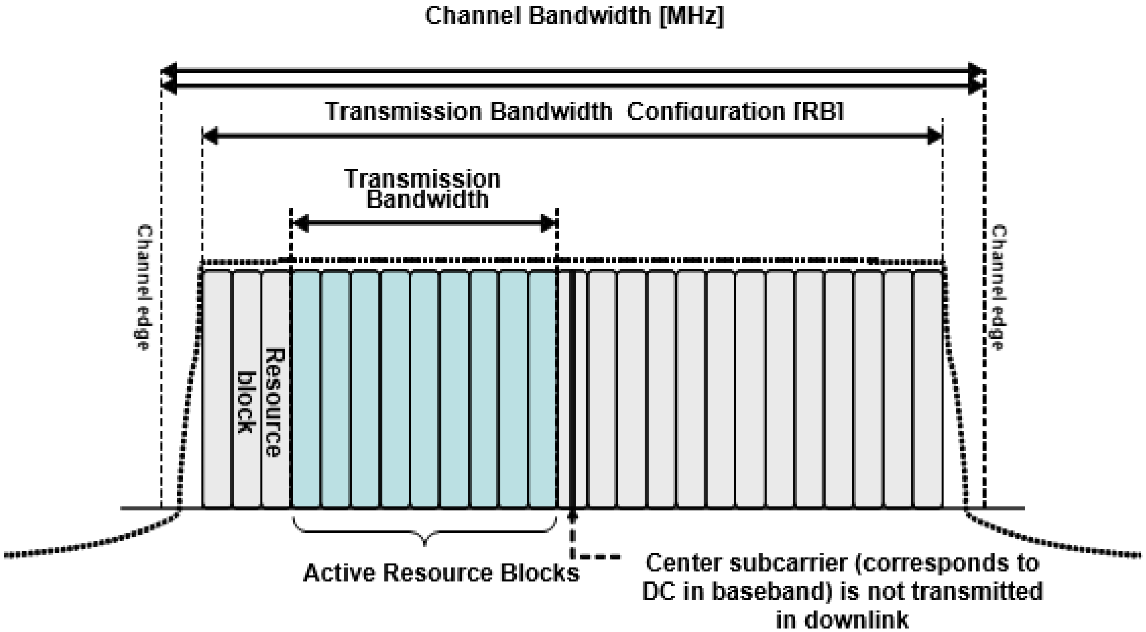


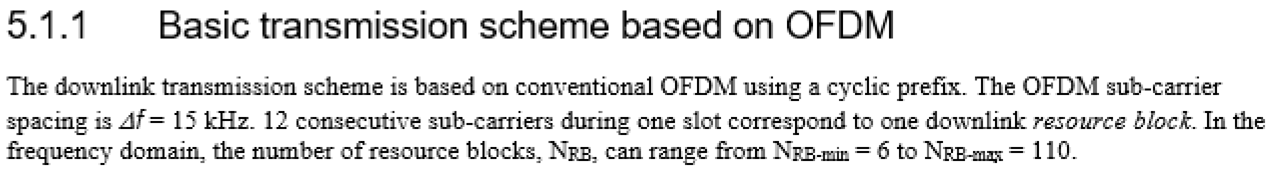
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

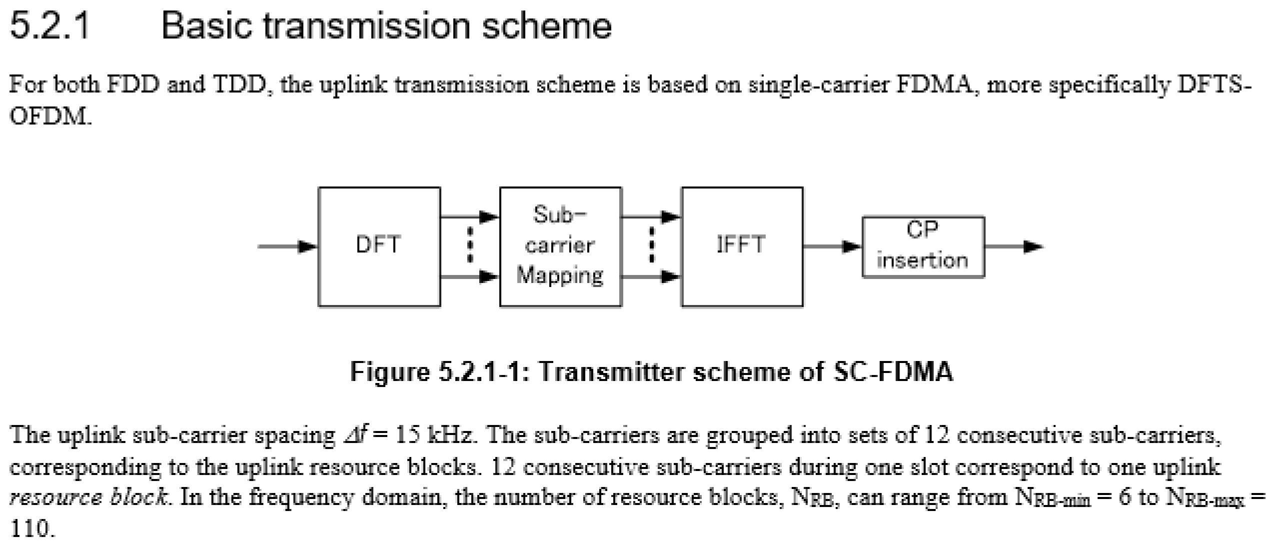
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

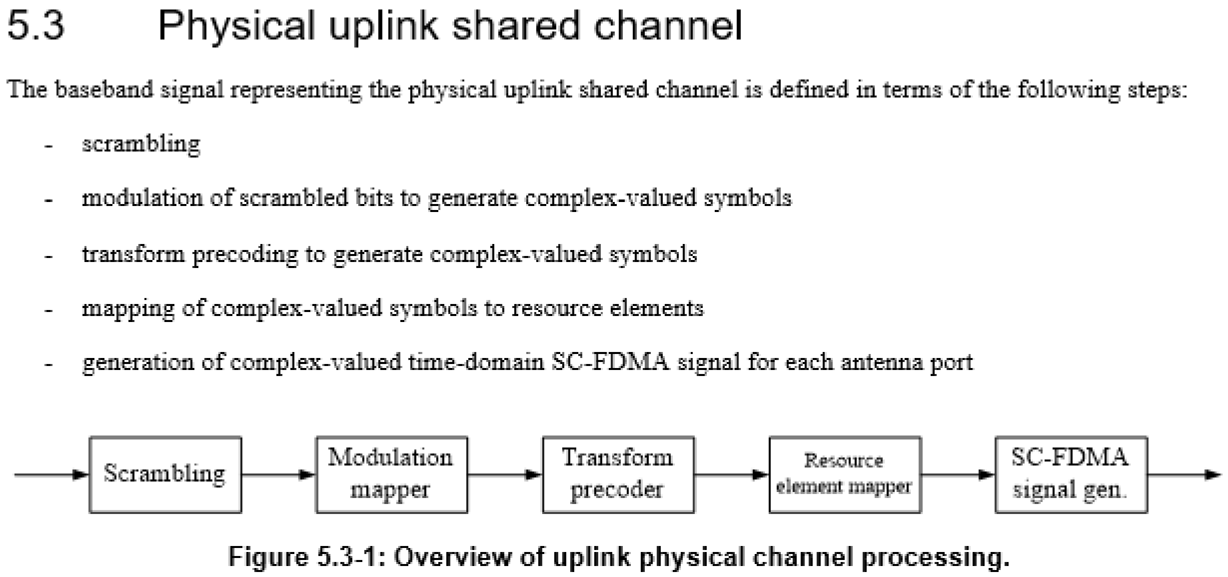
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

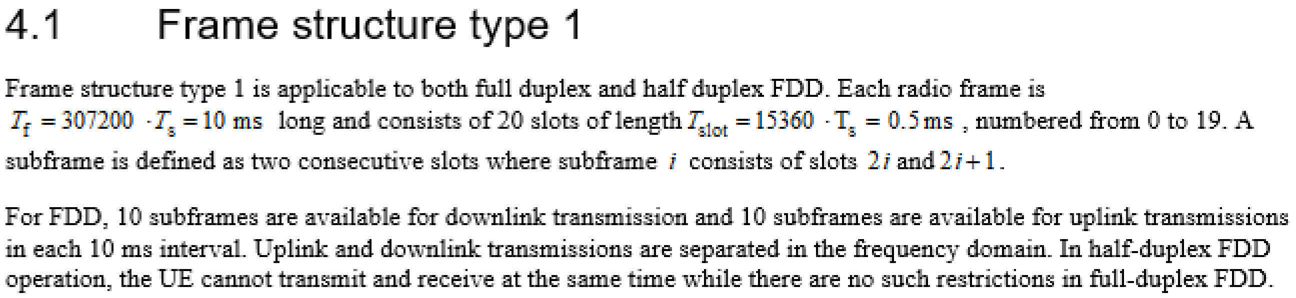
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

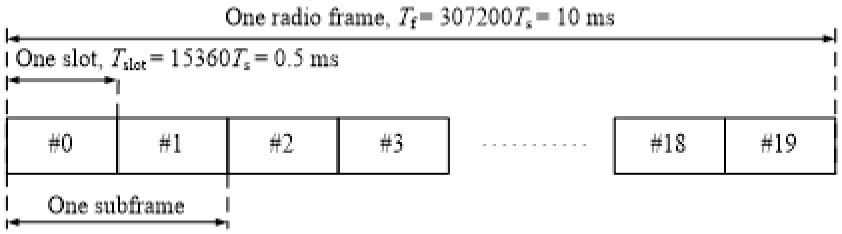


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.

4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

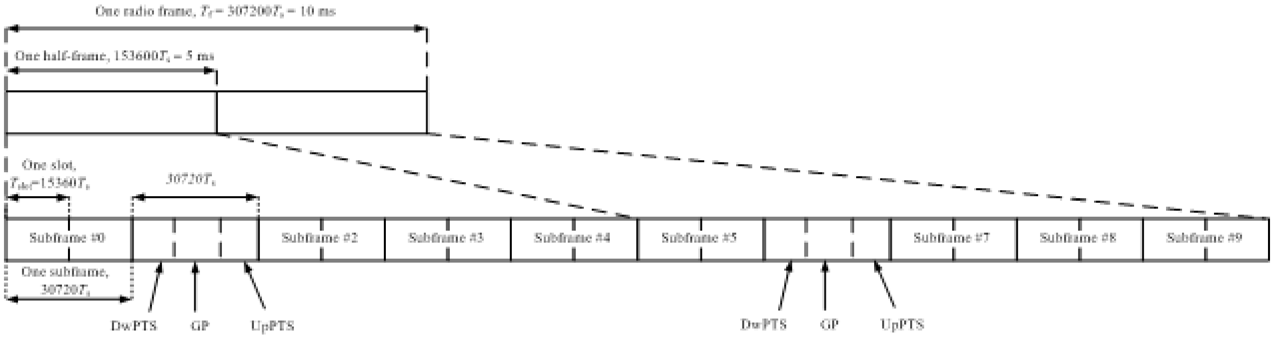


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).

5.2 Slot structure and physical resources

5.2.1 Resource grid

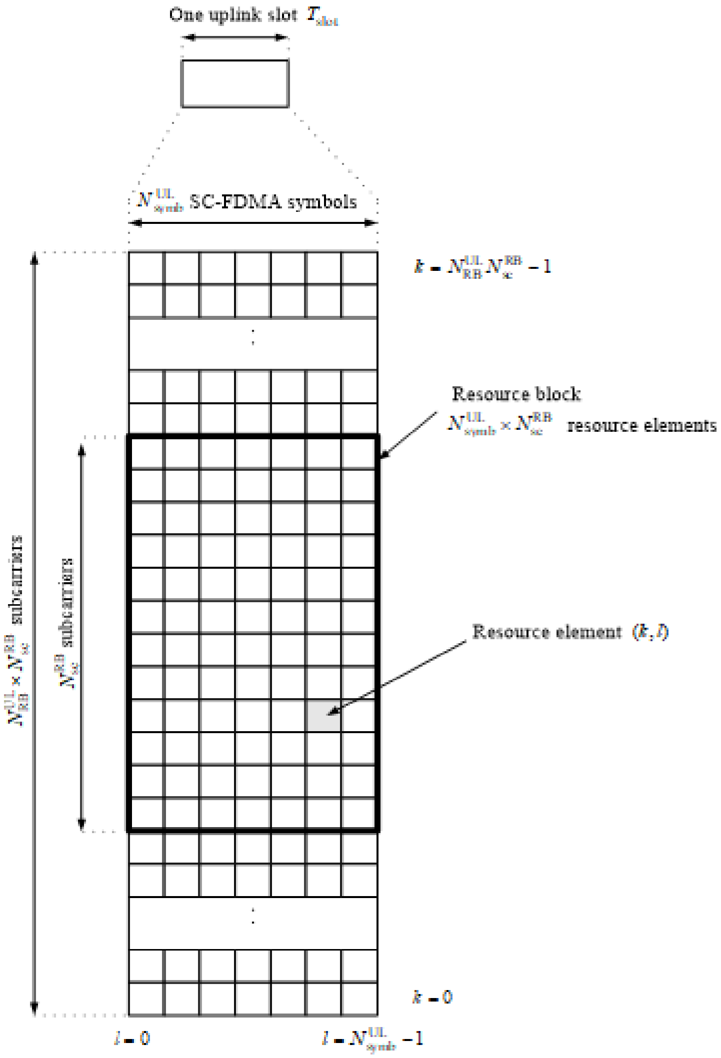
The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

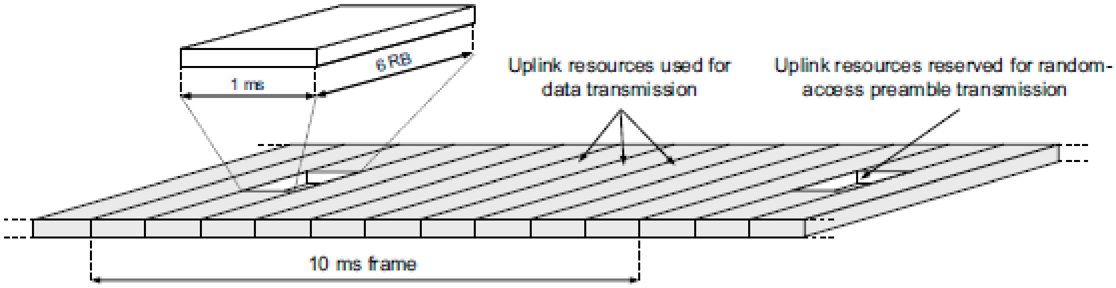
where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

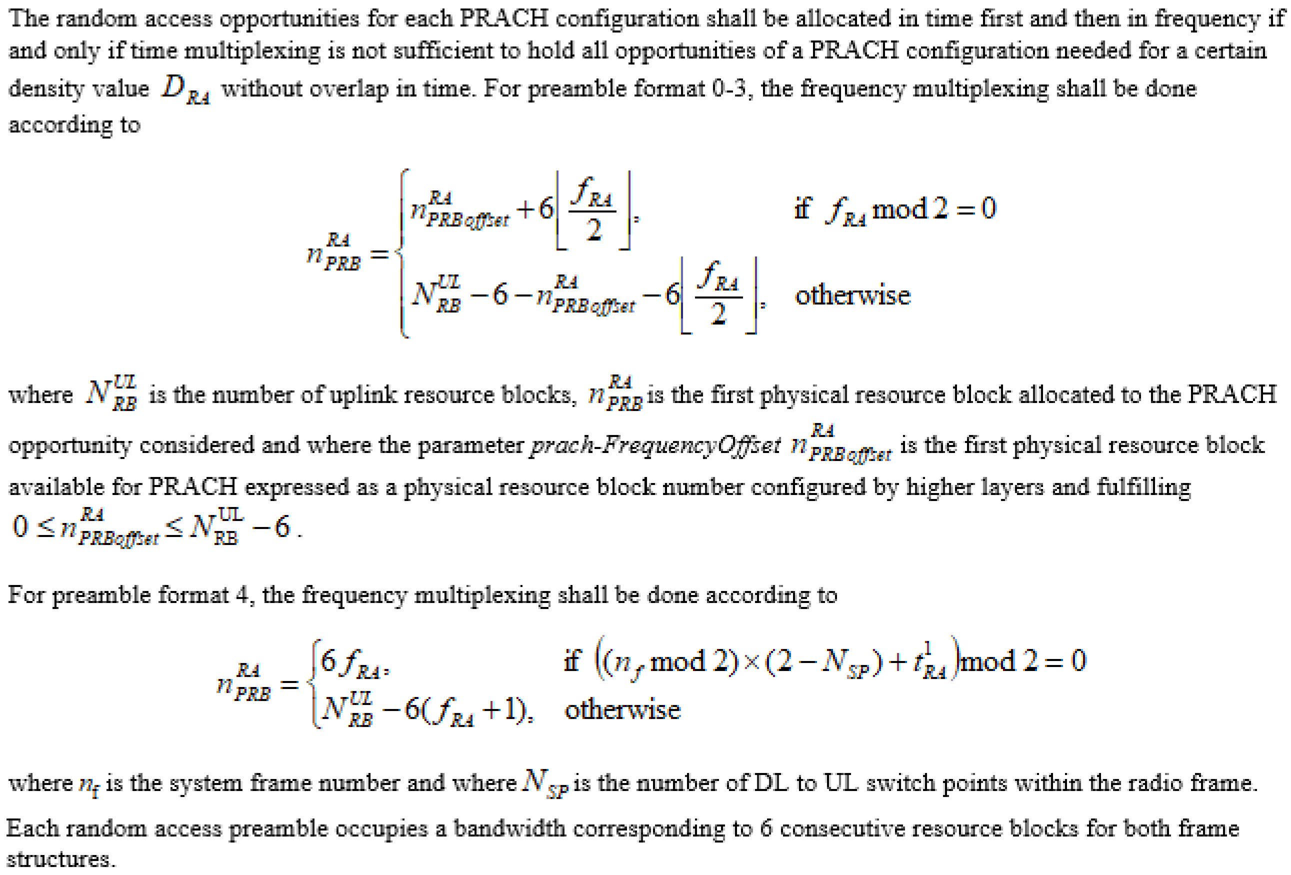
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	GM's Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

	The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

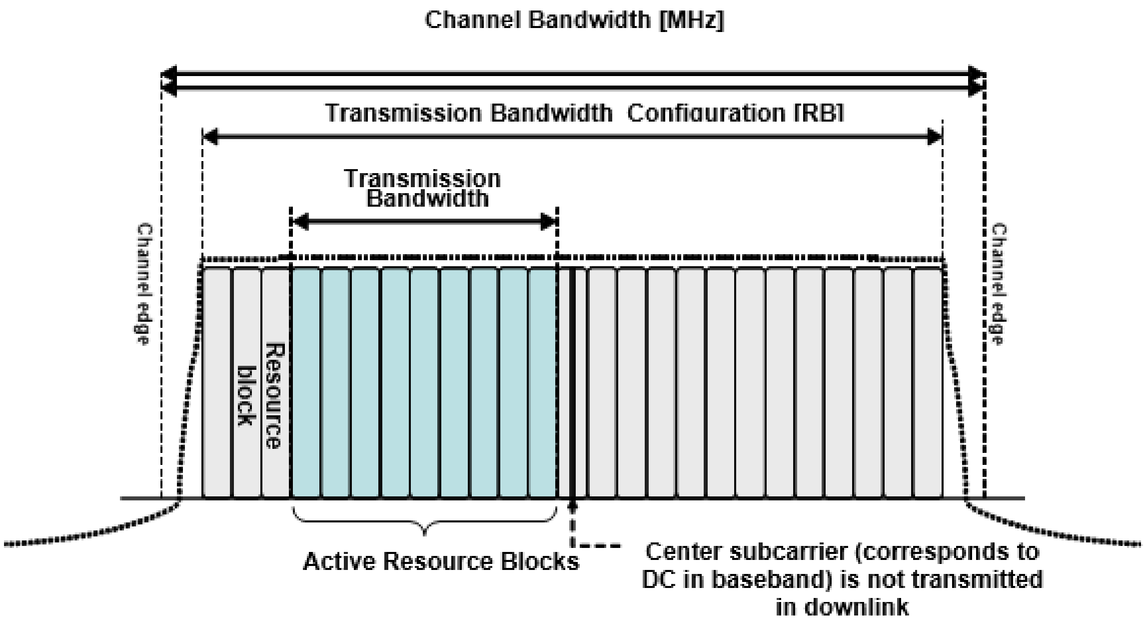
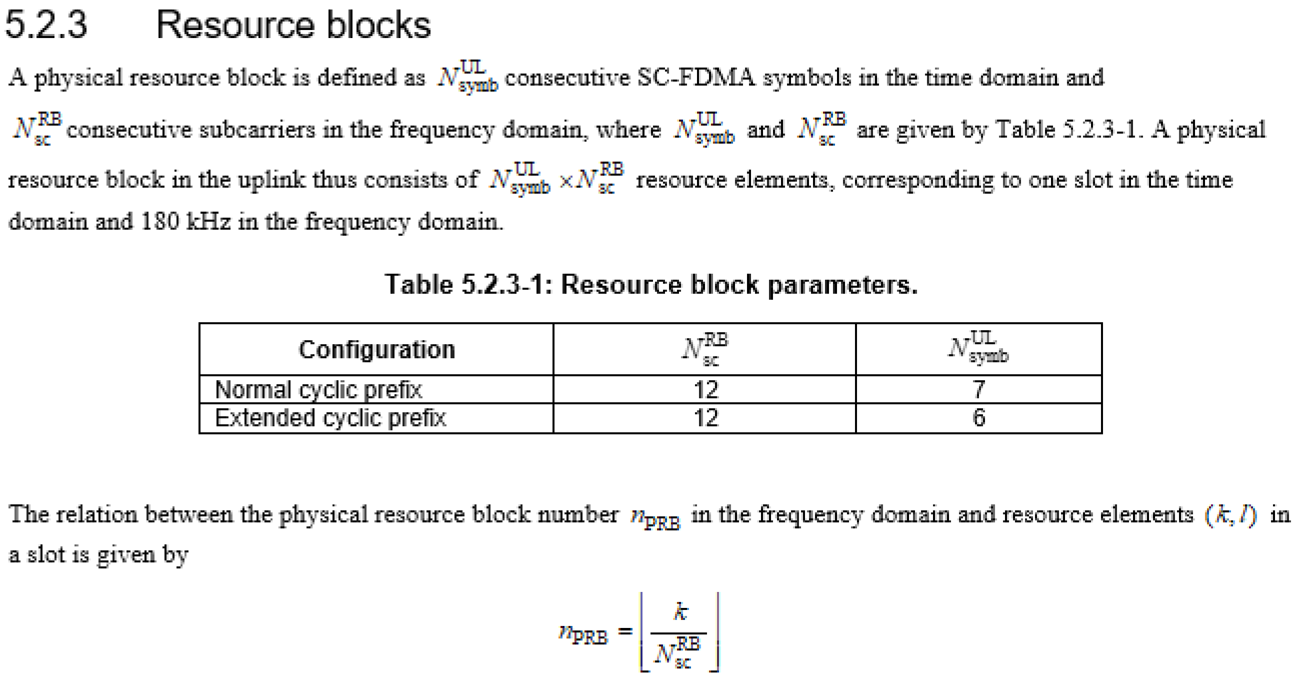


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

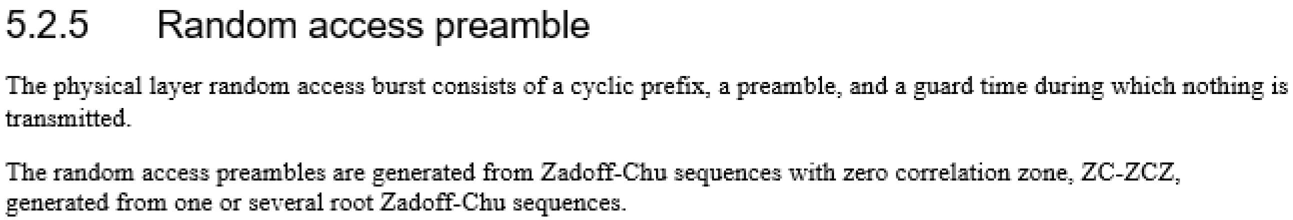
Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\mathrm{PRB}} = \left\lfloor \frac{k}{N_{\mathrm{sc}}^{\mathrm{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

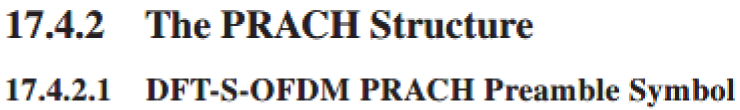


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

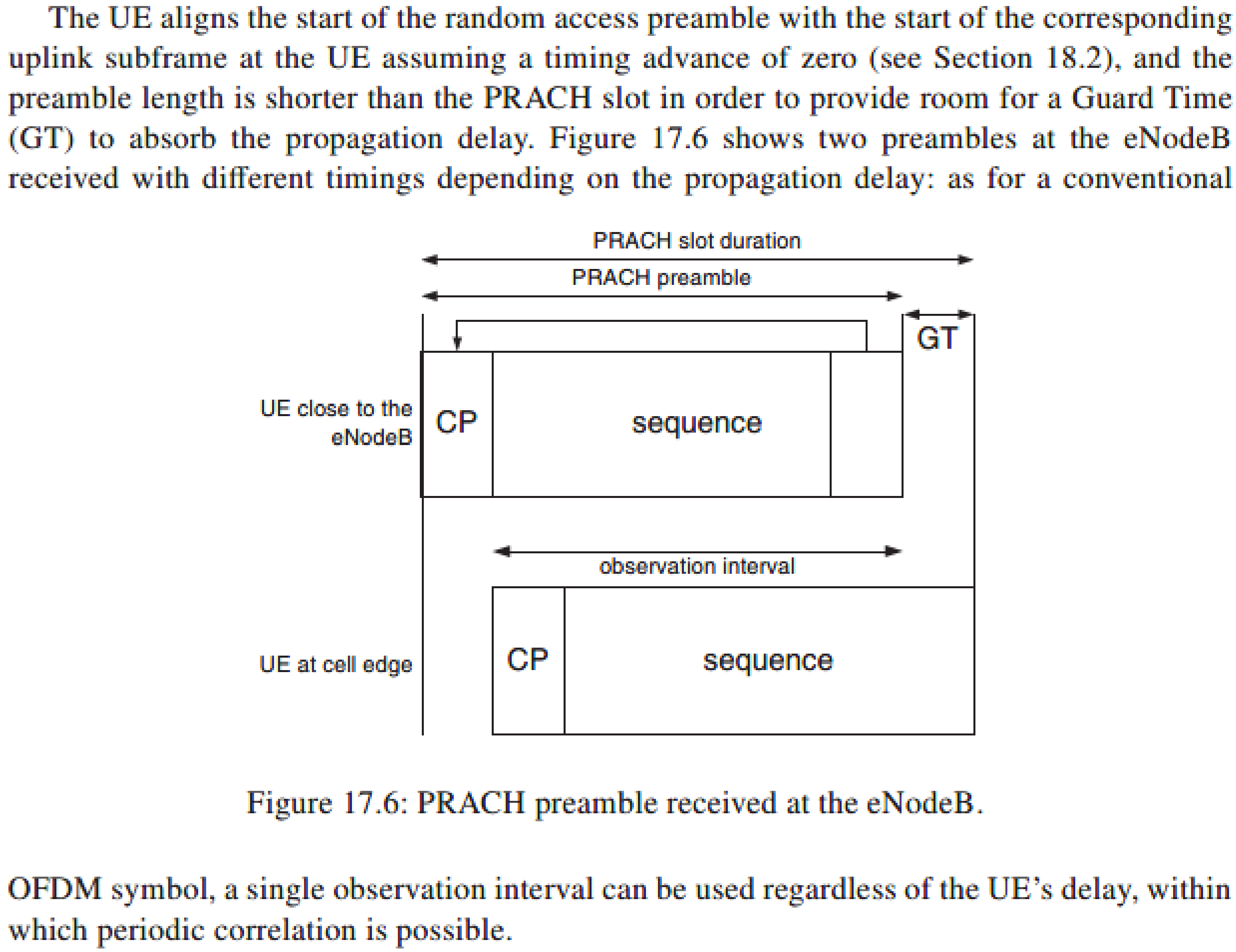


17.4.2 The PRACH Structure

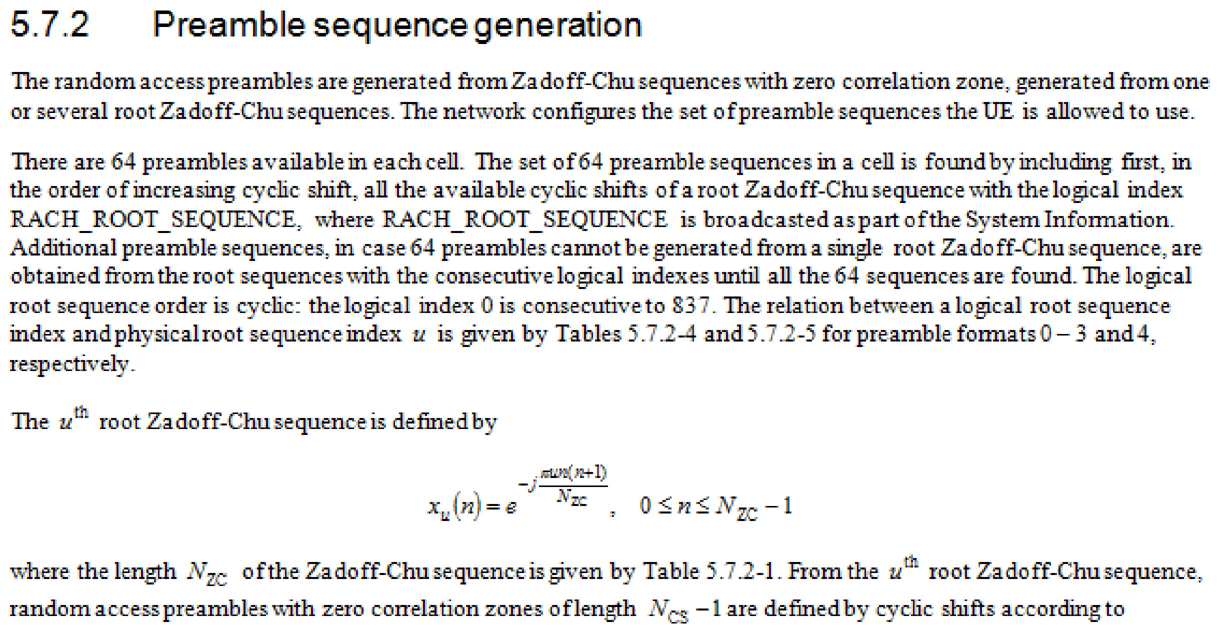
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

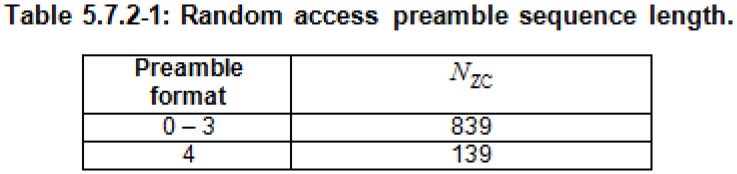
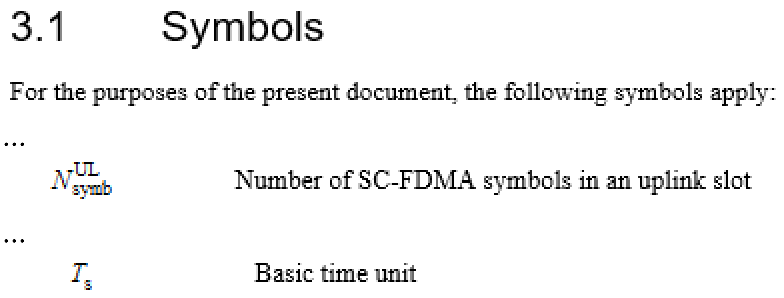
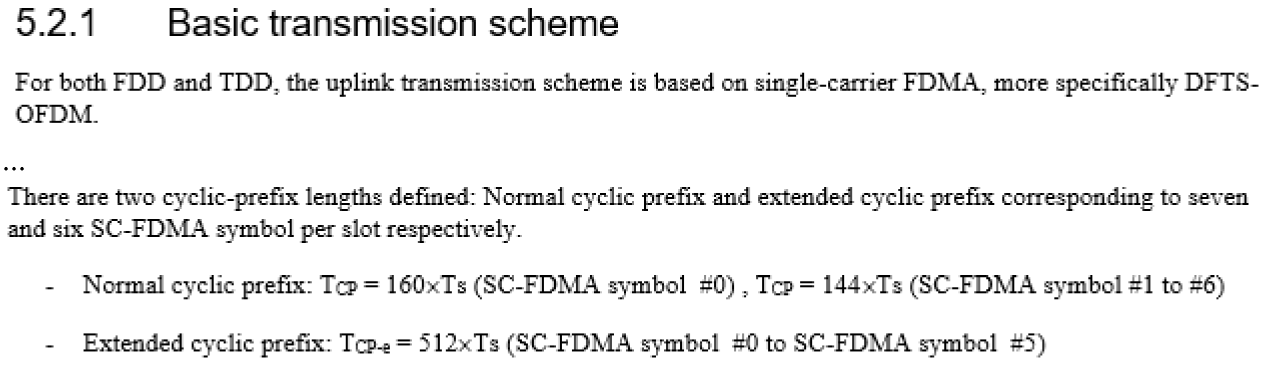


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using GM’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs. 3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_{s} Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals. 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

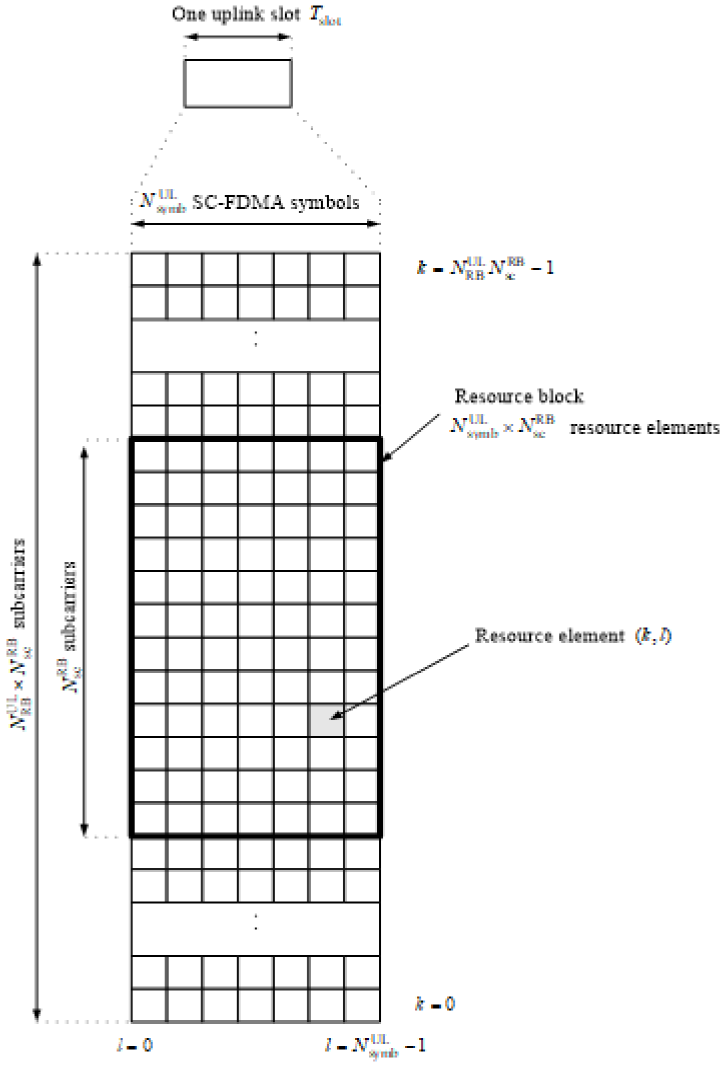
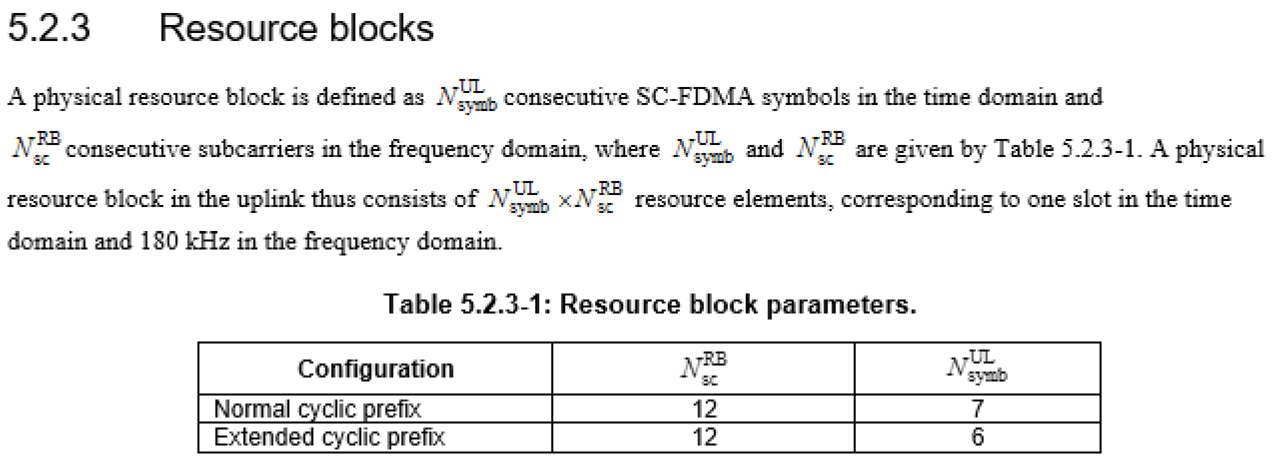


Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

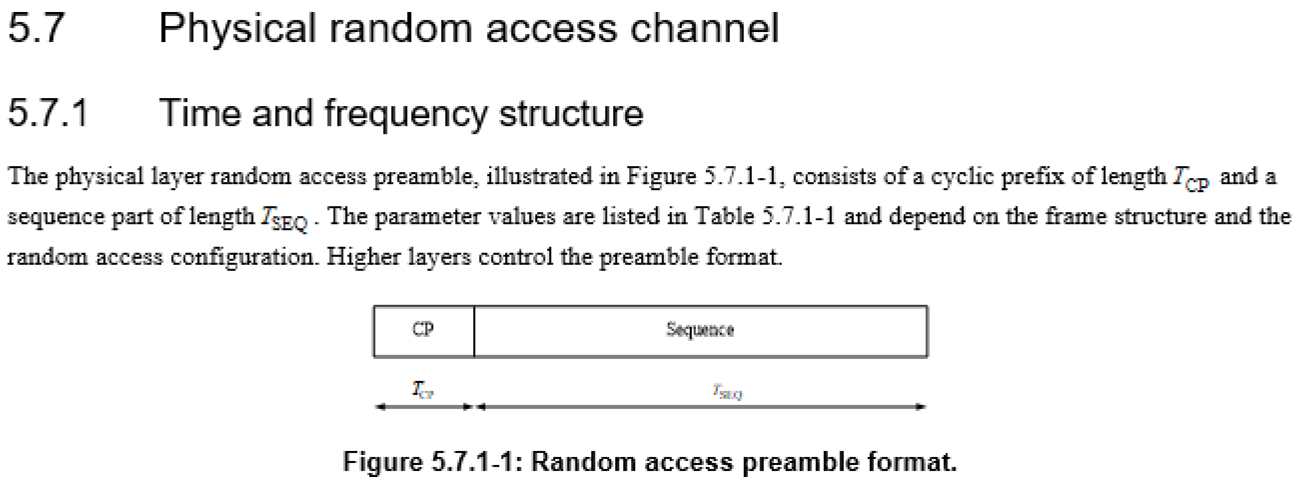
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

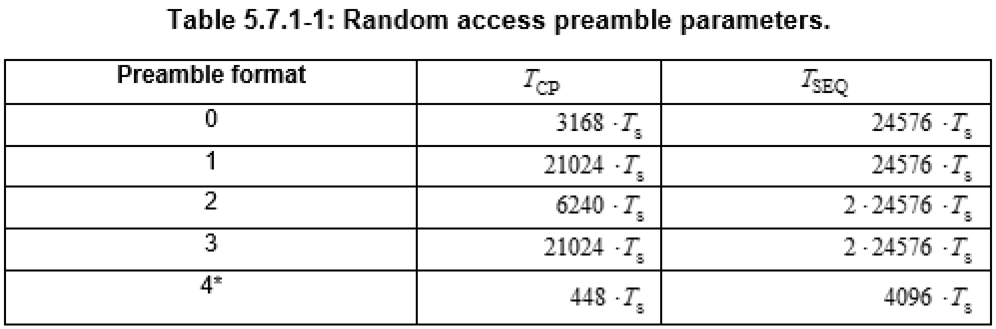
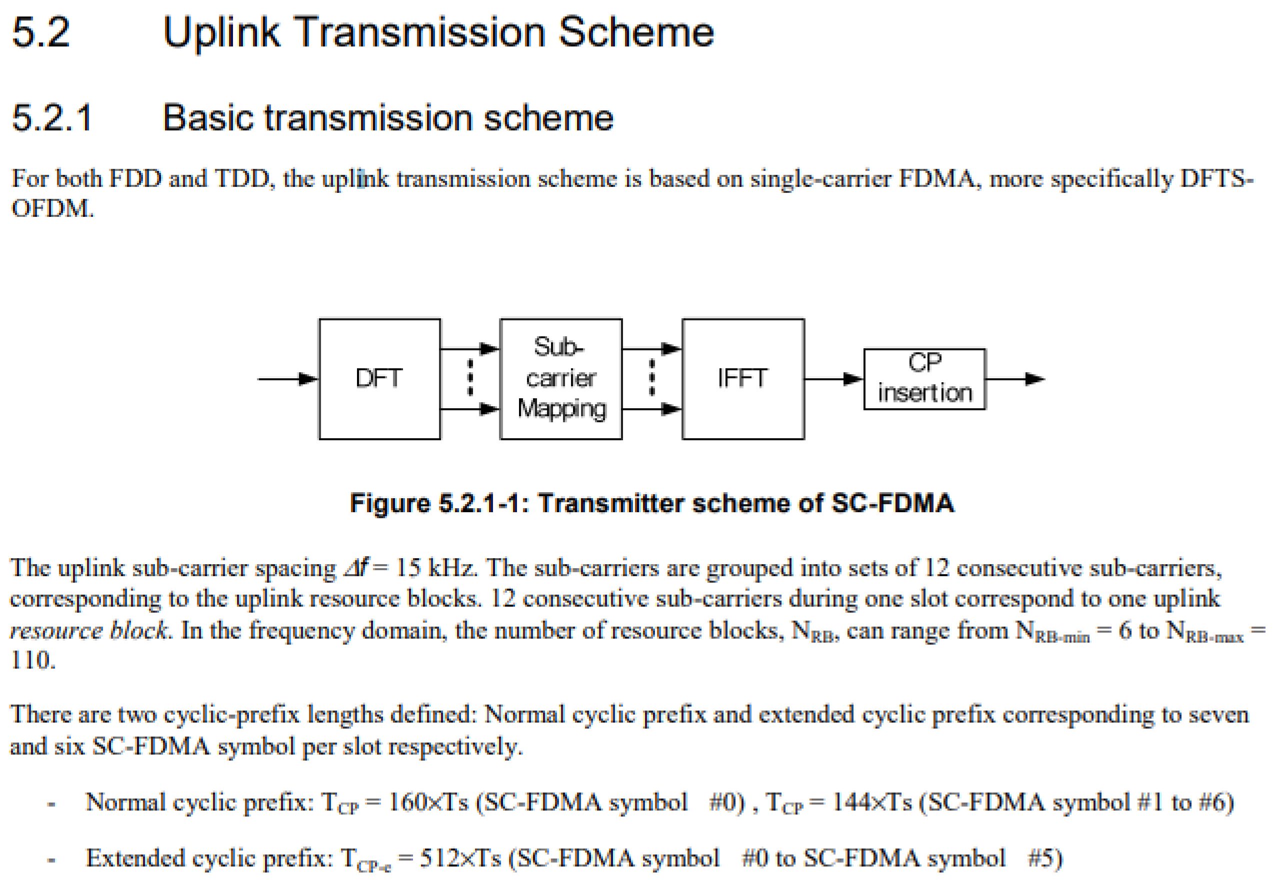


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	GM’s Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, GM’s Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160{\times}Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144{\times}Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512{\times}Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

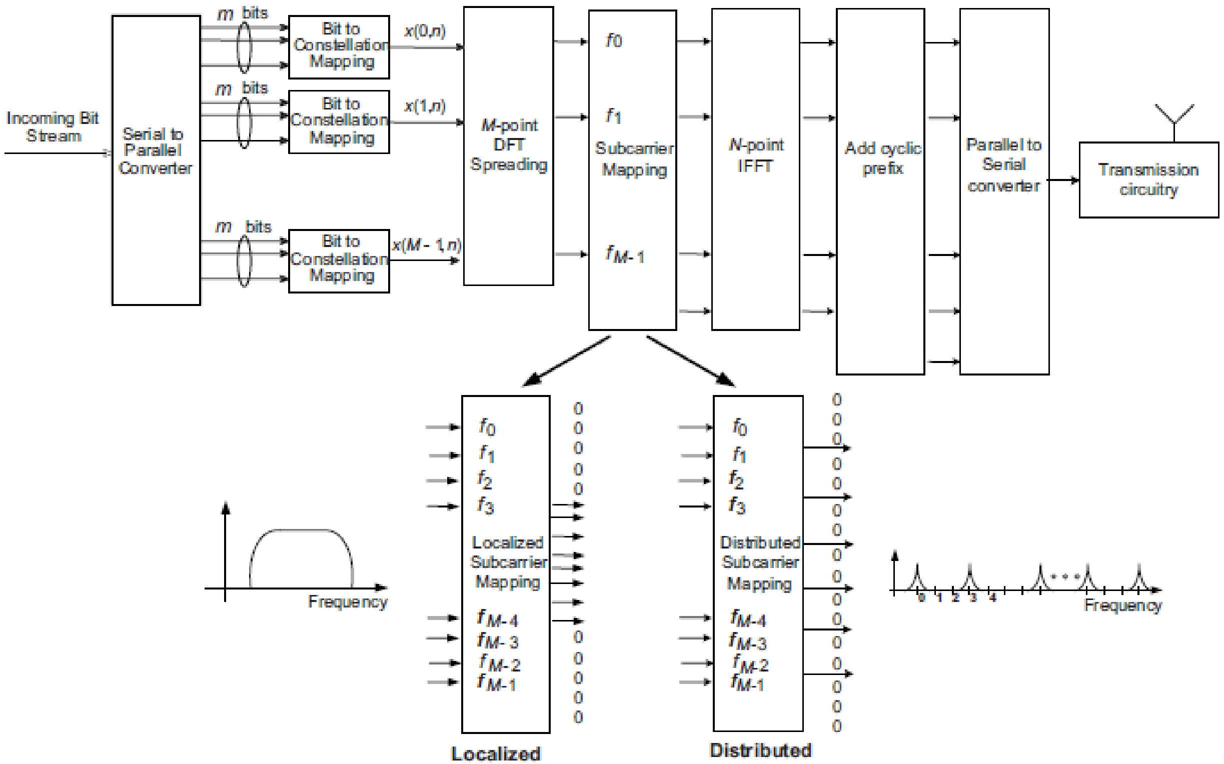


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

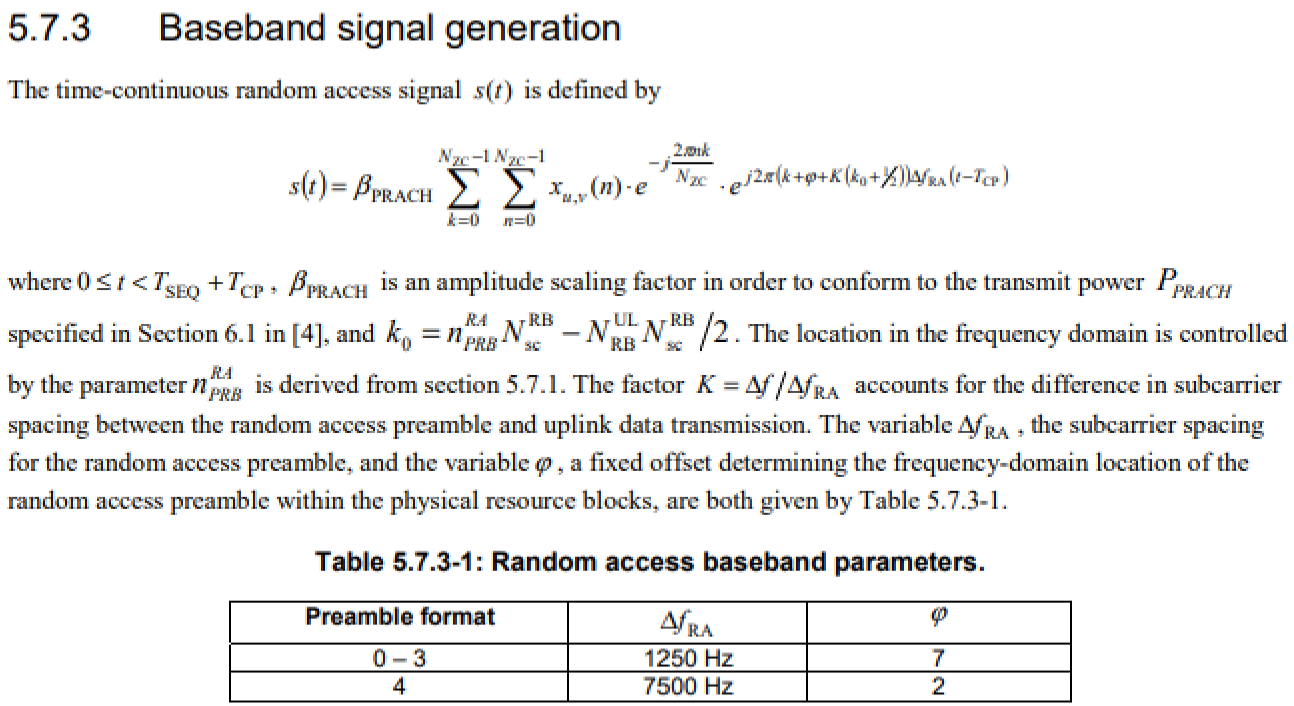
US Patent No. 10,833,908: Claim 21(f)

"wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band"

wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;

GM's Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

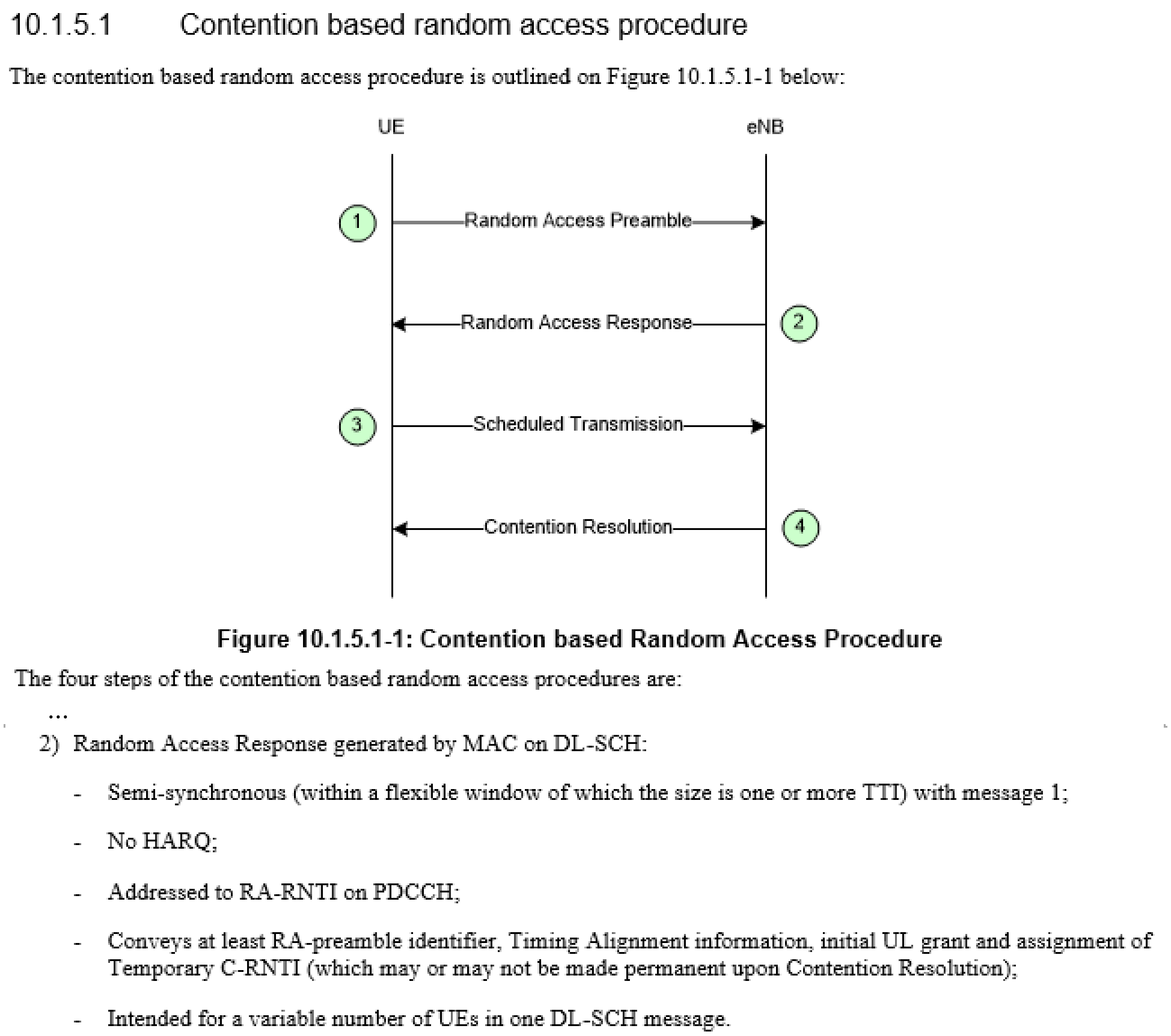
where $0\le t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

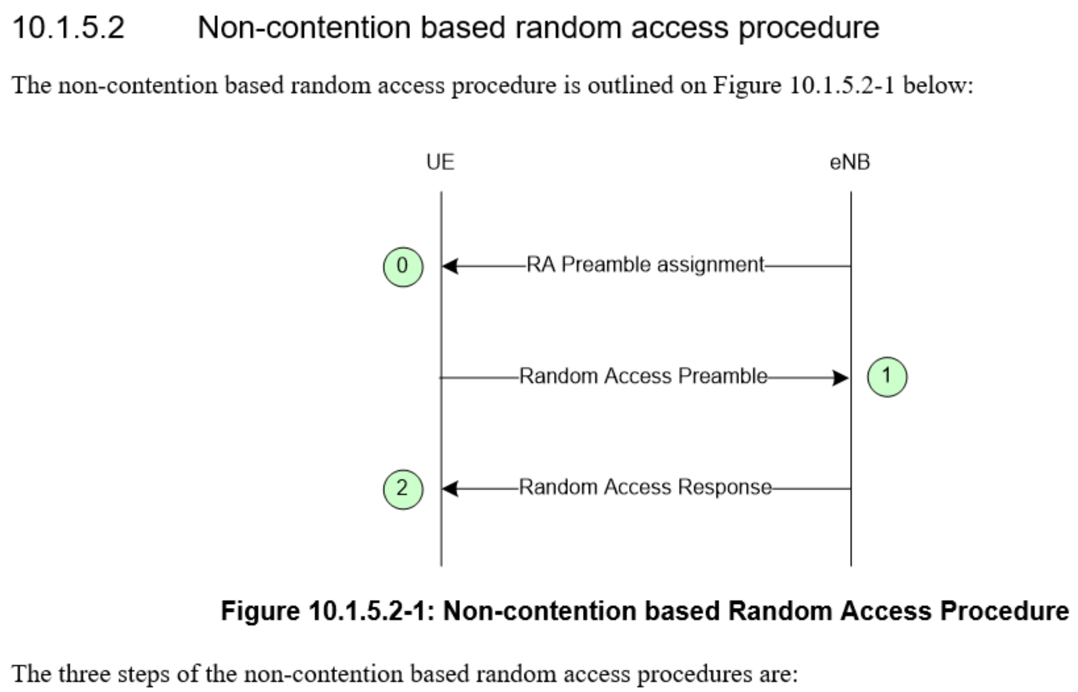
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

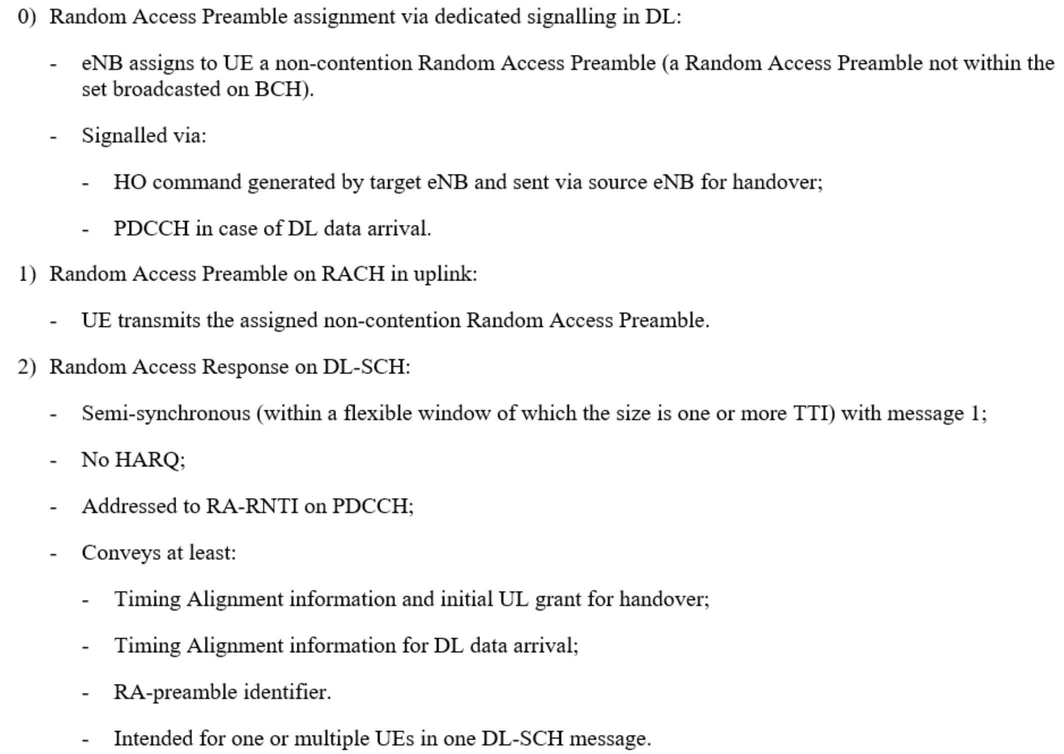
US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

wherein the mobile station is further configured to receive, from the base station, a second analog signal	GM's Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: ... 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

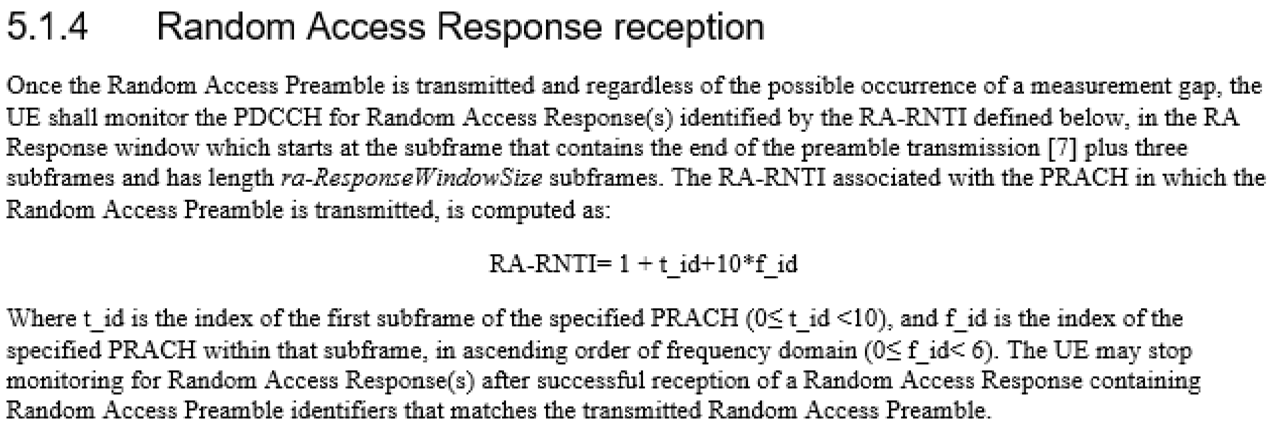


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

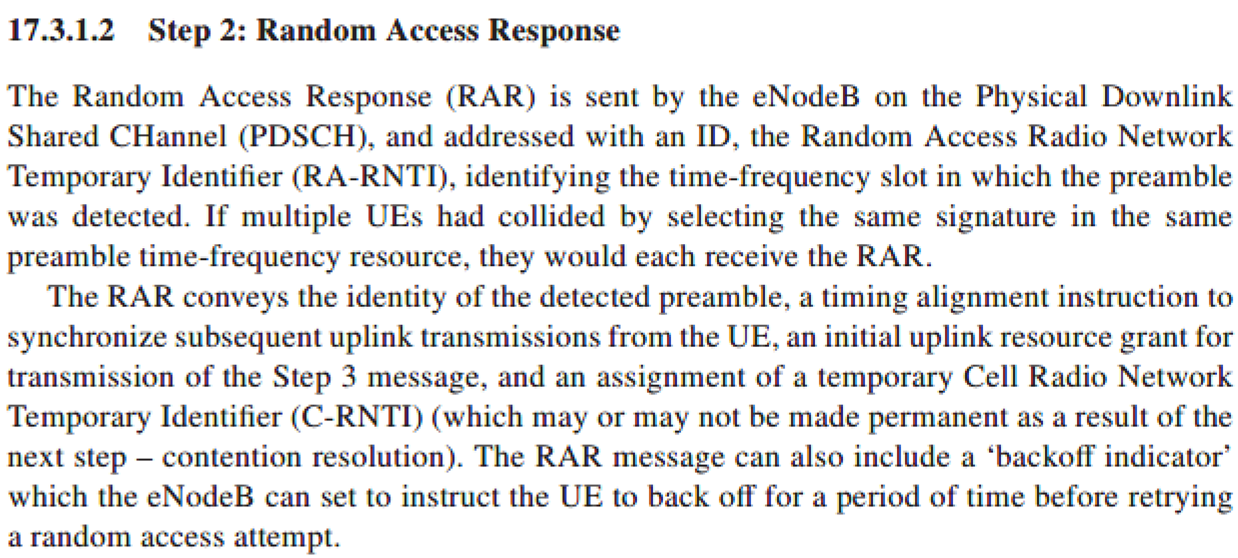
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

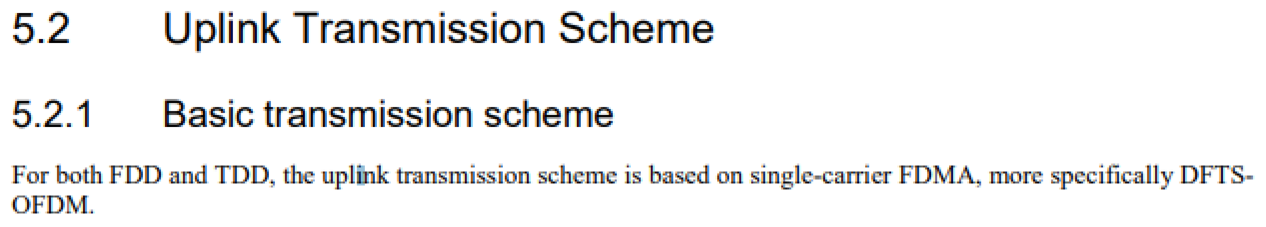
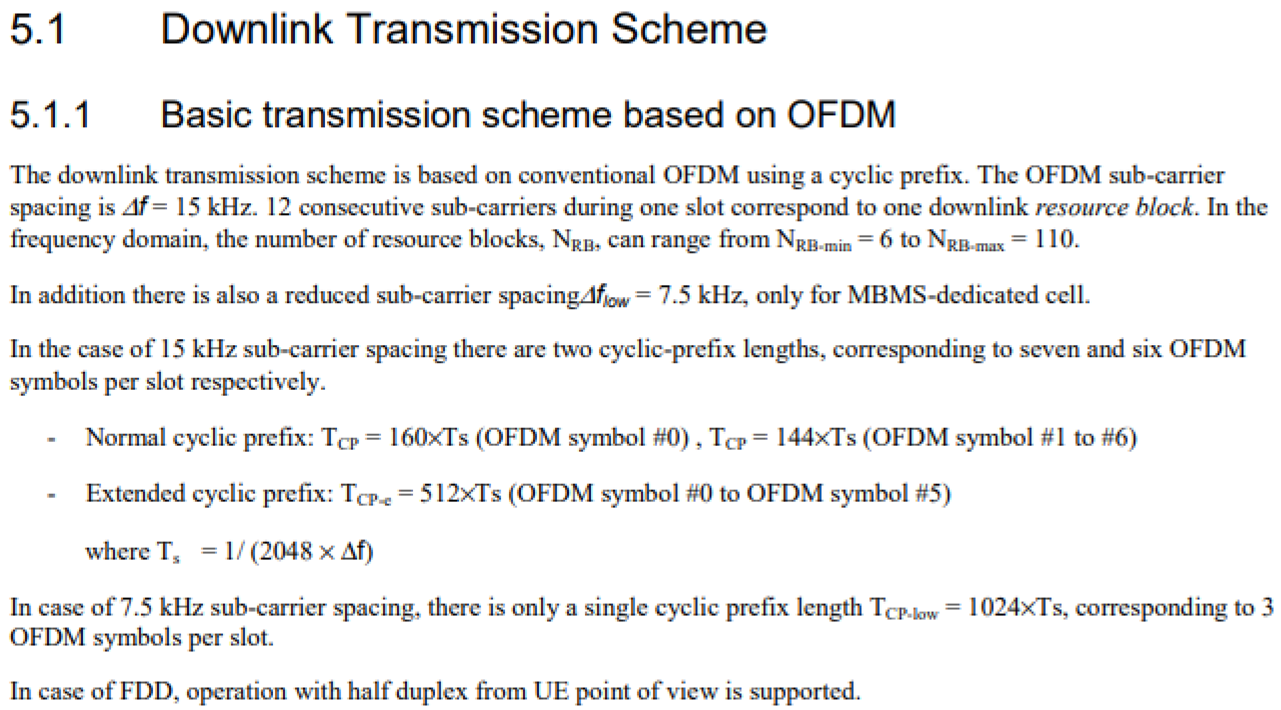
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	GM's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, GM's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.  5.1 Downlink Transmission Scheme 5.1.1 Basic transmission scheme based on OFDM The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110. In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (OFDM symbol #0) , T_{CP} = 144×Ts (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low}$ = 1024×Ts, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

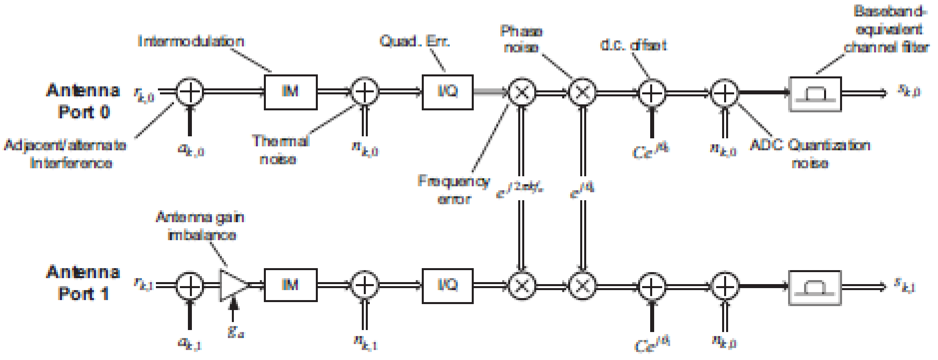
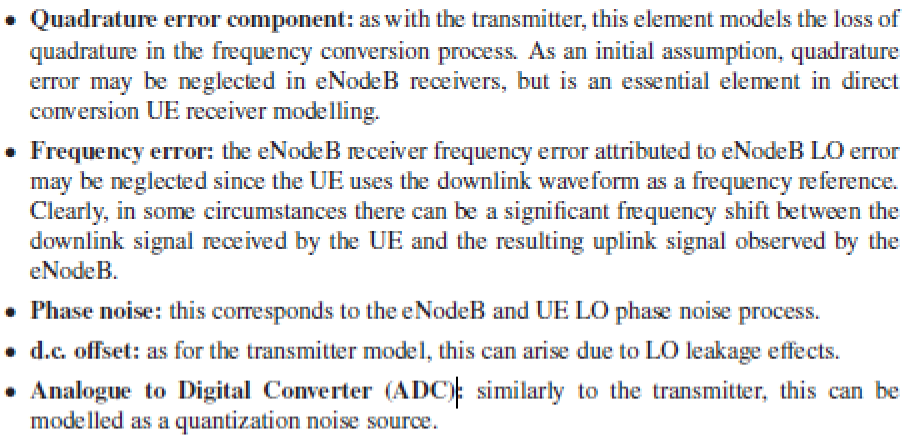


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.



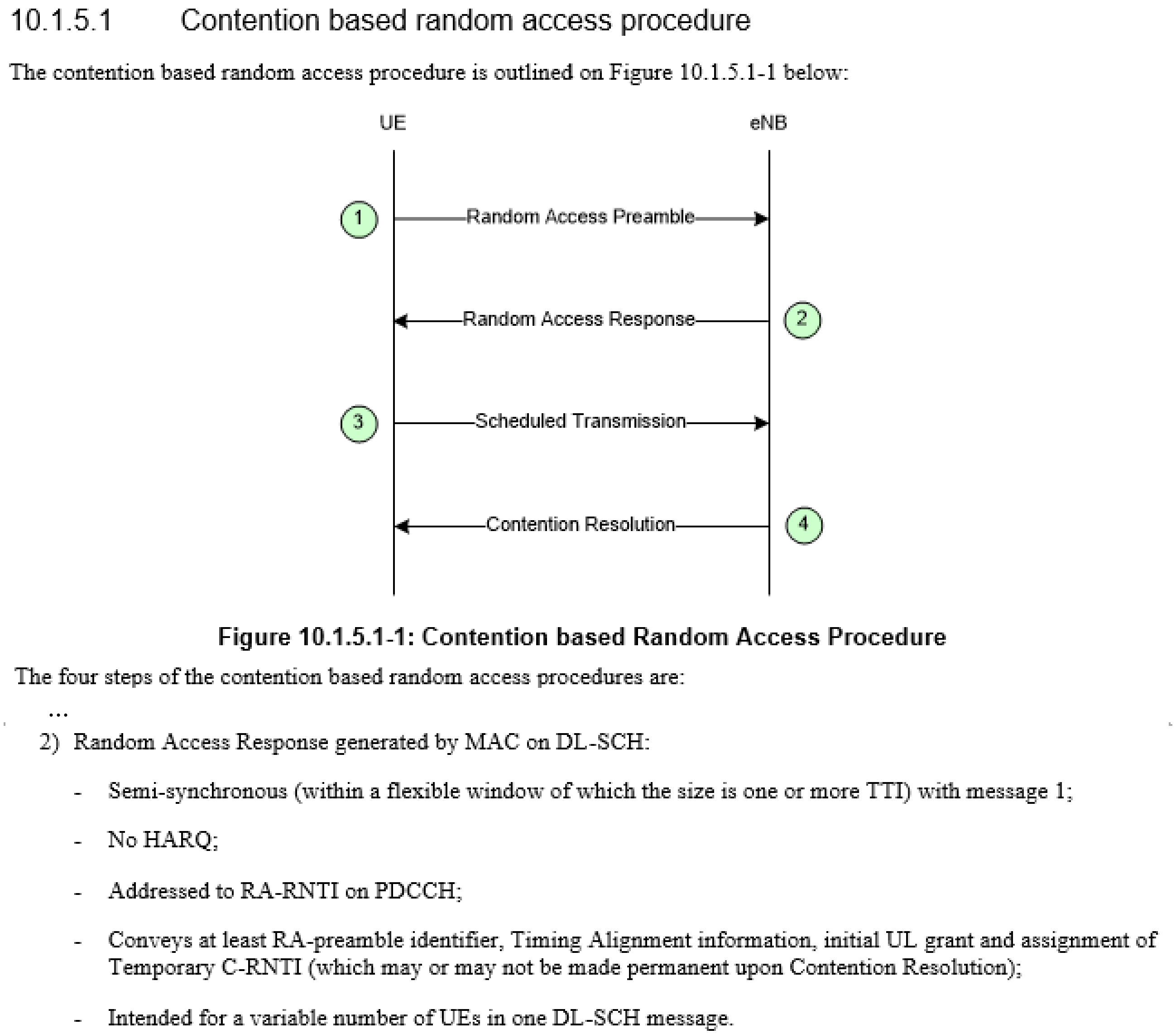
- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

<table>
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10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

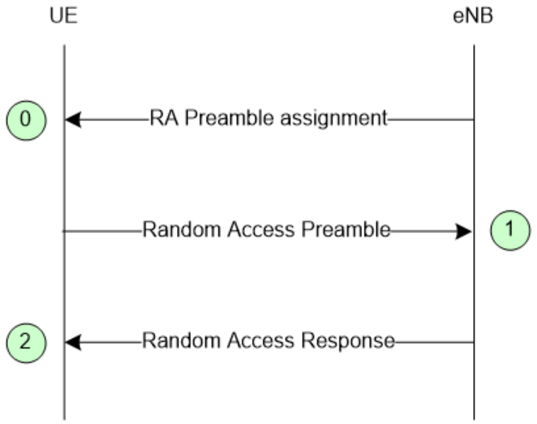


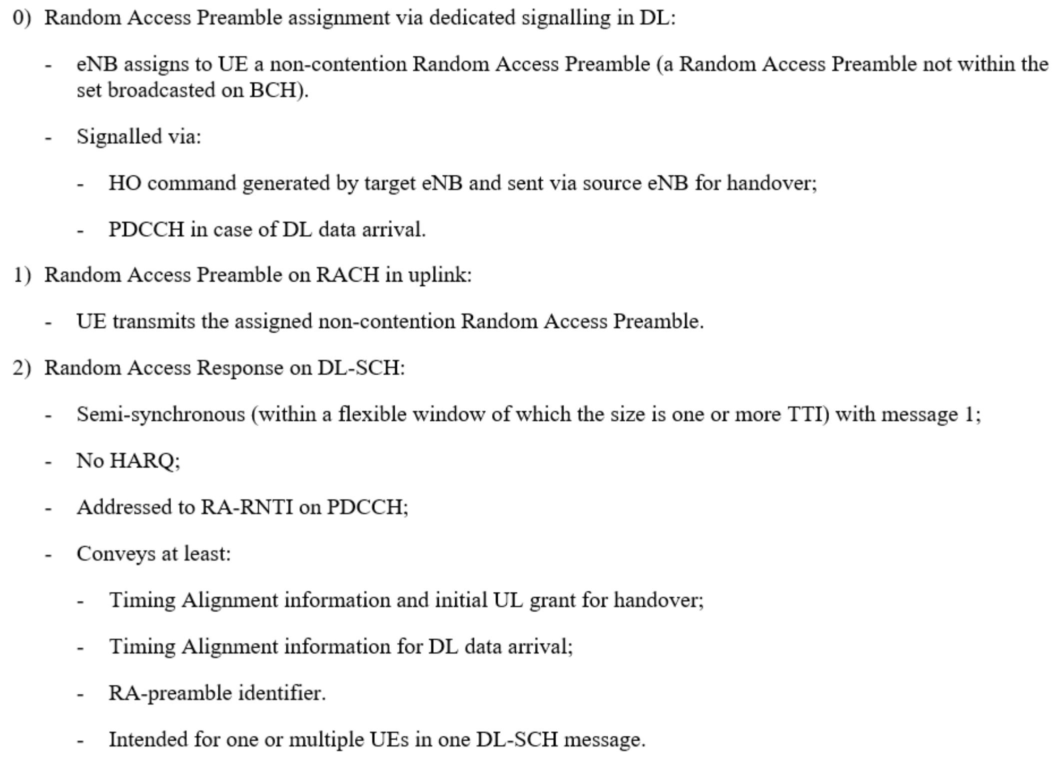
Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

</td></tr>
</table>

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

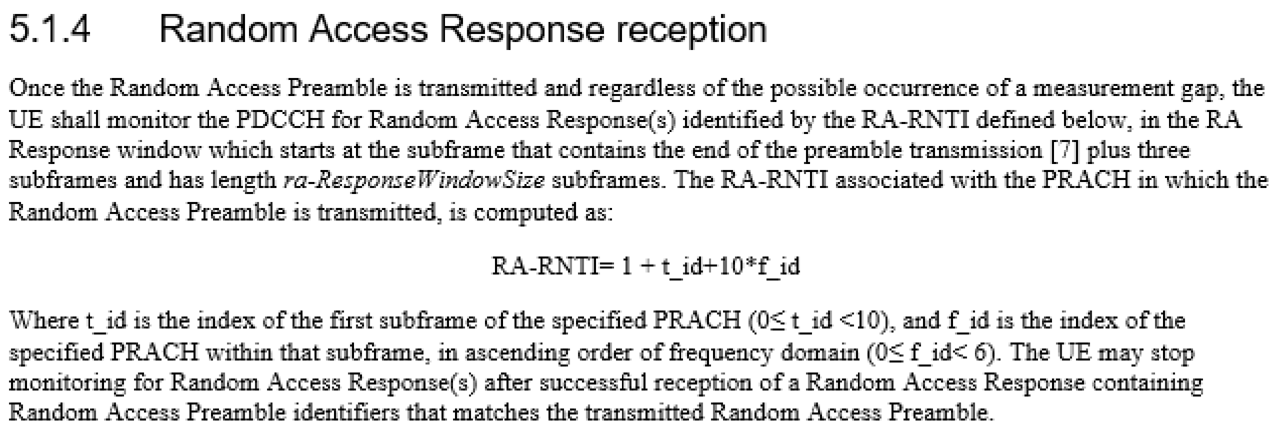


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.

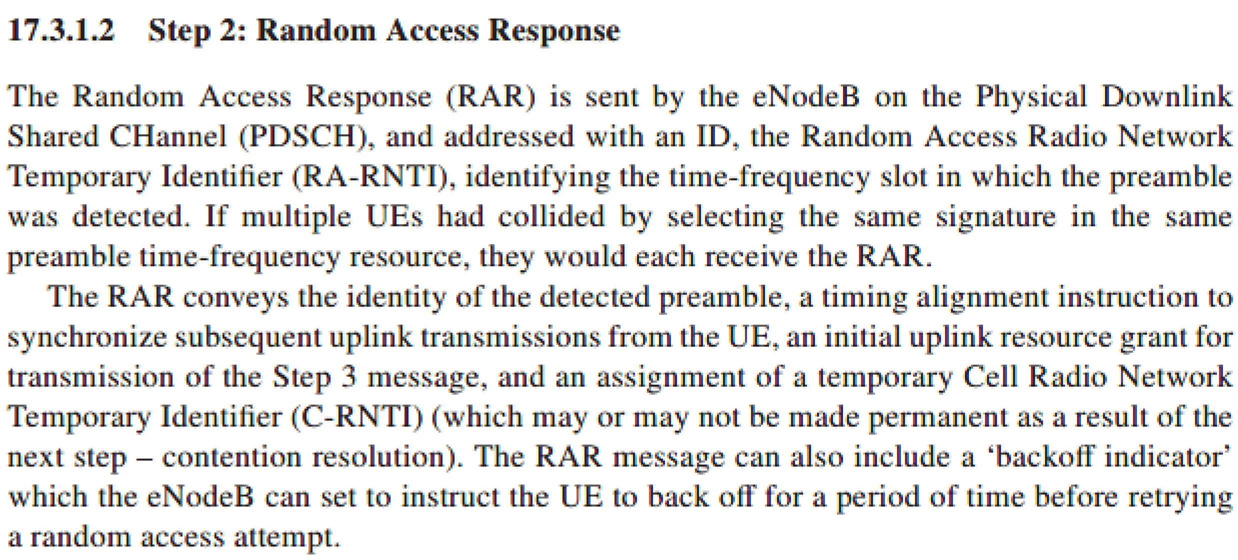


5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

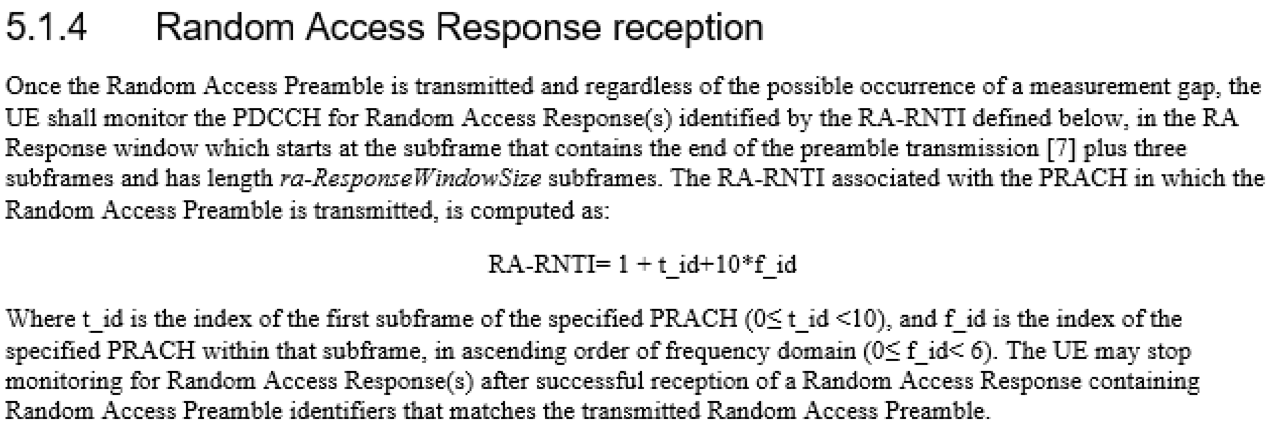
	See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

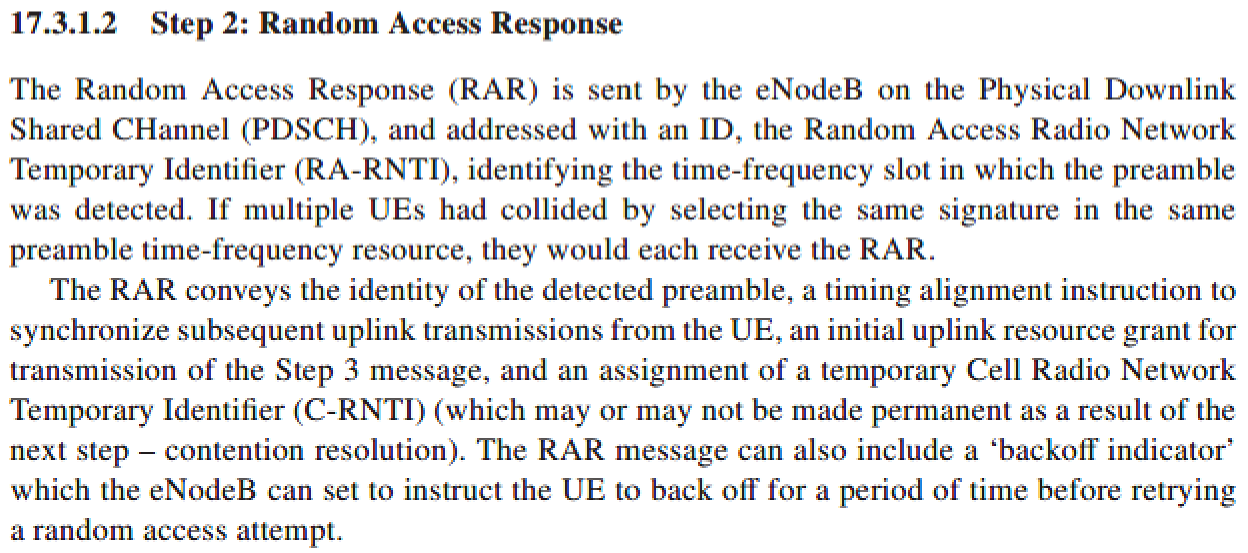
22. The mobile station of claim 21, wherein:	*See* Claim 21.

US Patent No. 10,833,908: Claim 22(b)

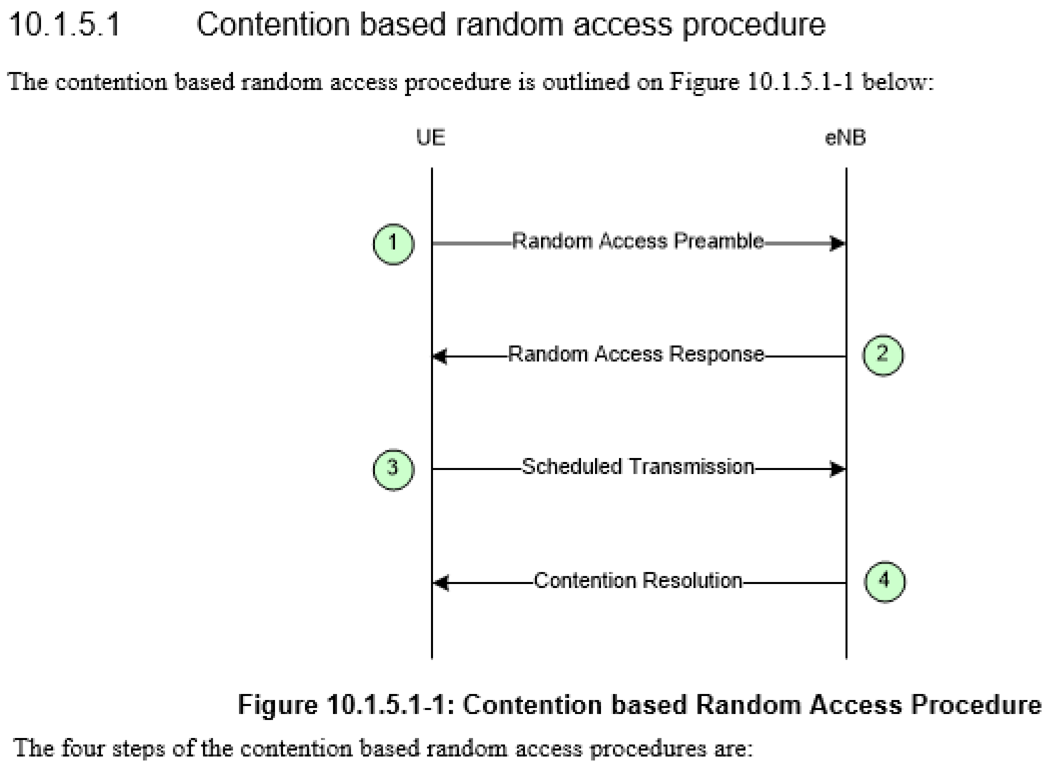
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	GM’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

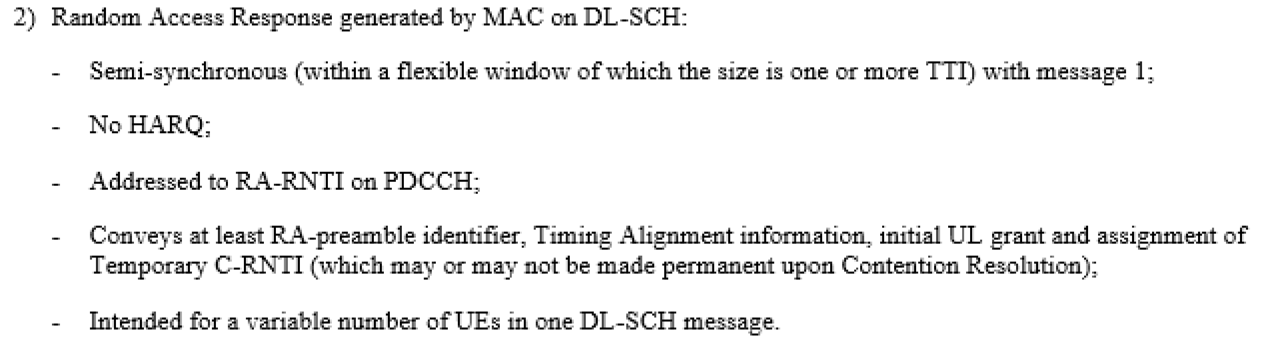
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, GM’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

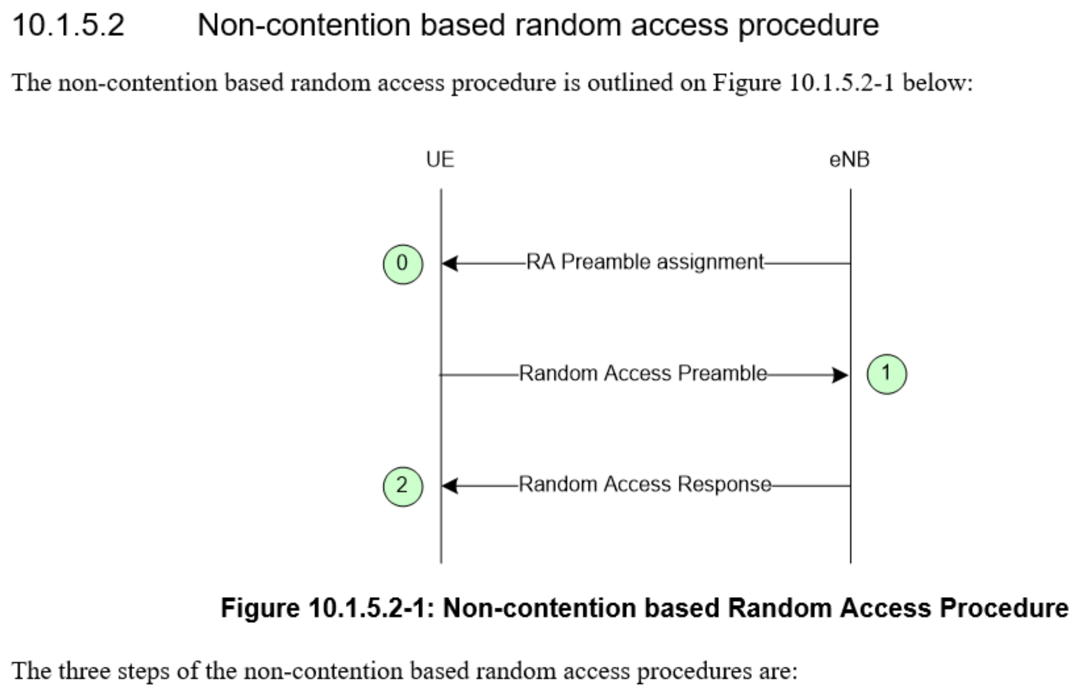
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



10.1.5.2 Non-contention based random access procedure

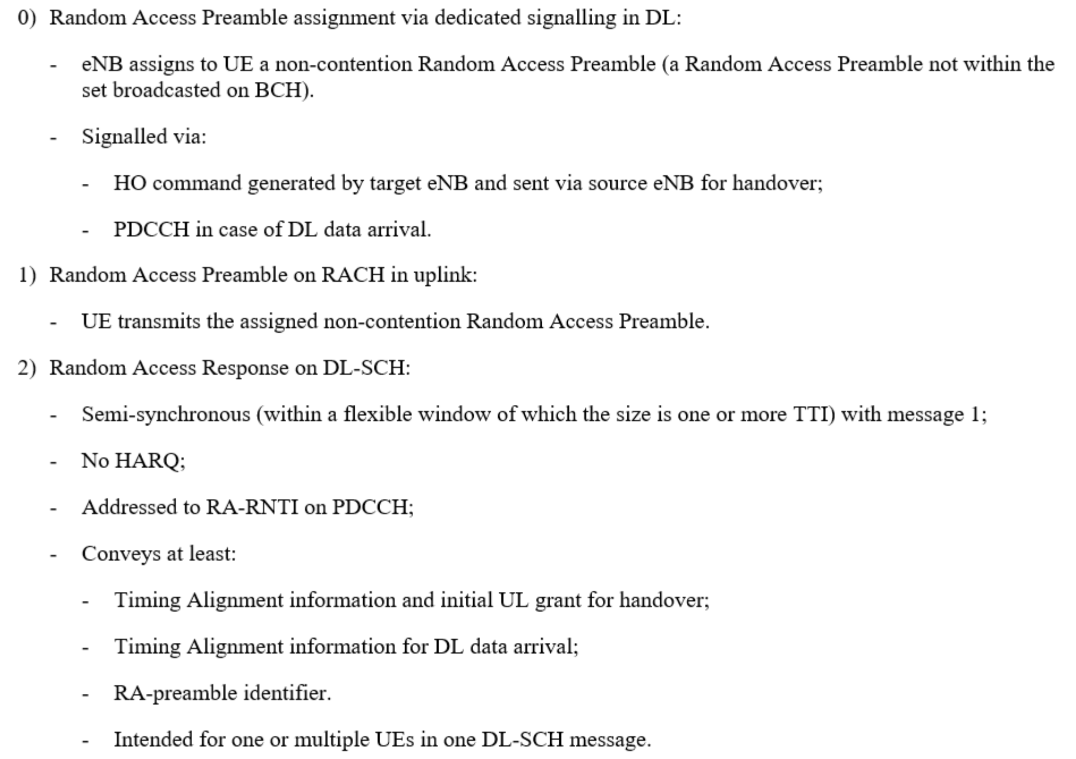
The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)

"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

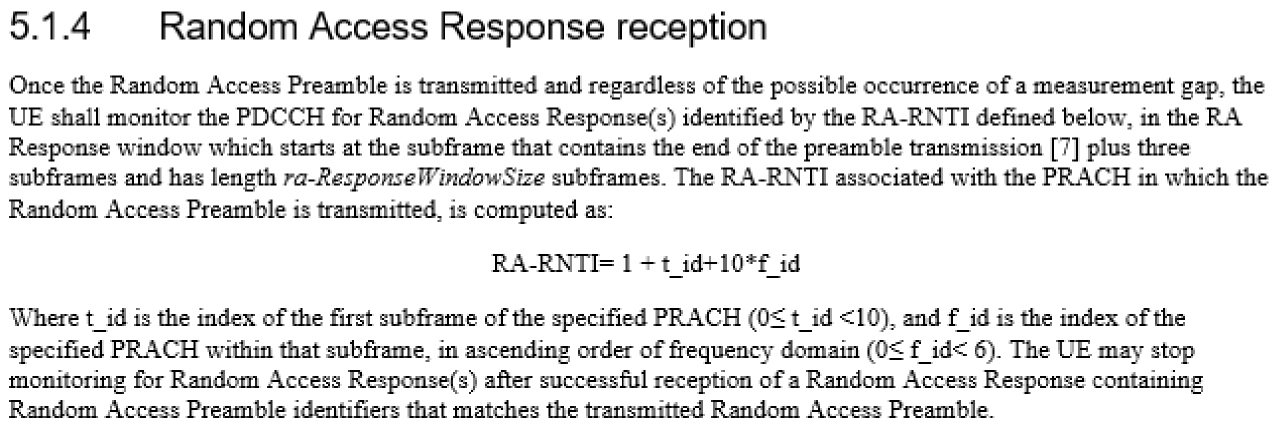
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

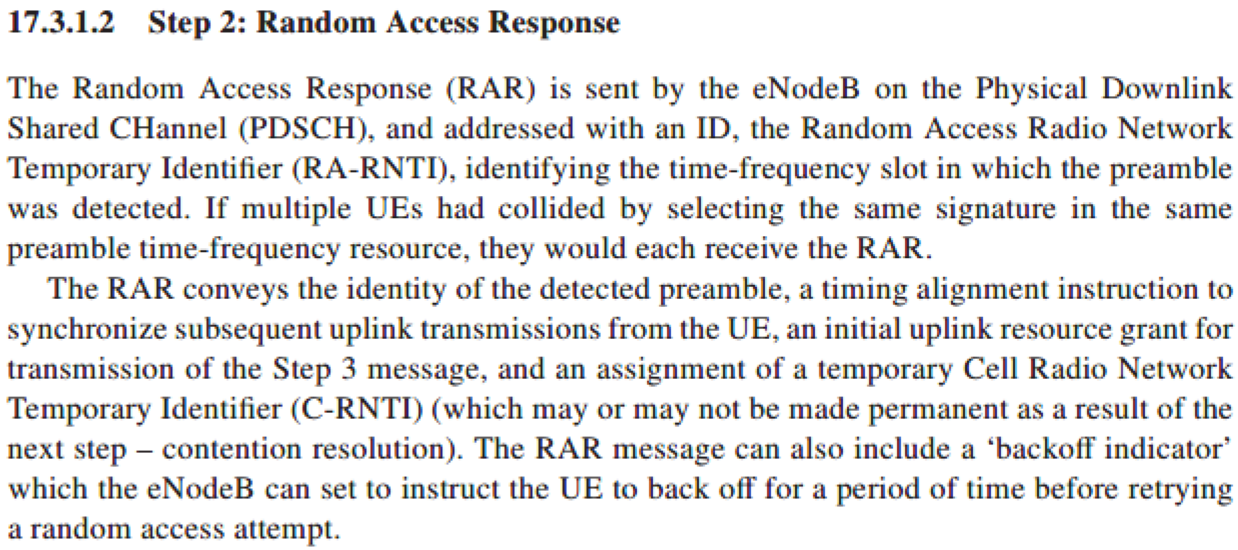
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$RA\text{-}RNTI= 1 + t\_id+10*f\_id$$

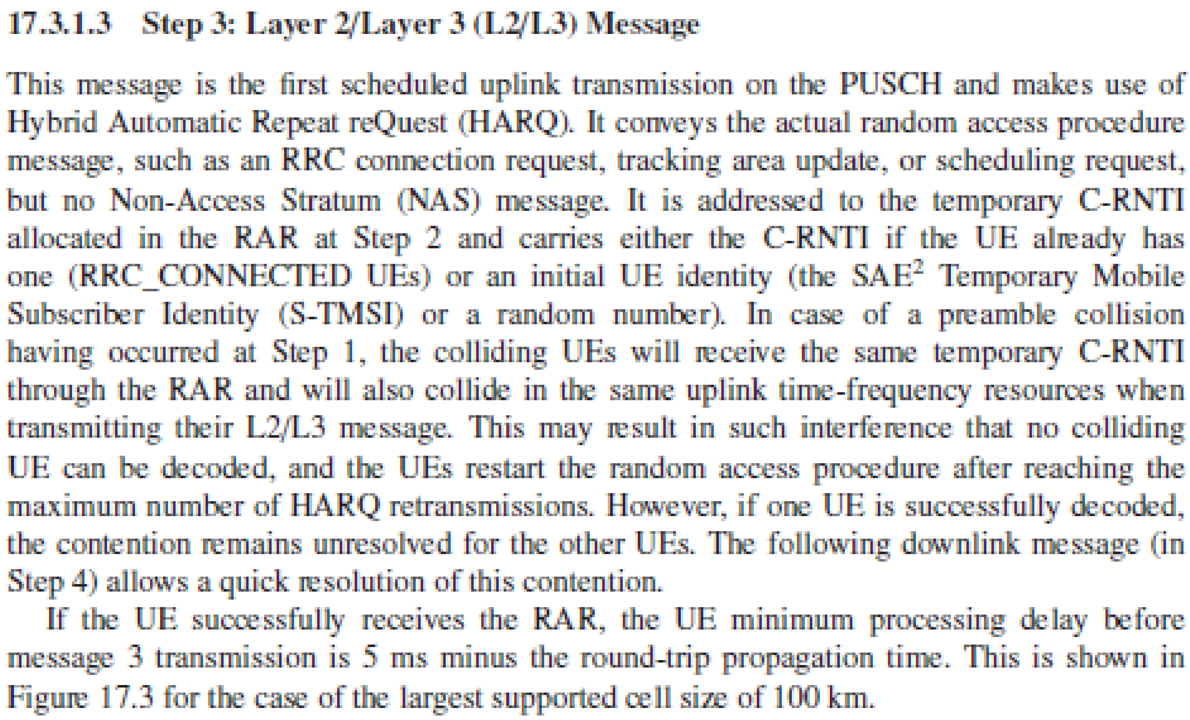
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

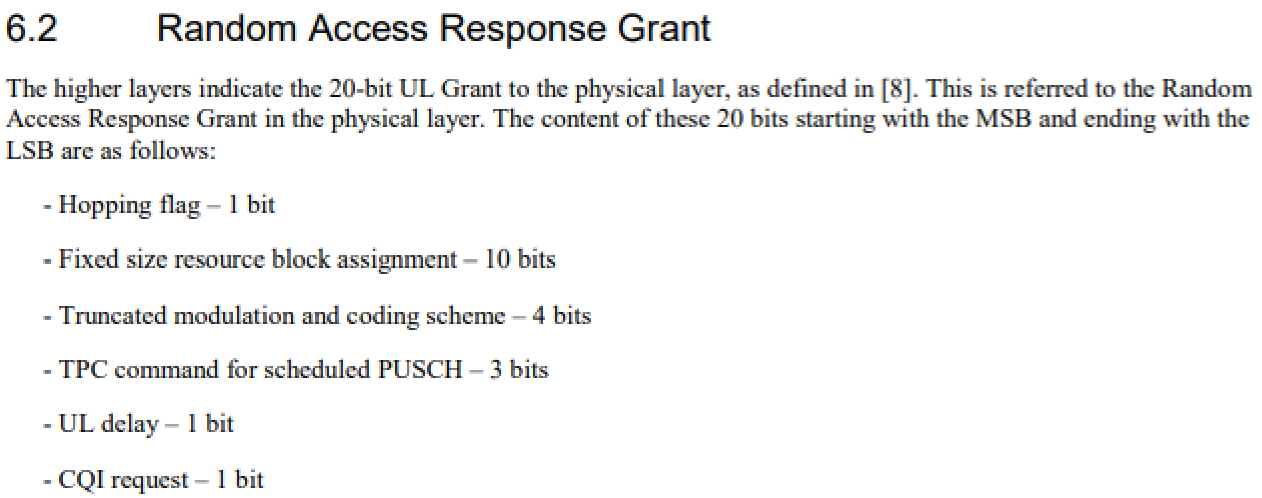
US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

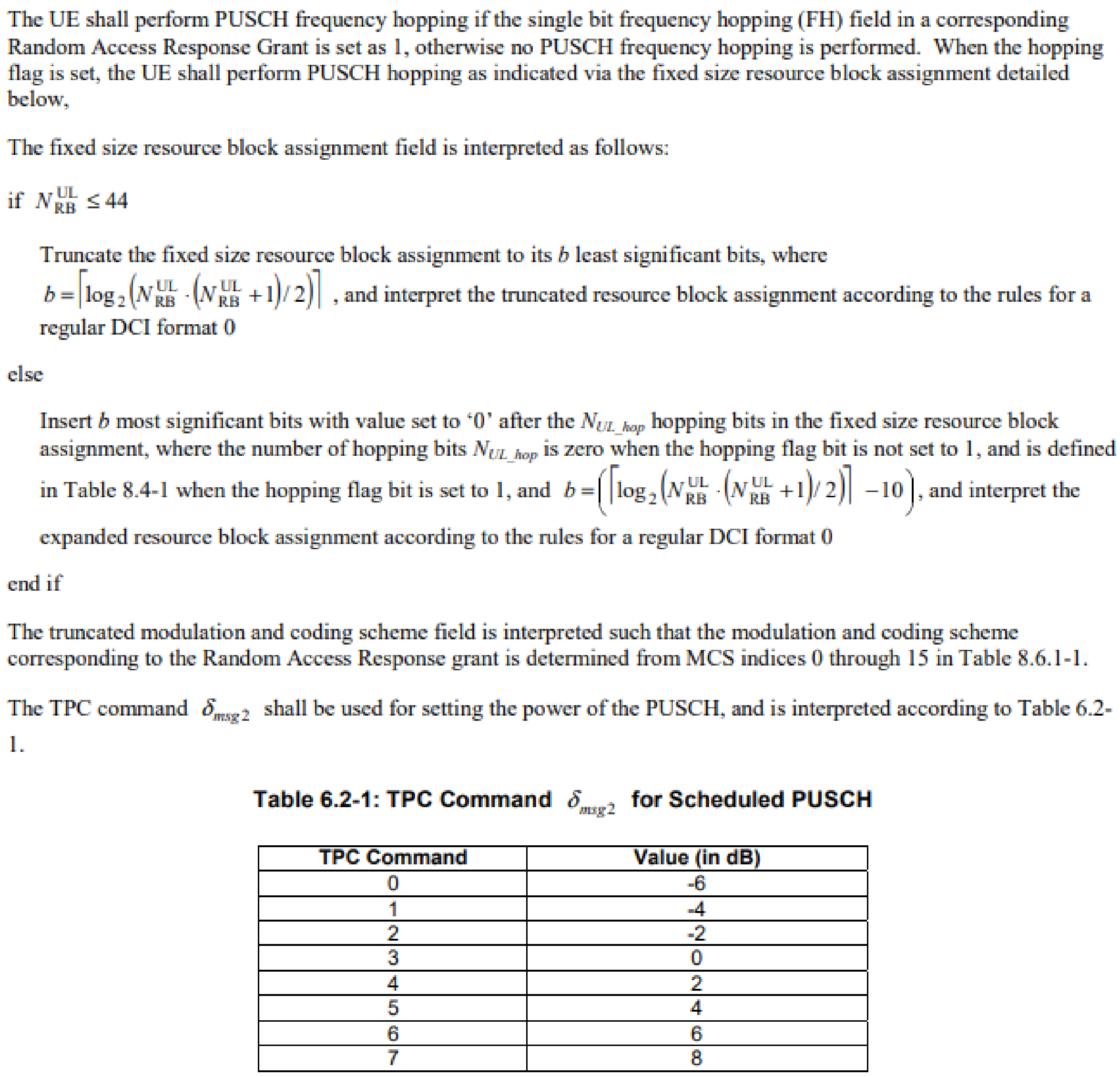
US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by GM's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
“The mobile station of claim 22, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

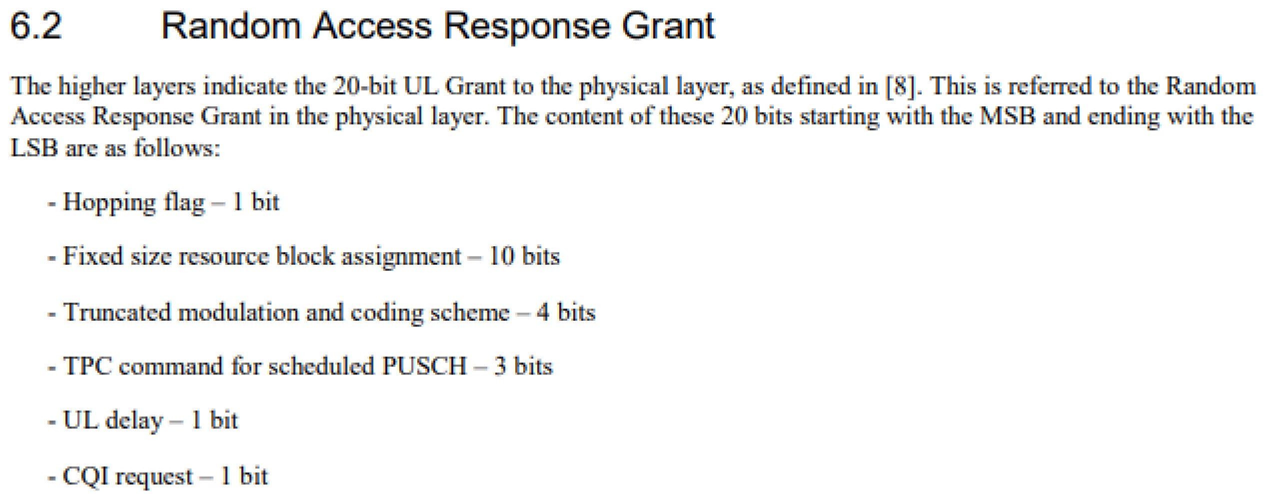
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

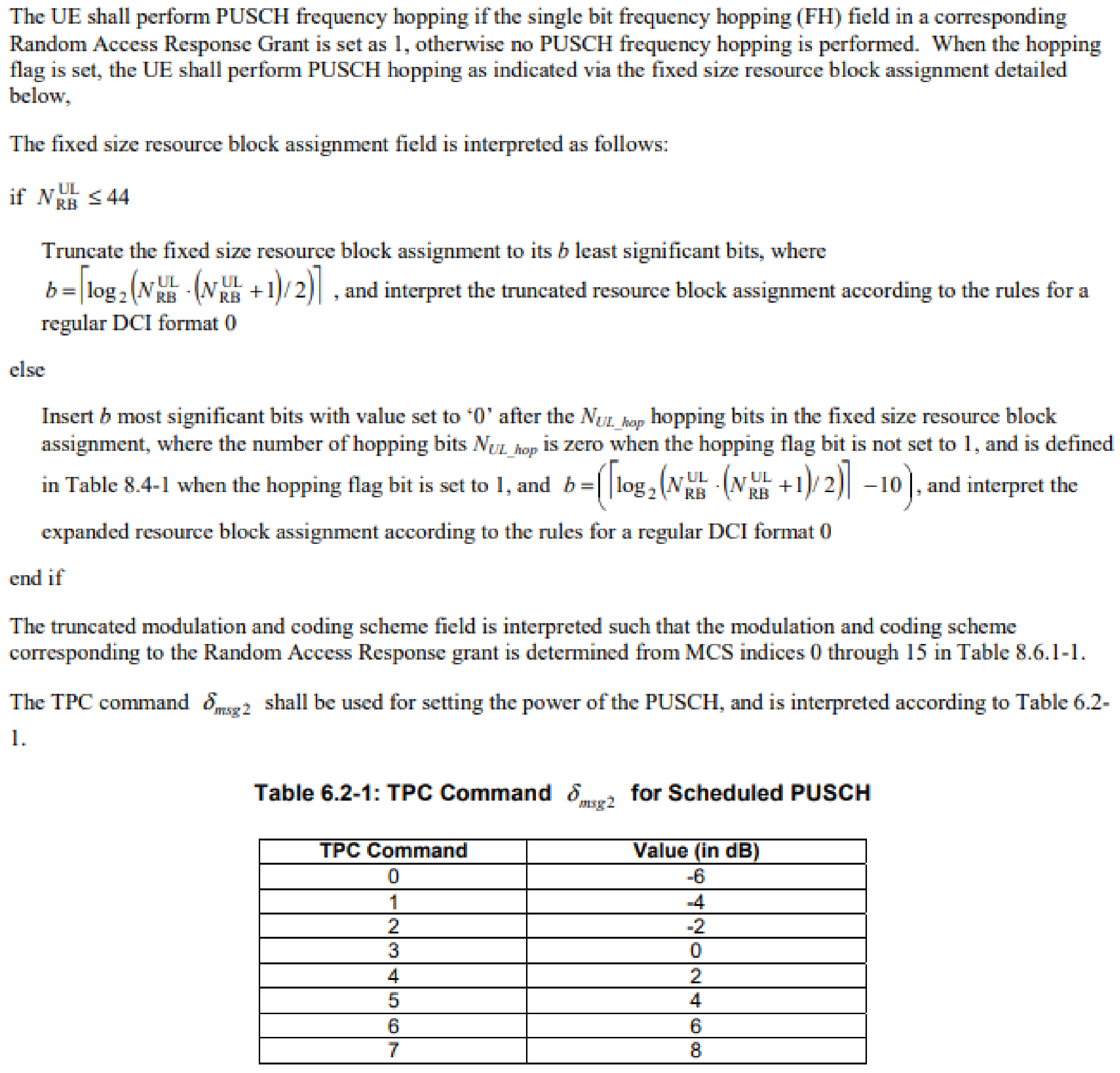
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	GM’s Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

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TPC Command	Value (in dB)
0	-6
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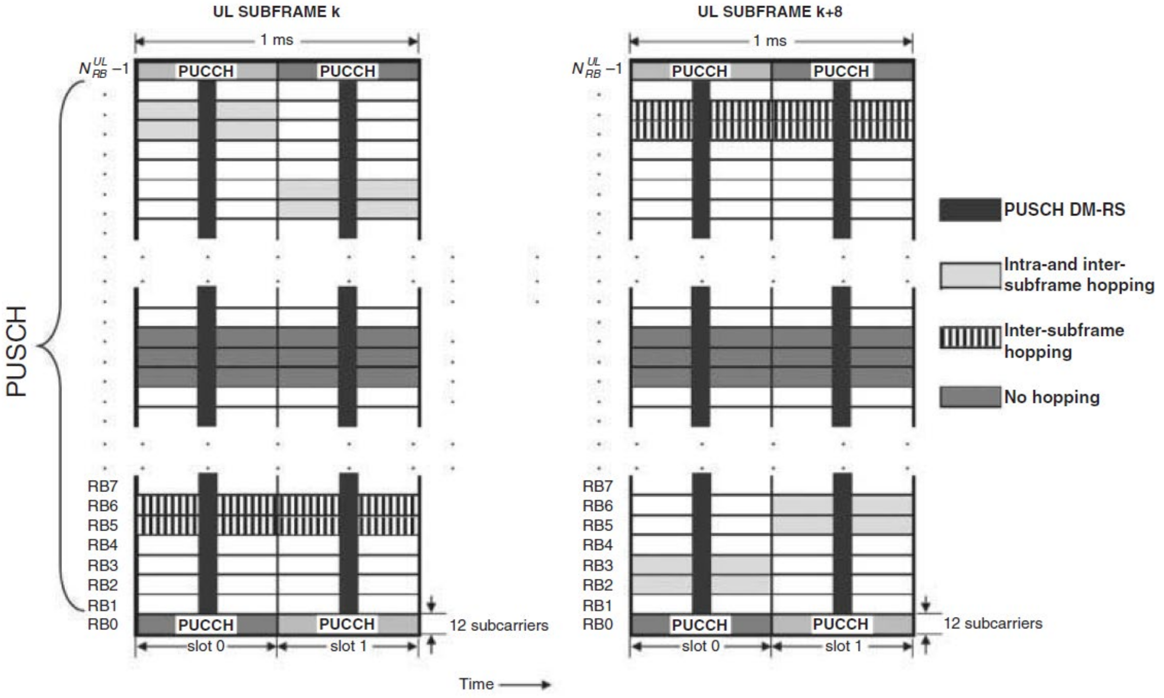
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

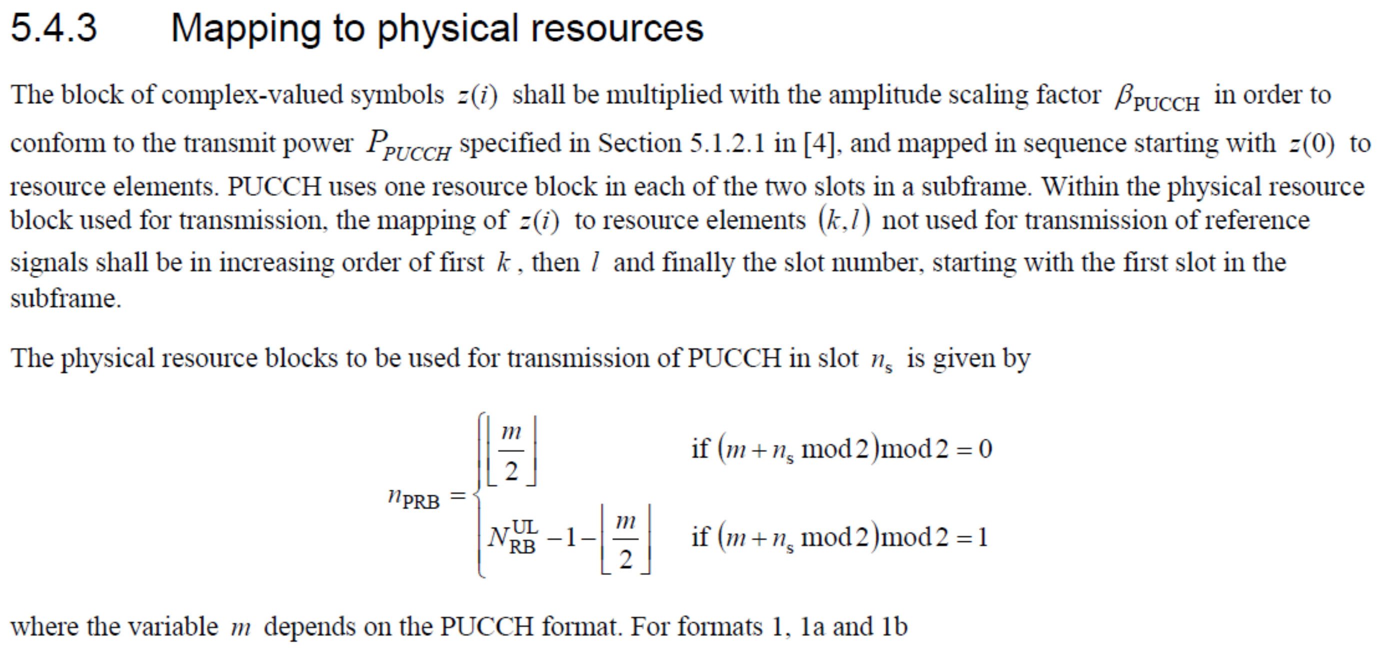
US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by GM’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 24
" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

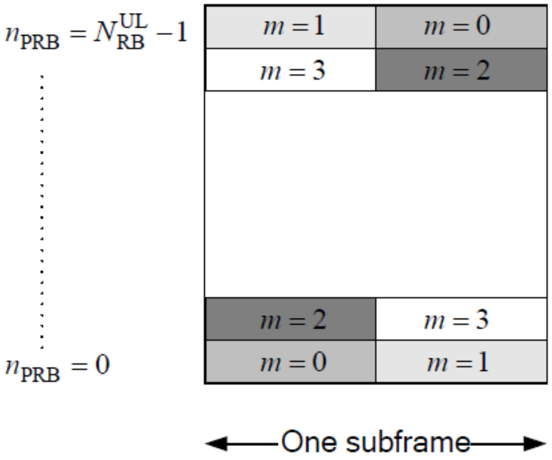
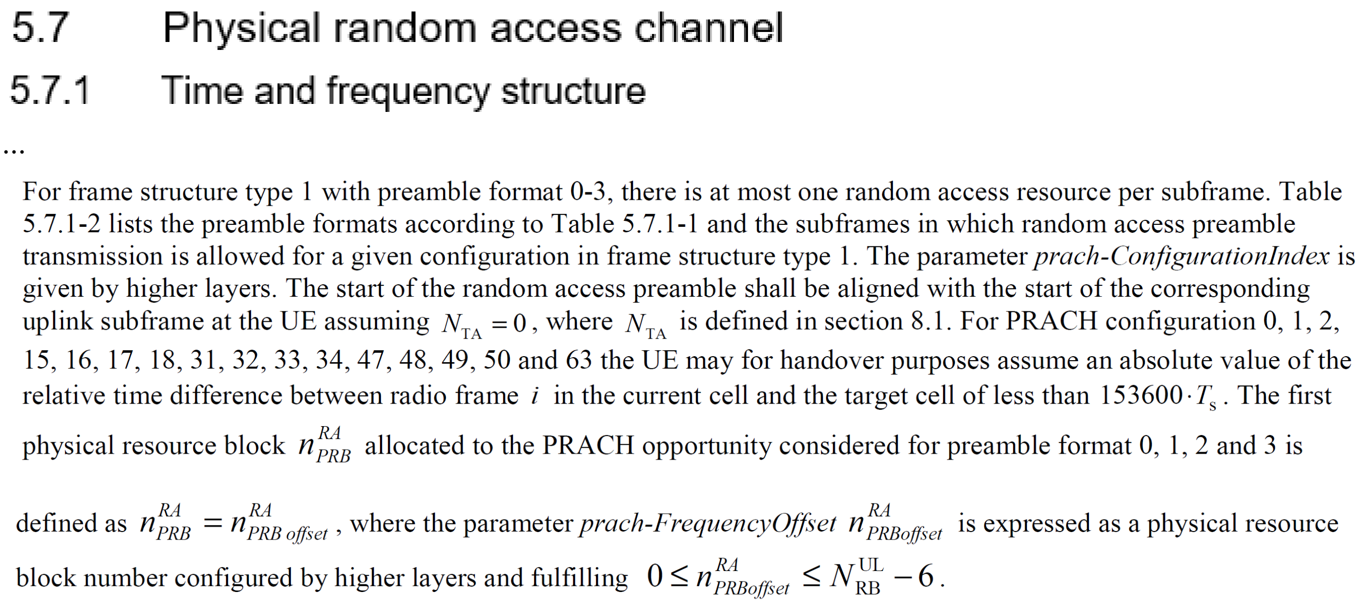


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

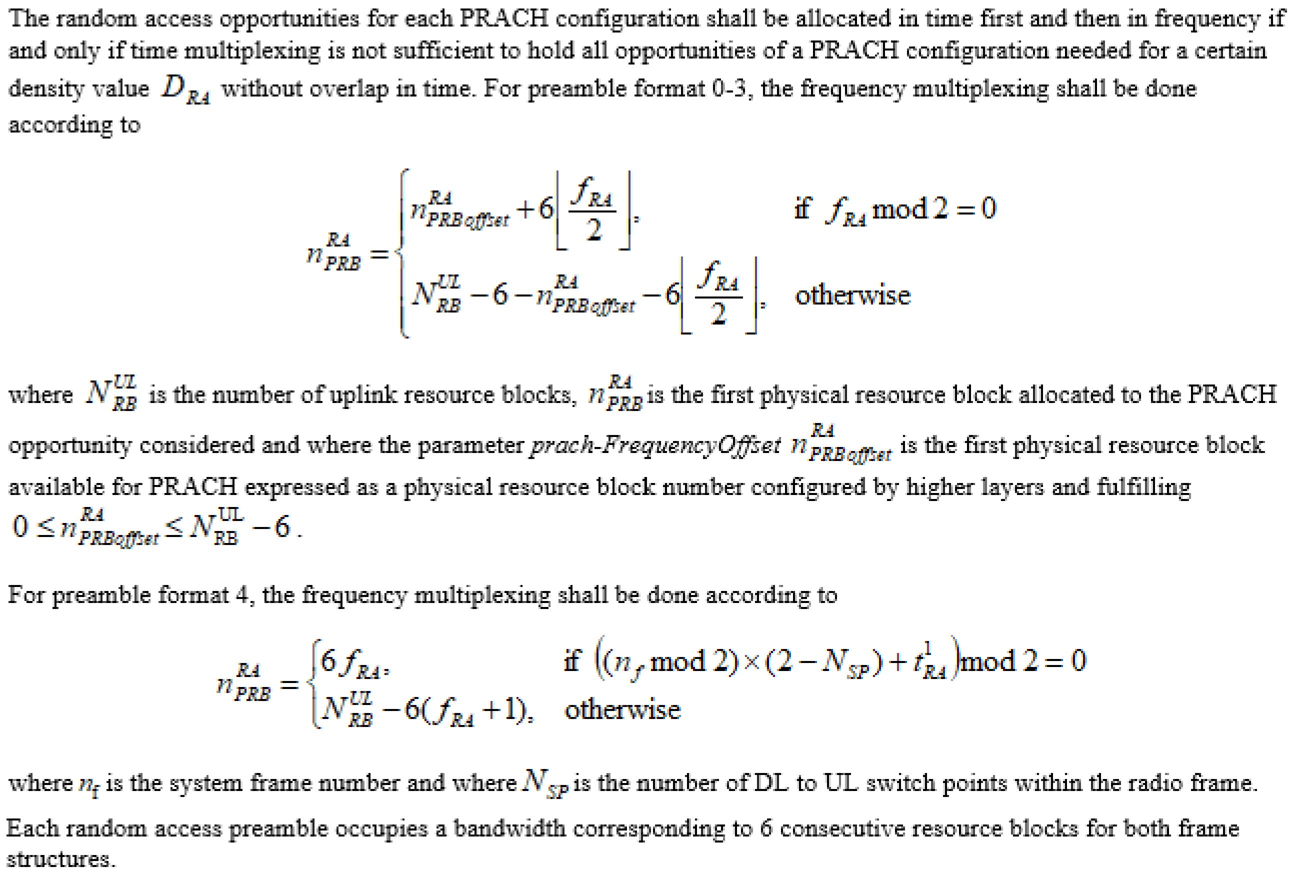
...

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 24

" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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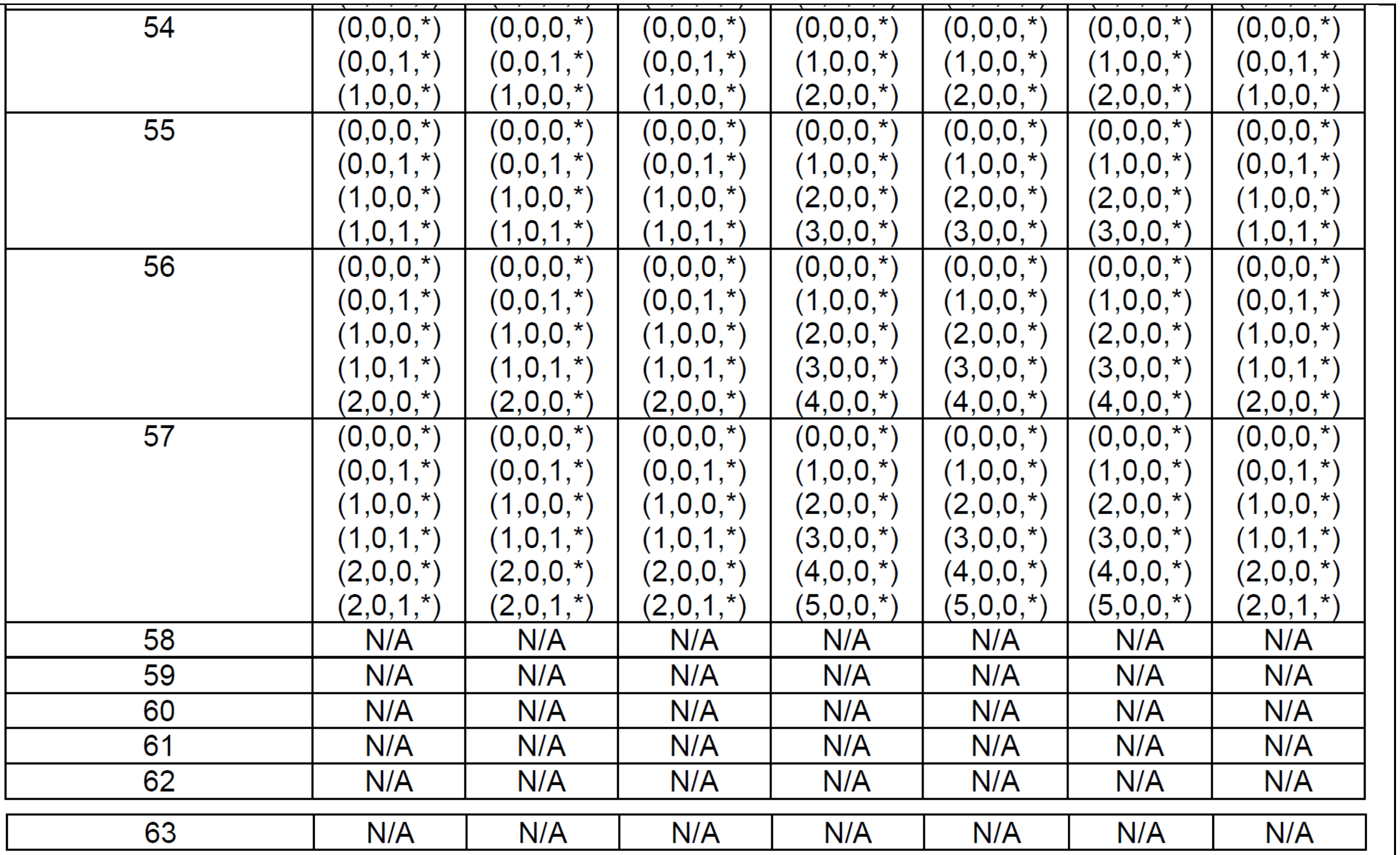
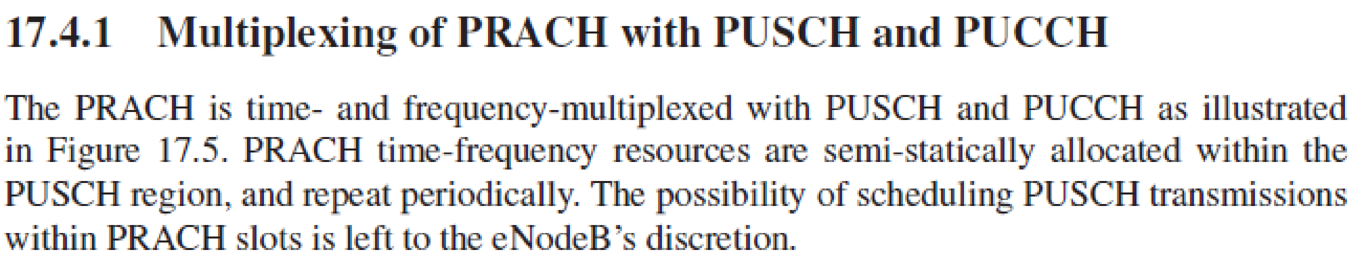
US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

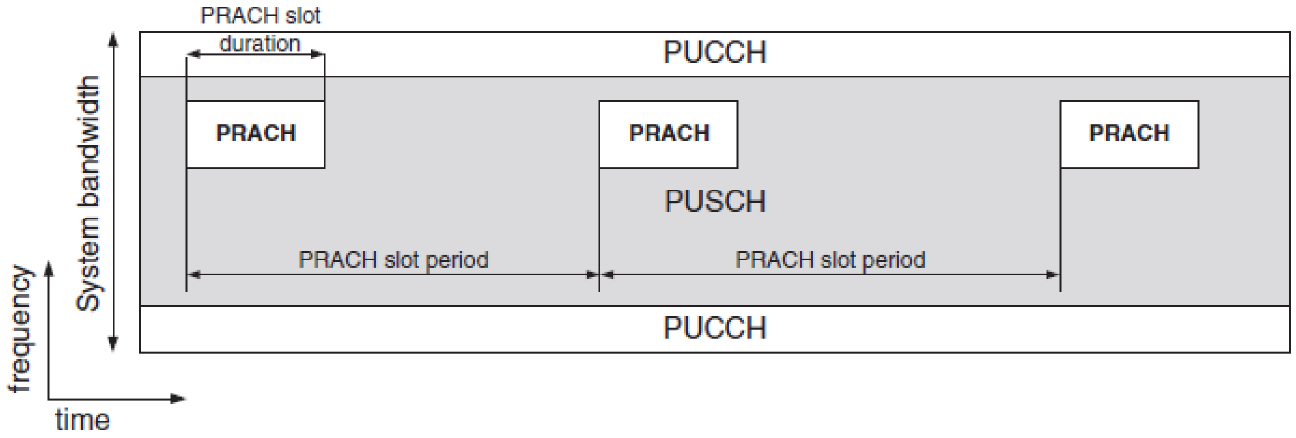
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

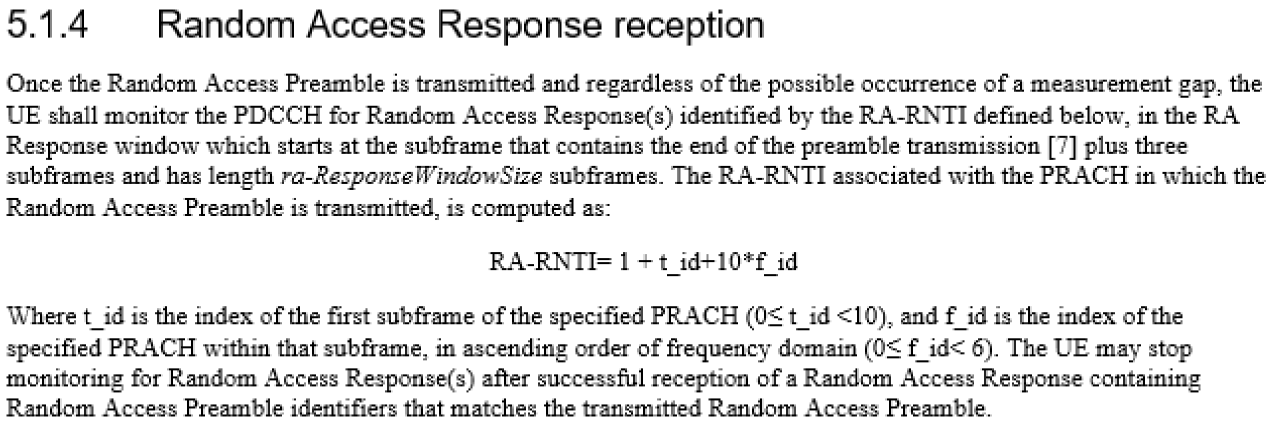
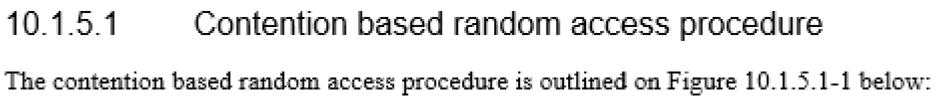
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

<table>
<tr>
<td></td>
<td>
Figure 17.5: PRACH multiplexing with PUSCH and PUCCH.
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5.

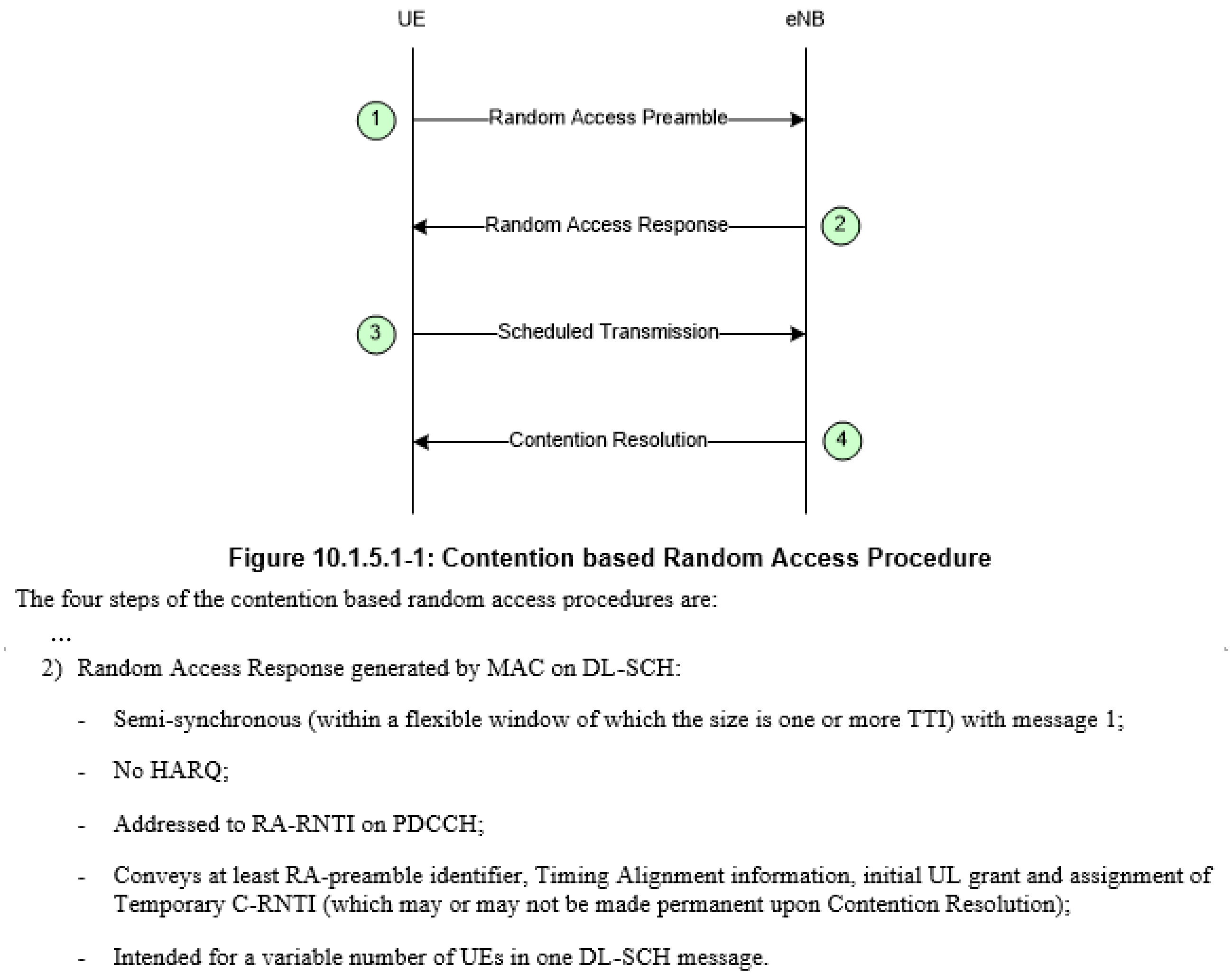
See also Claim 4.</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of GM's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

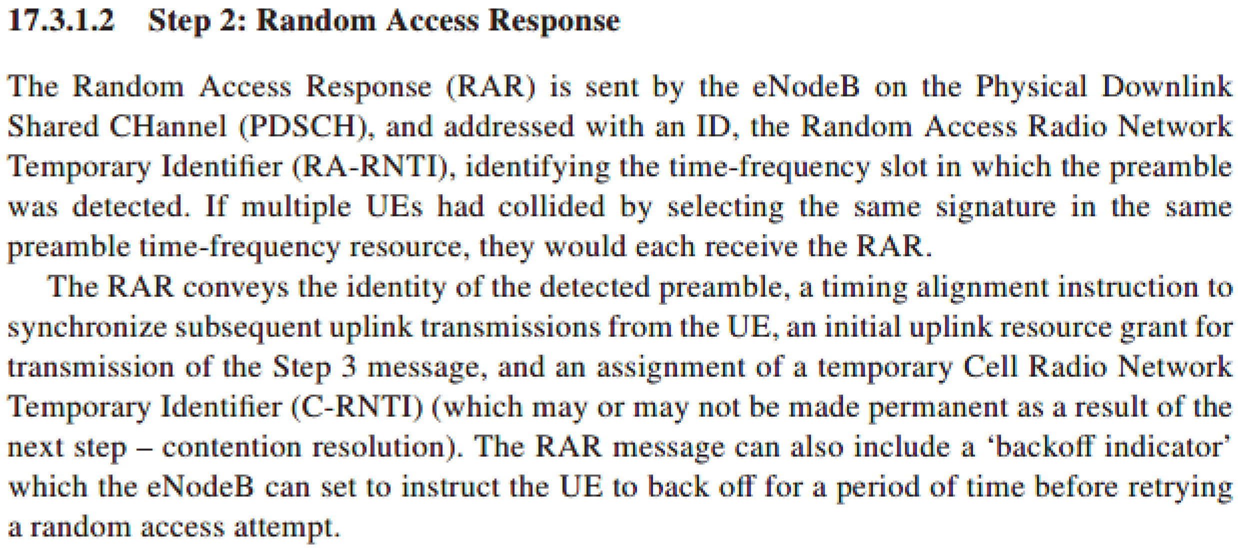
US Patent No. 10,833,908: Claim 25

“25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: ... 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

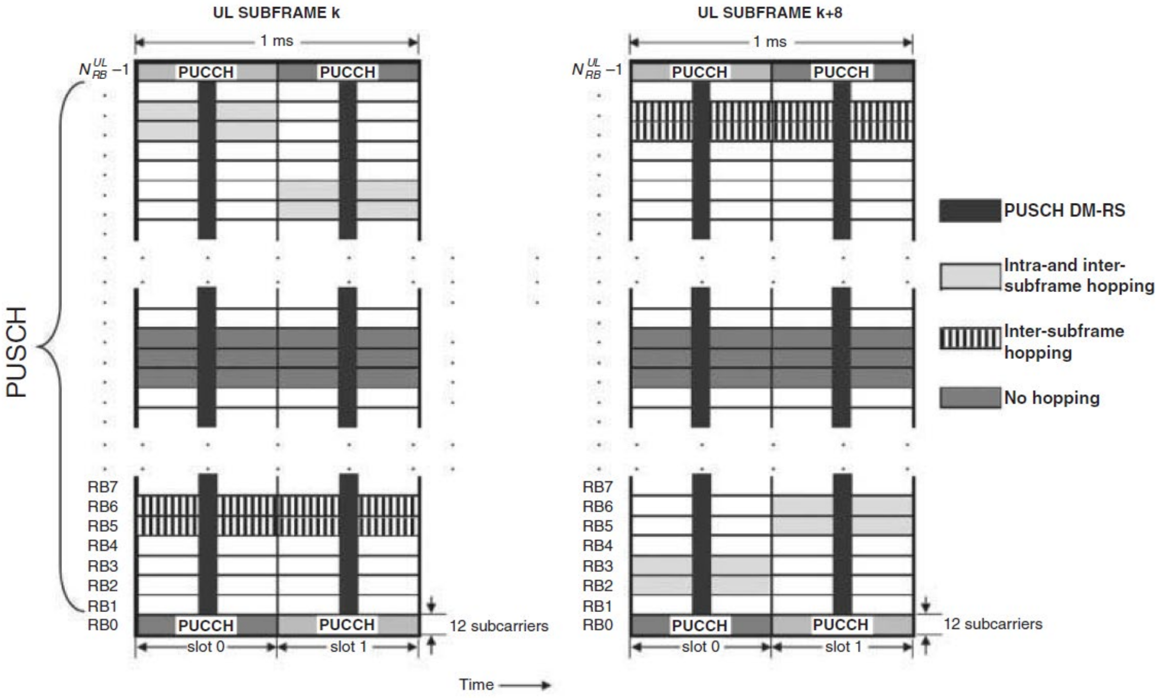
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with GM's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

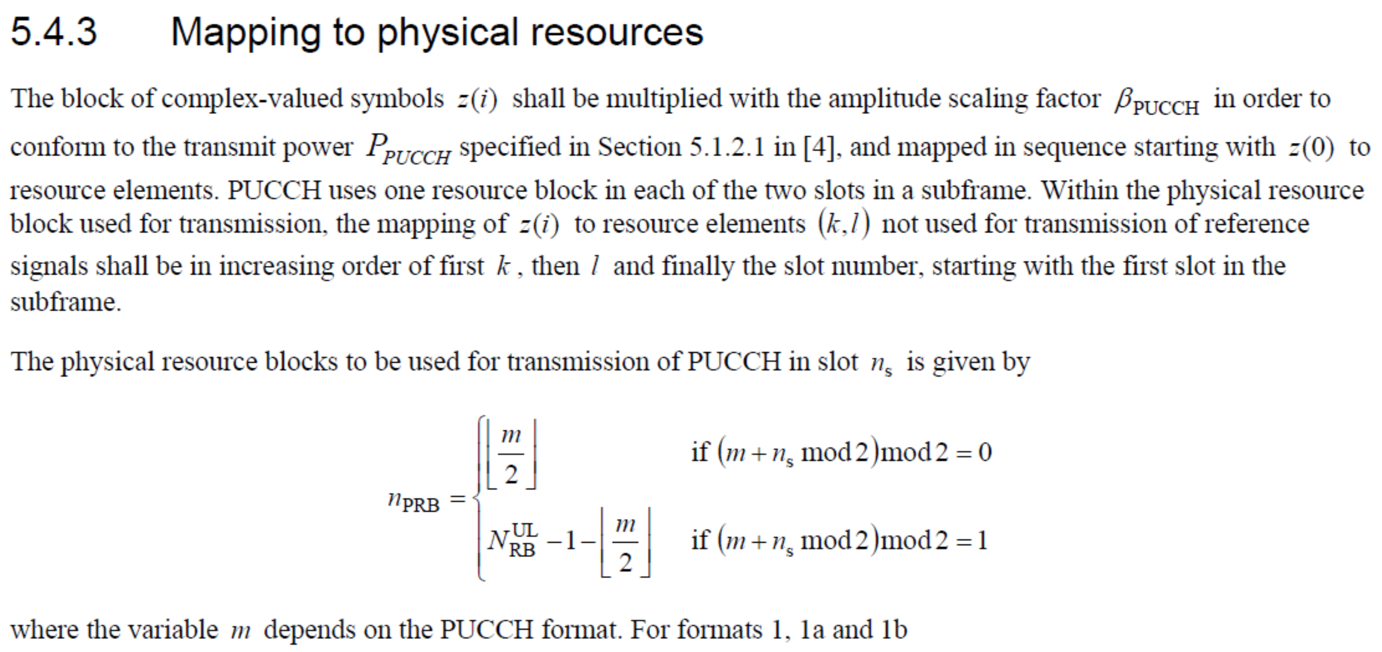
27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with GM's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

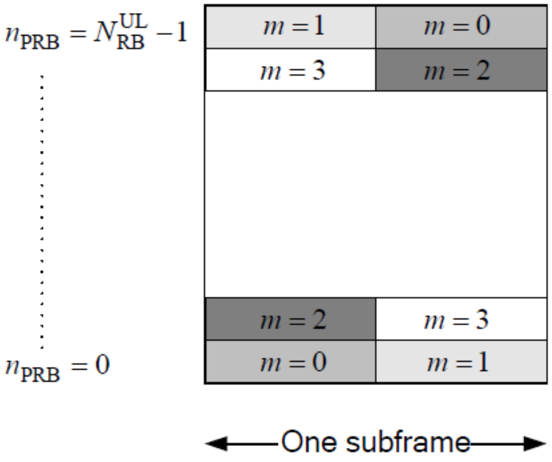


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

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“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

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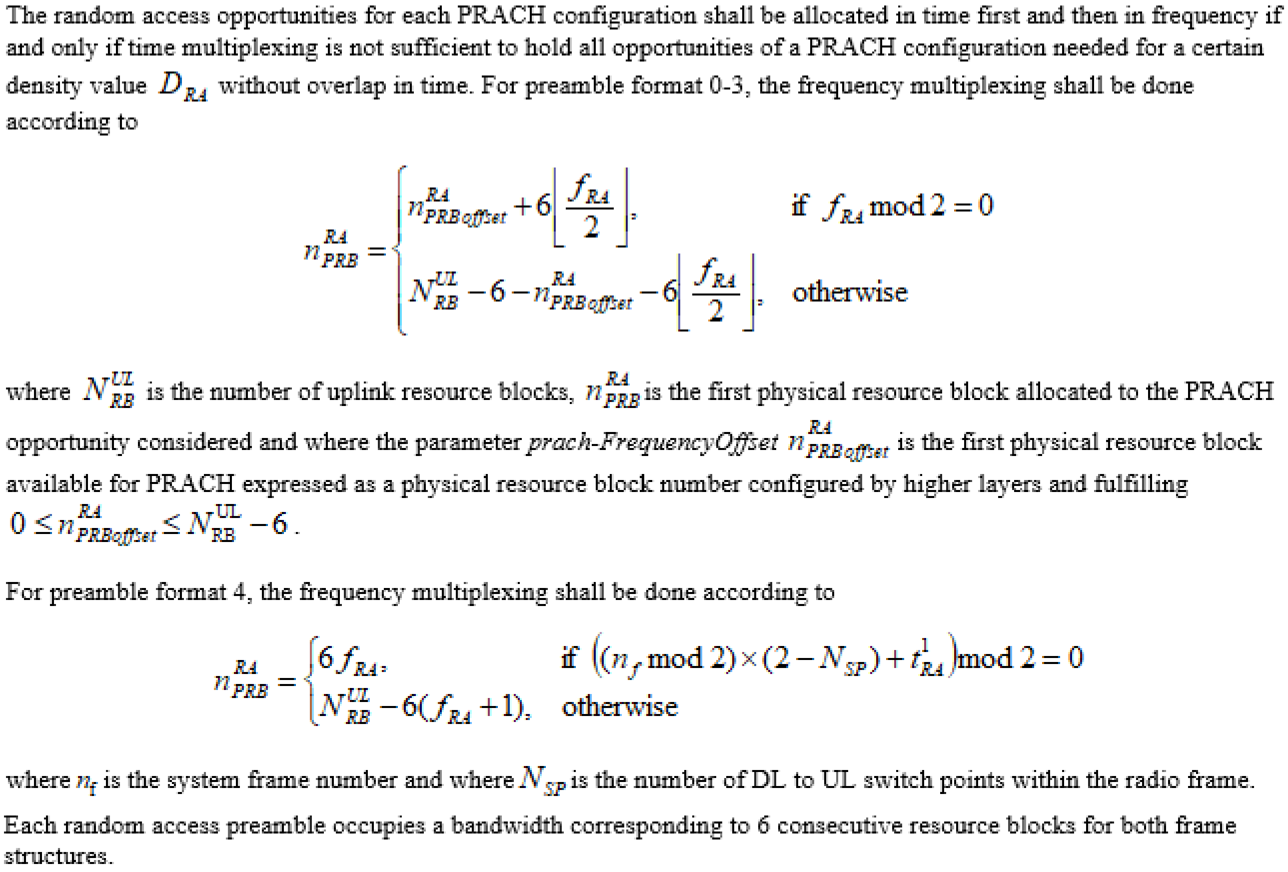
“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

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“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

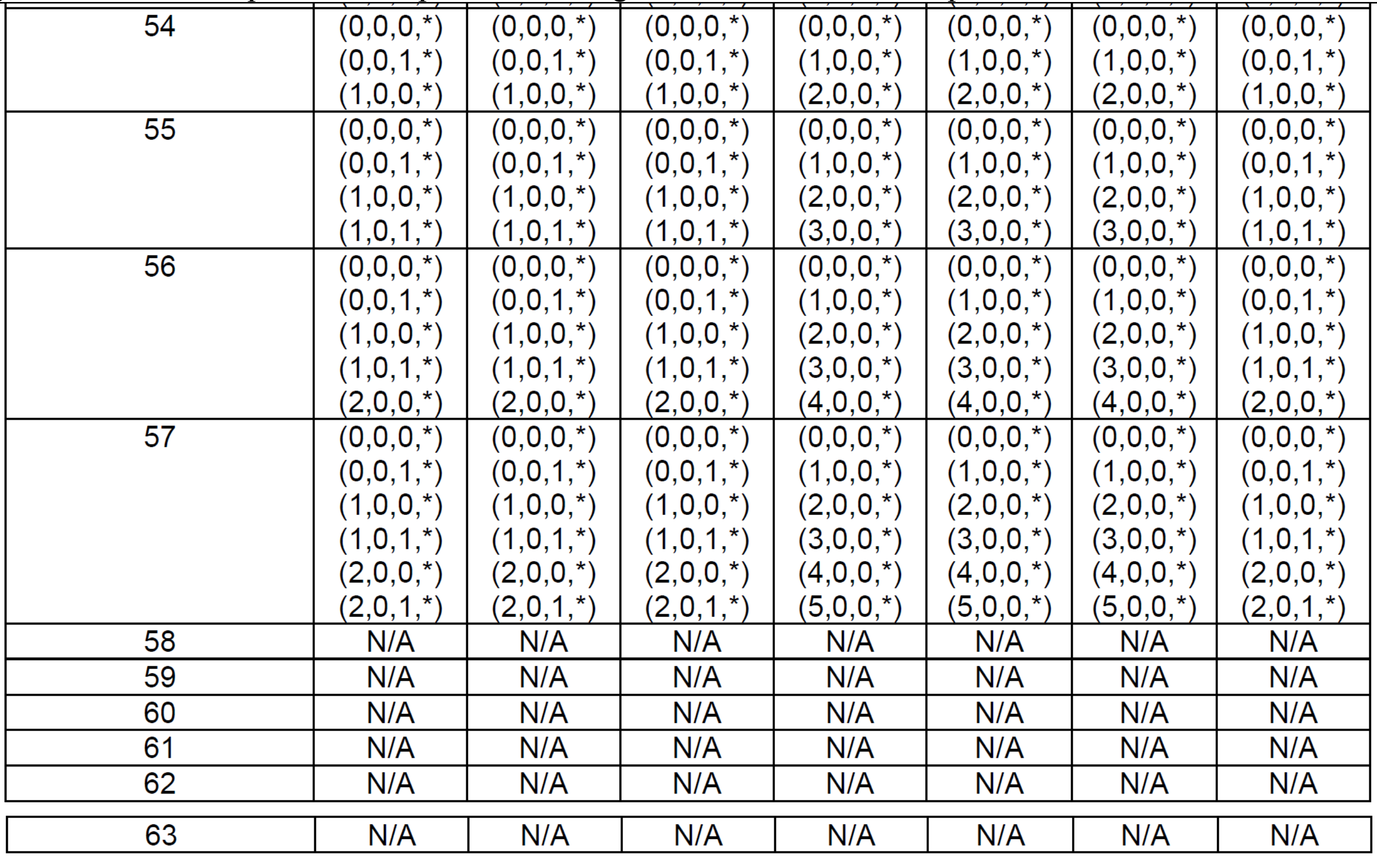
Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.
.
.

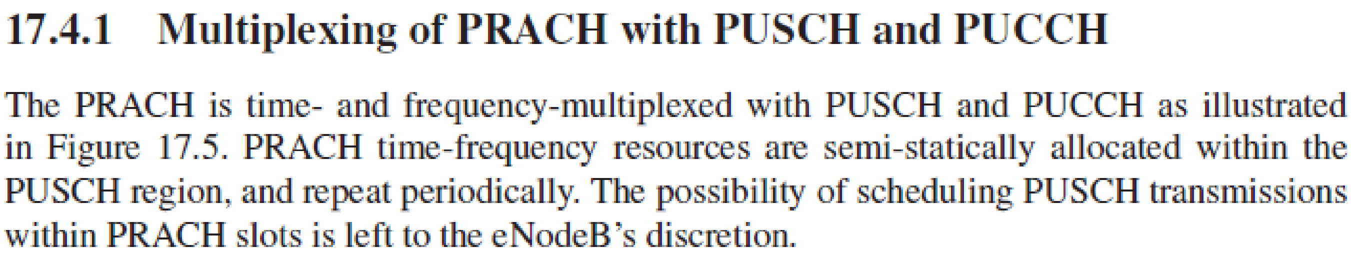
US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

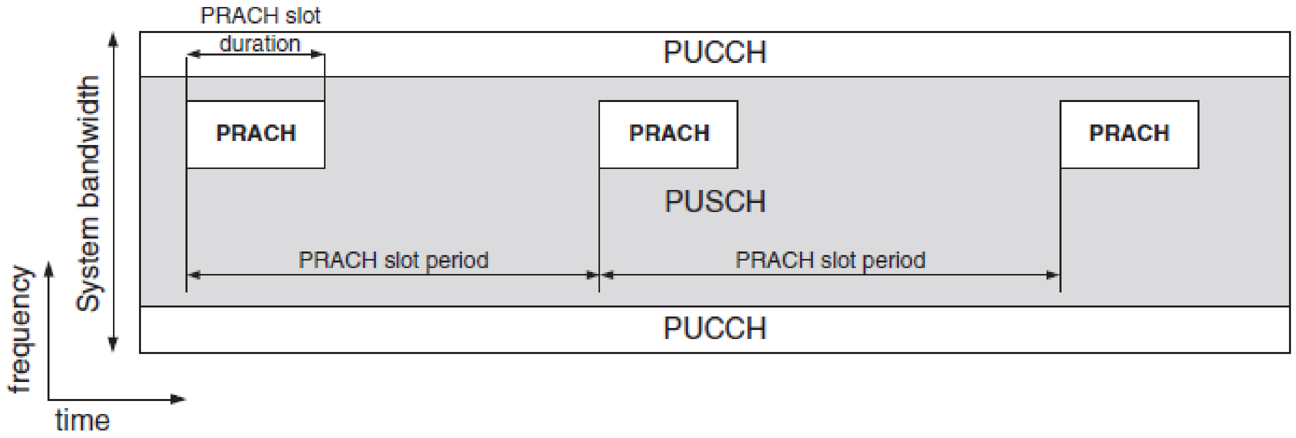
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

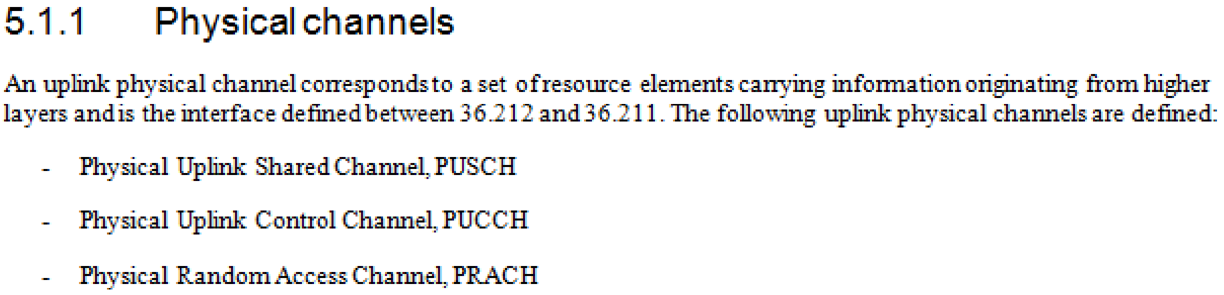
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

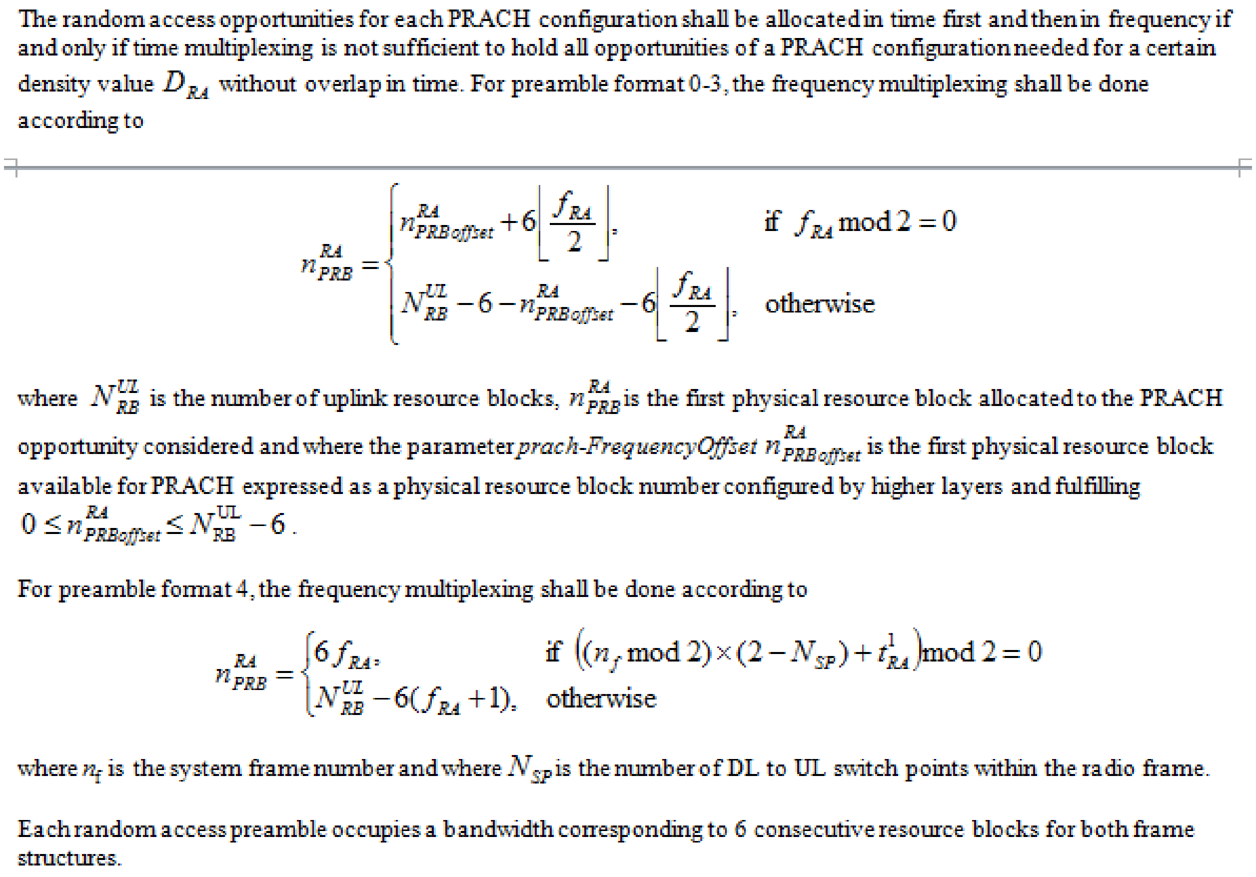
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

US Patent No. 10,833,908: Claim 28

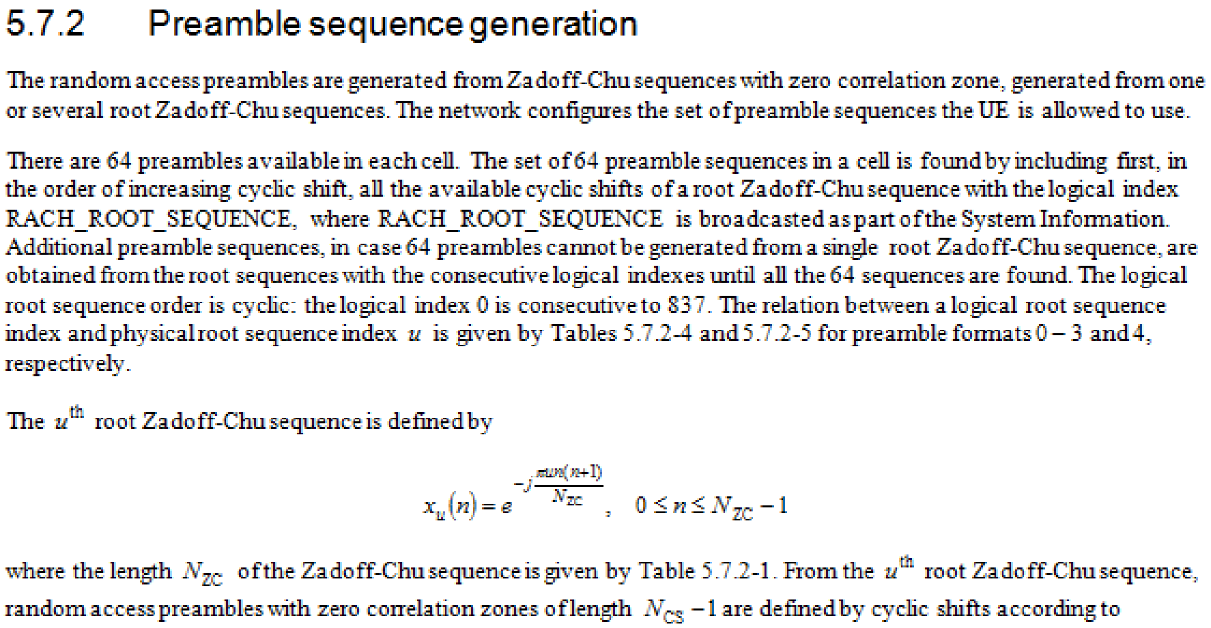
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with GM’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB. 5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n)=e^{-j\frac{\pi un(n+1)}{N_{ZC}}},\quad 0\le n\le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

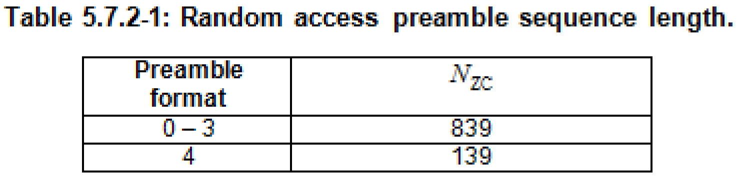
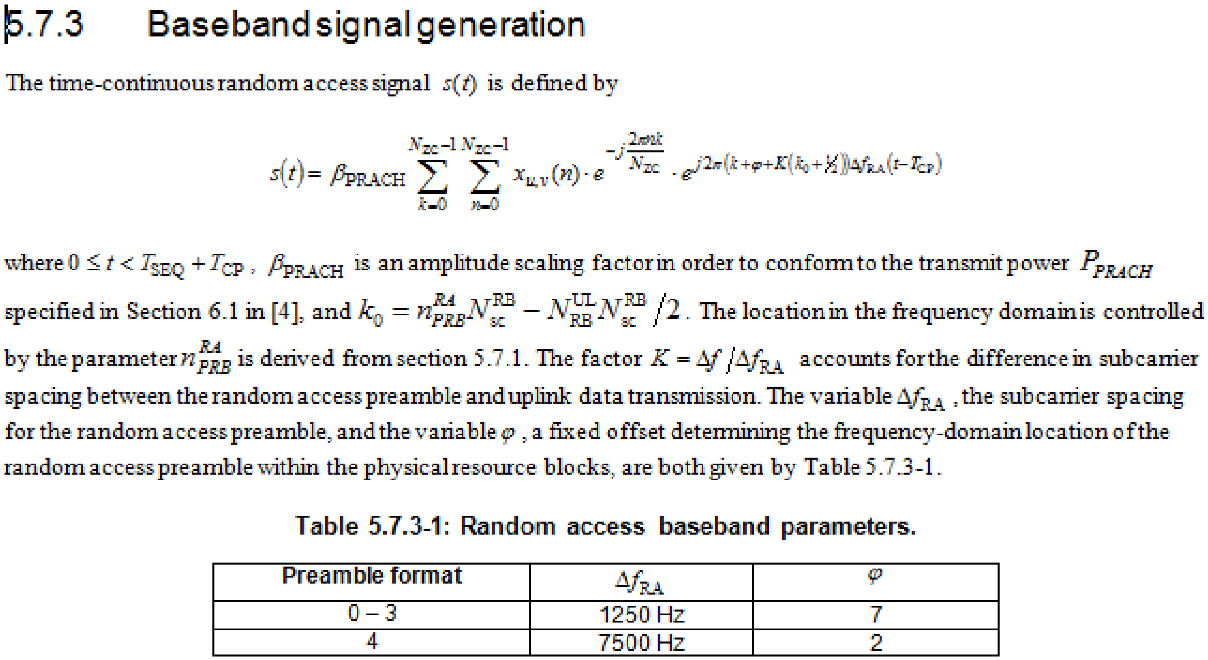


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

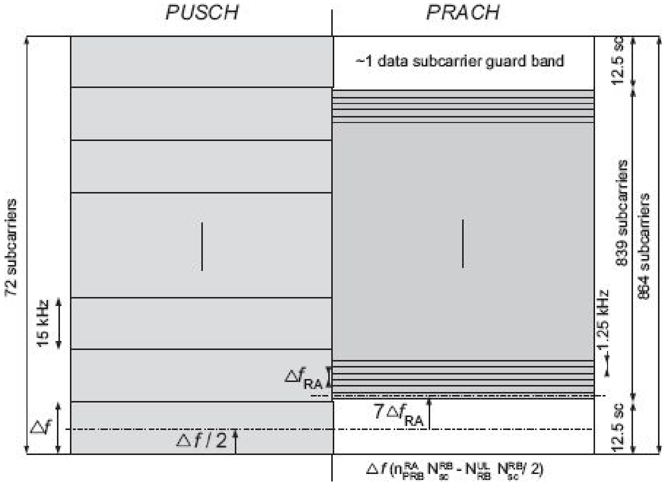
where $0\leq t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

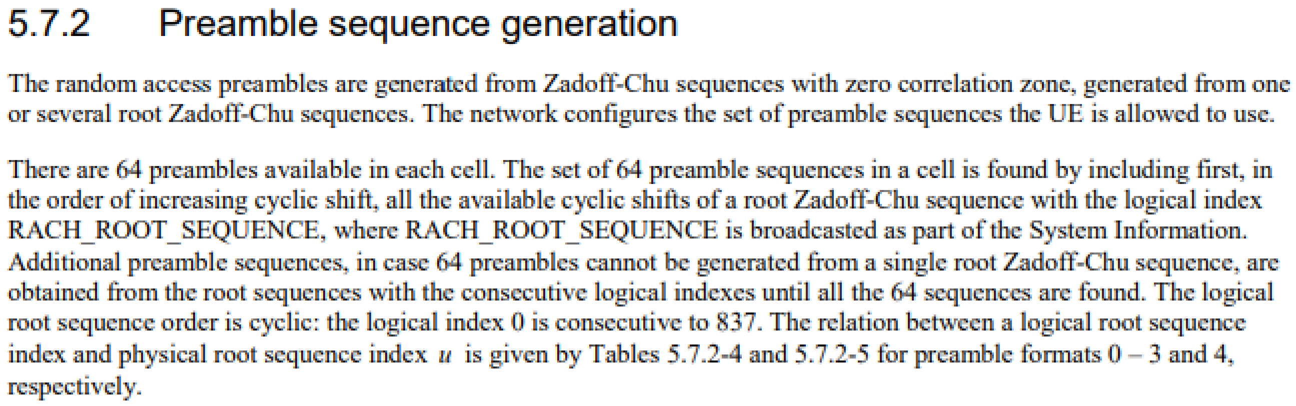
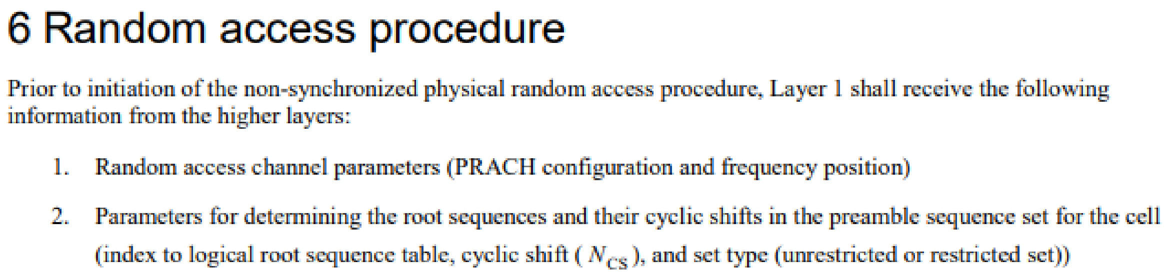
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of GM’s Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

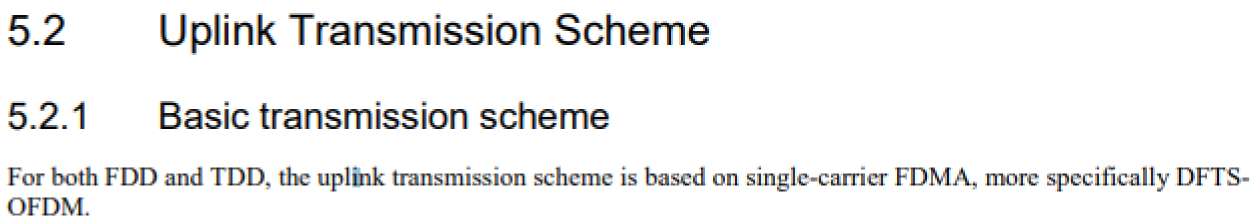
RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

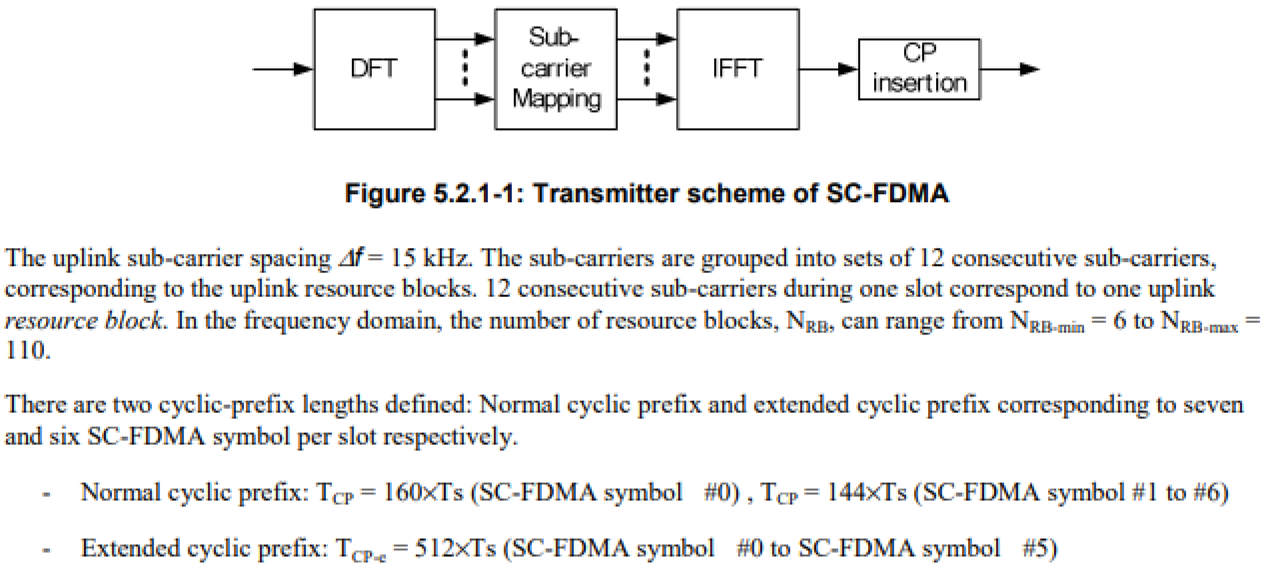
US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 GM’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* GM’s Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

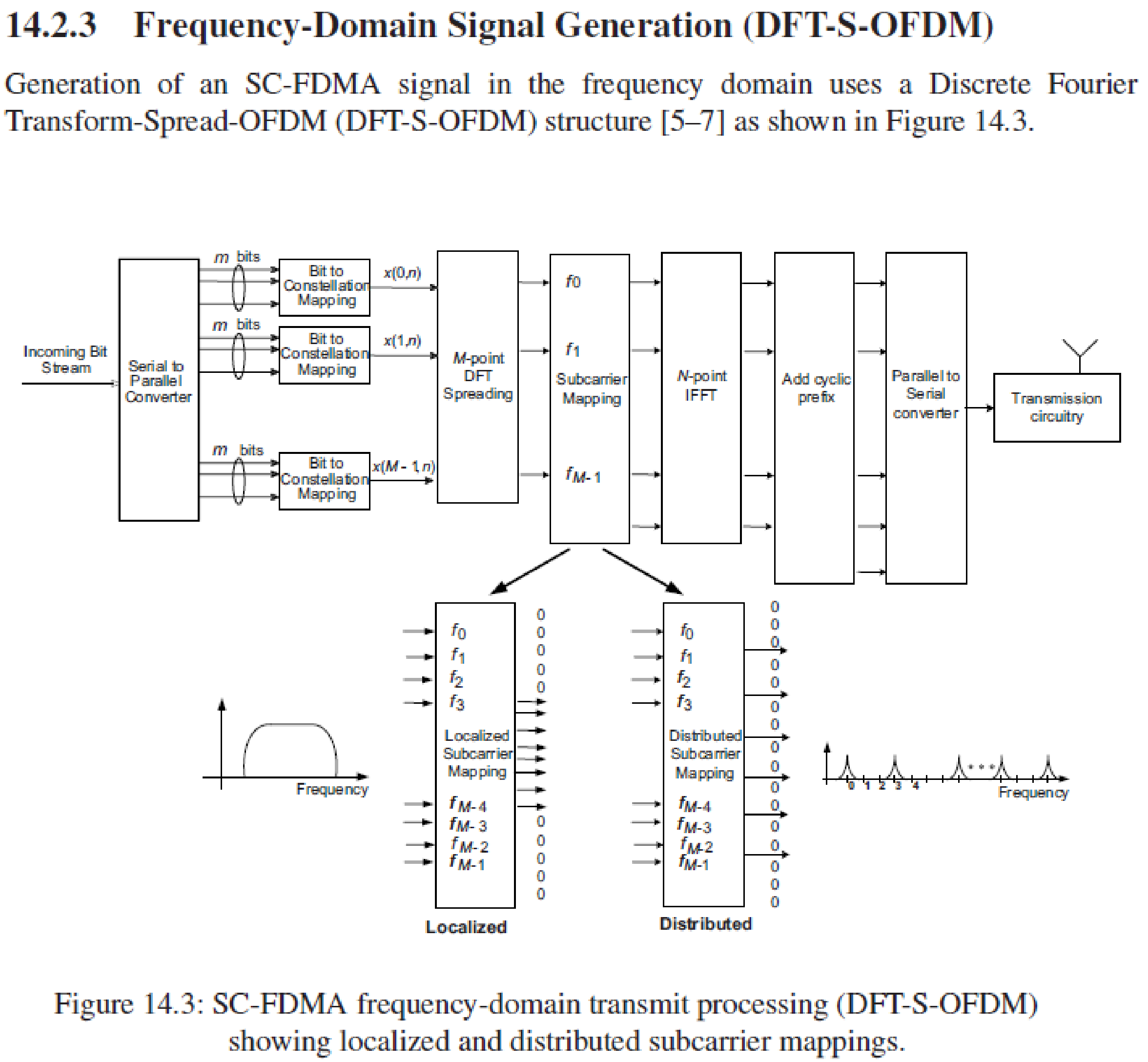
US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

	 **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160\times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144\times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512\times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

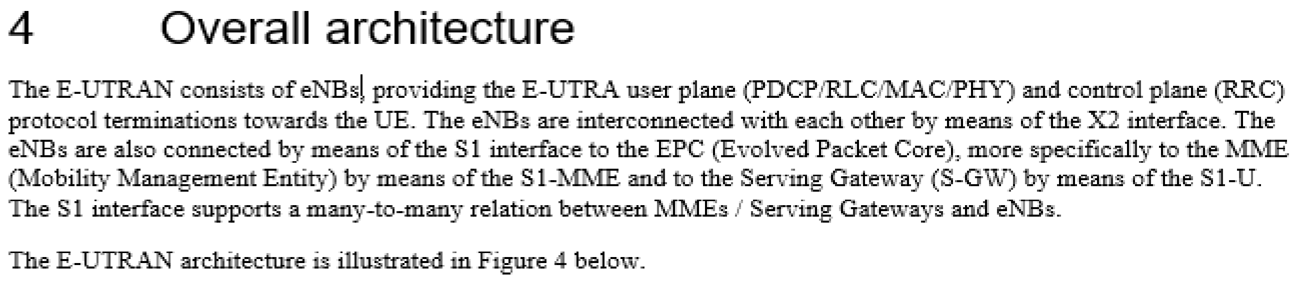
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

See also Claim 10.

Plaintiff's Infringement Contentions to Tesla

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, Tesla's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* Tesla's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Tesla offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

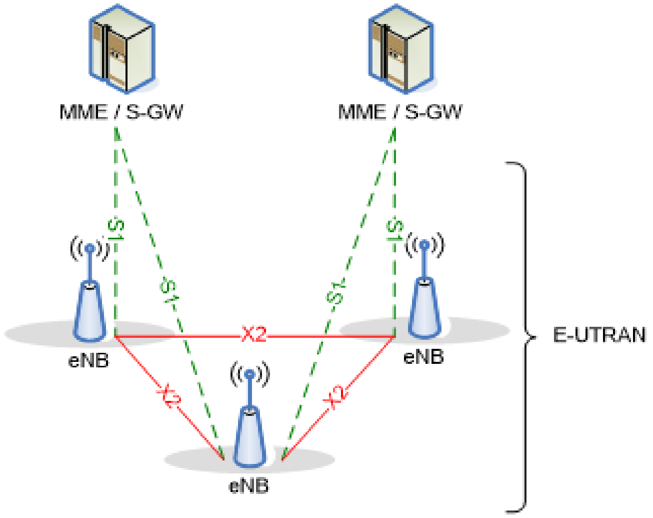
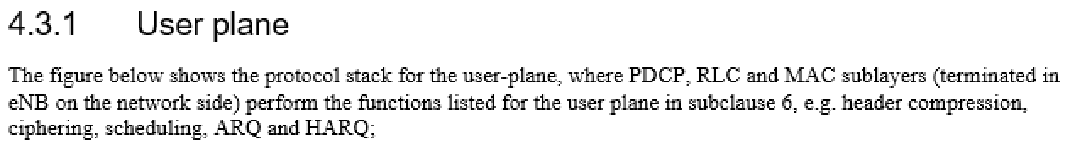


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

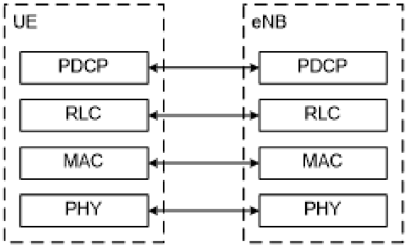


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

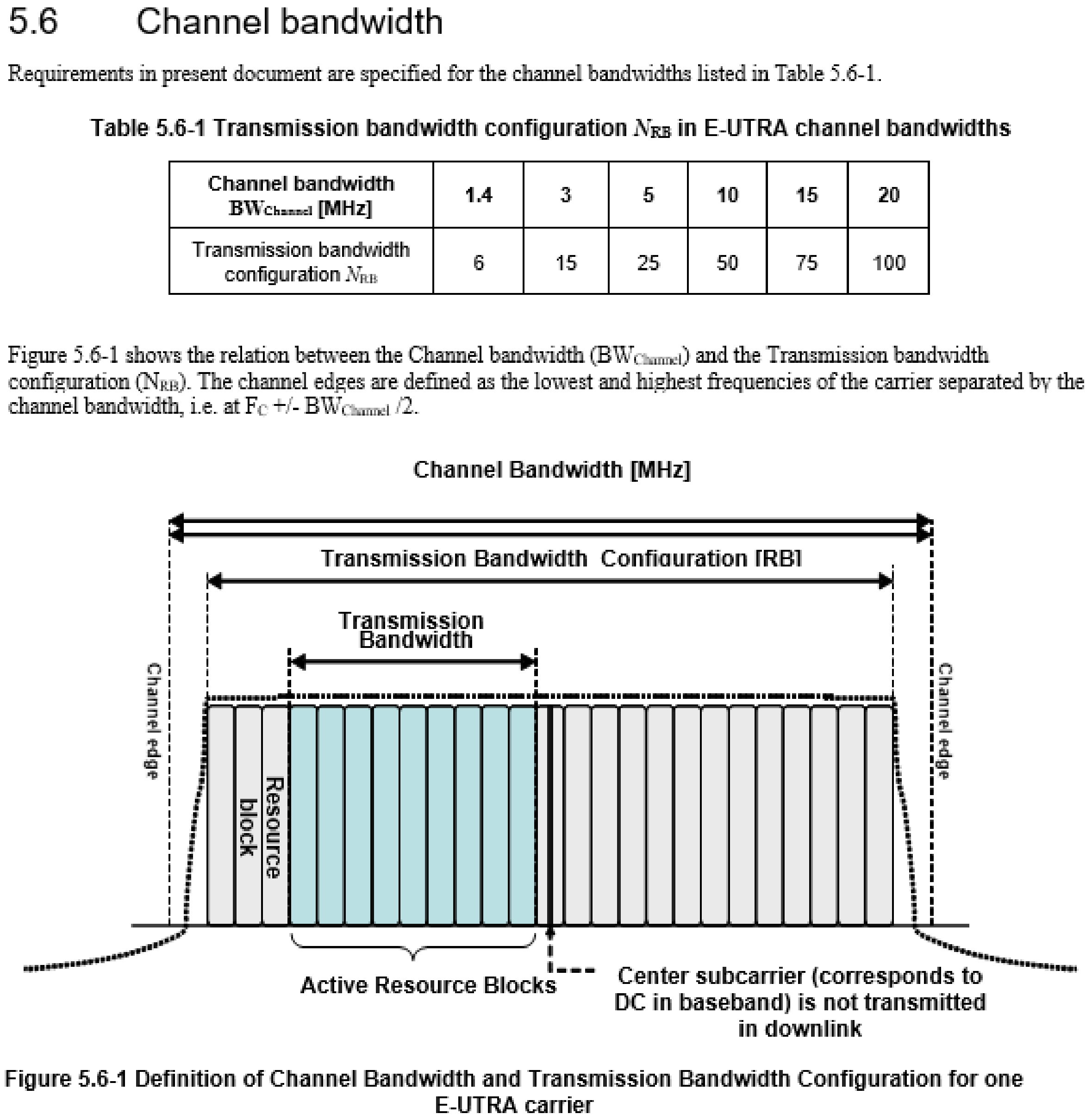
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Tesla's Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, Tesla's Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

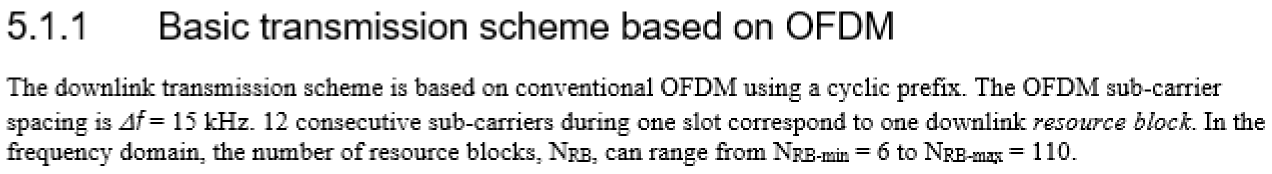
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

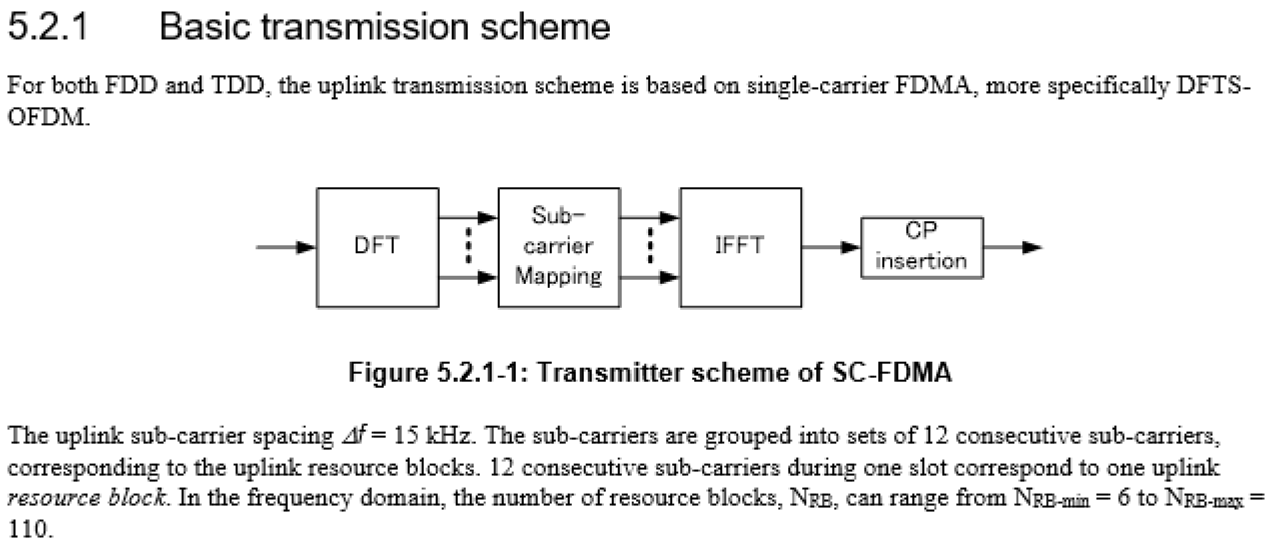
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

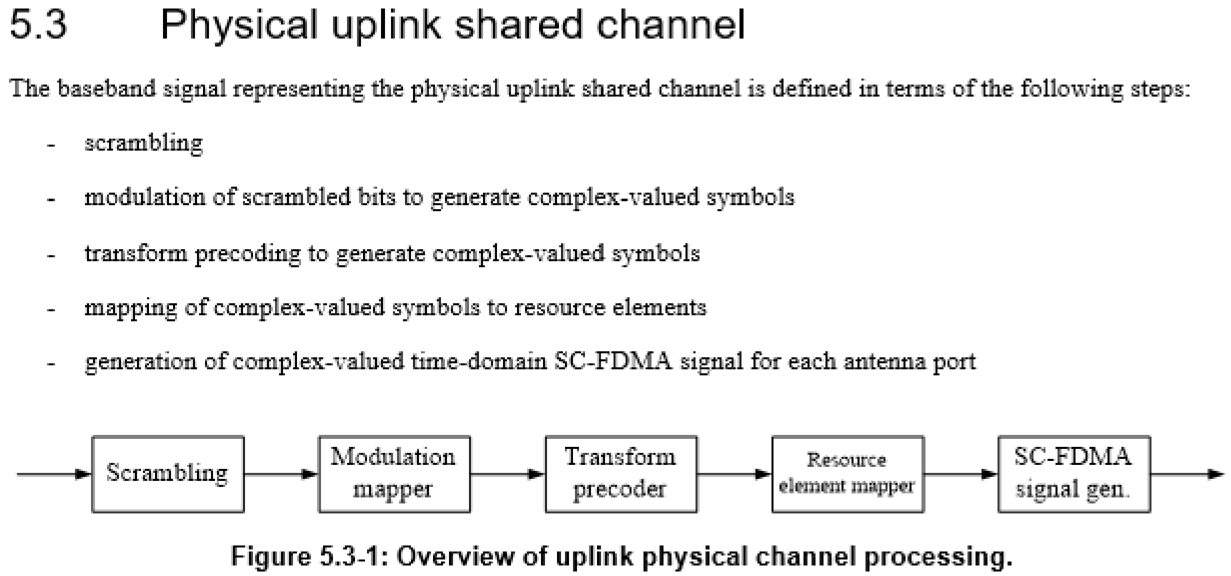
The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.3 Physical uplink shared channel

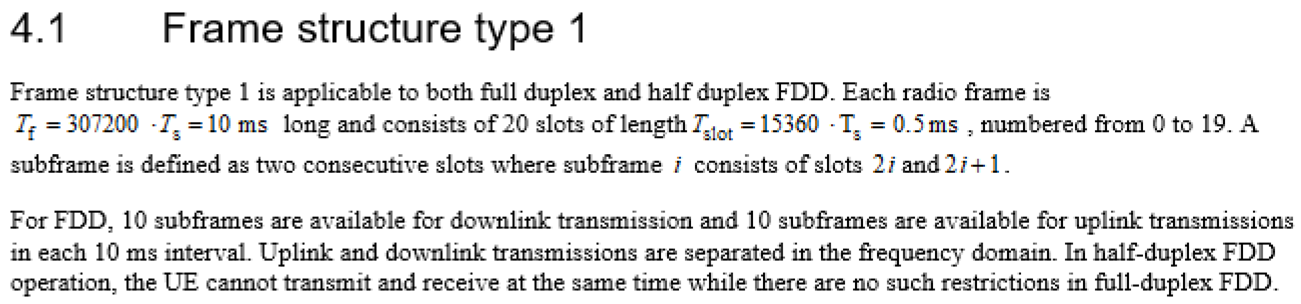
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

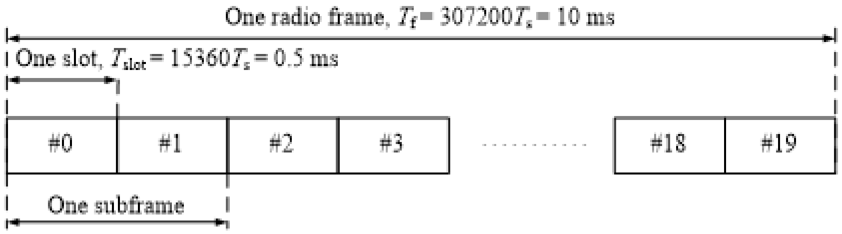
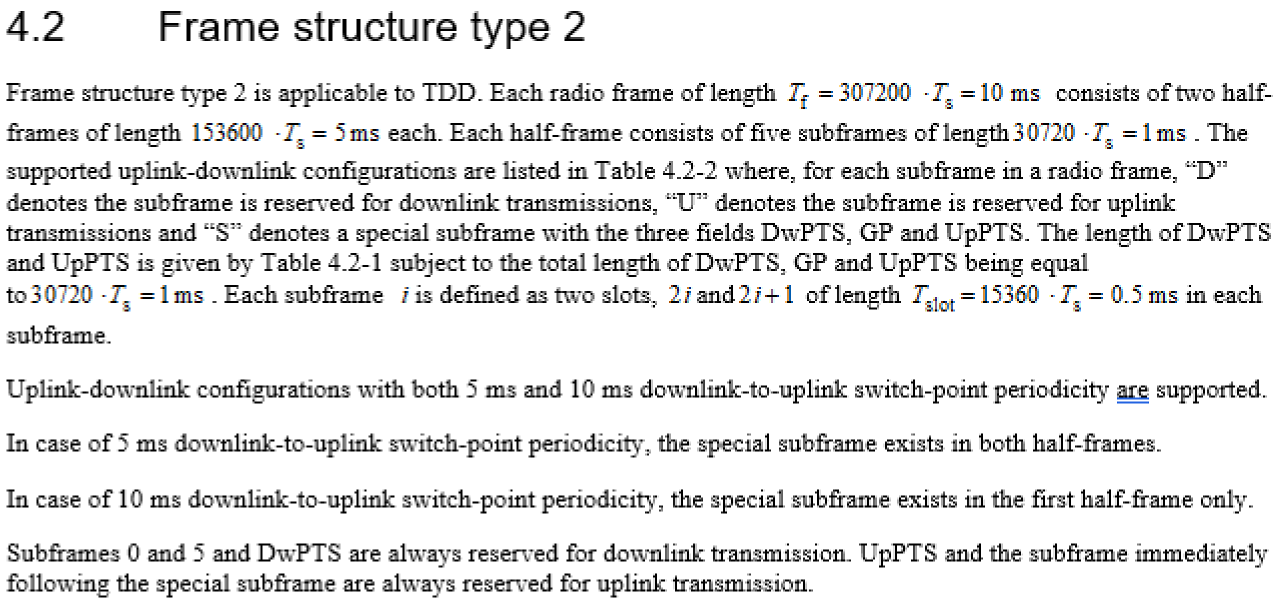


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

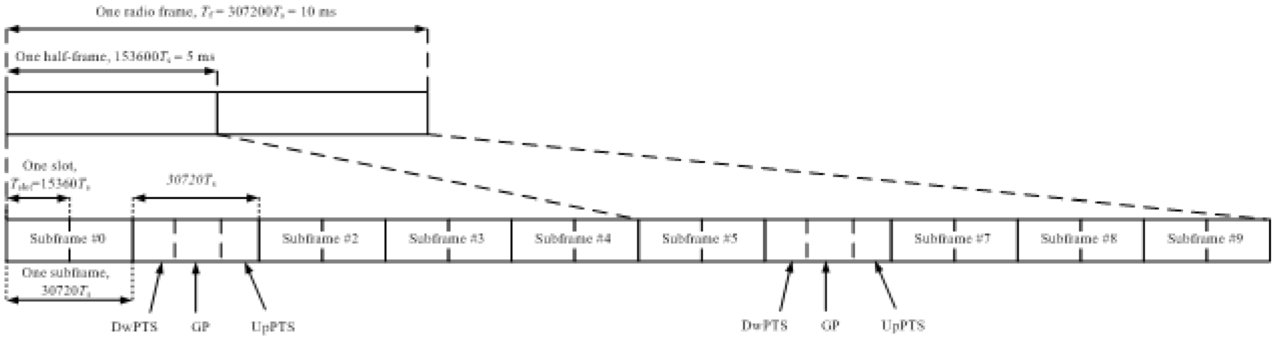
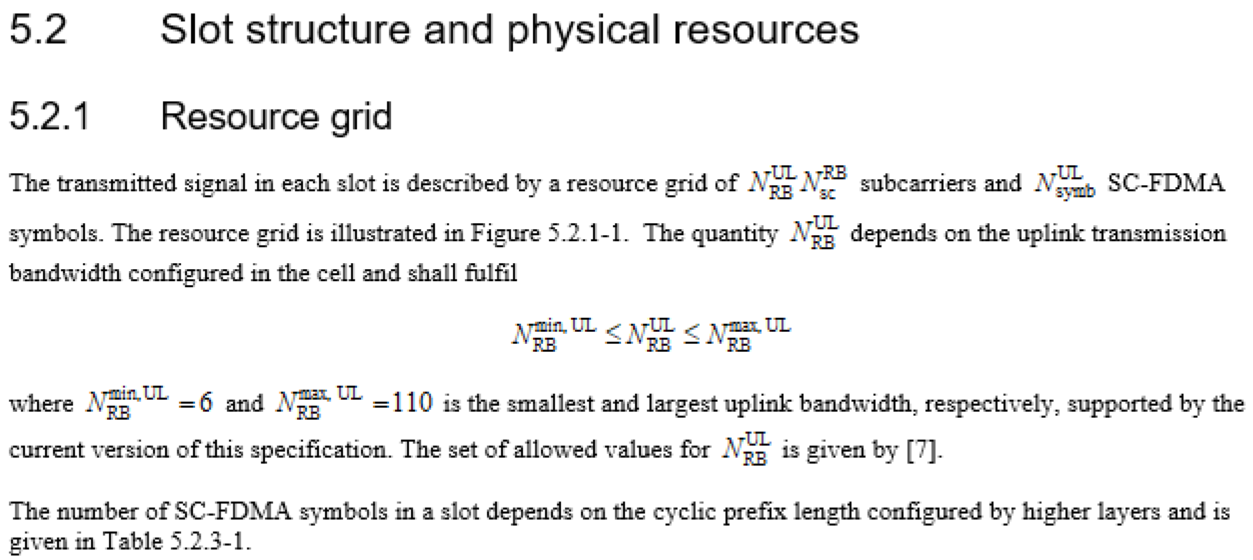


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

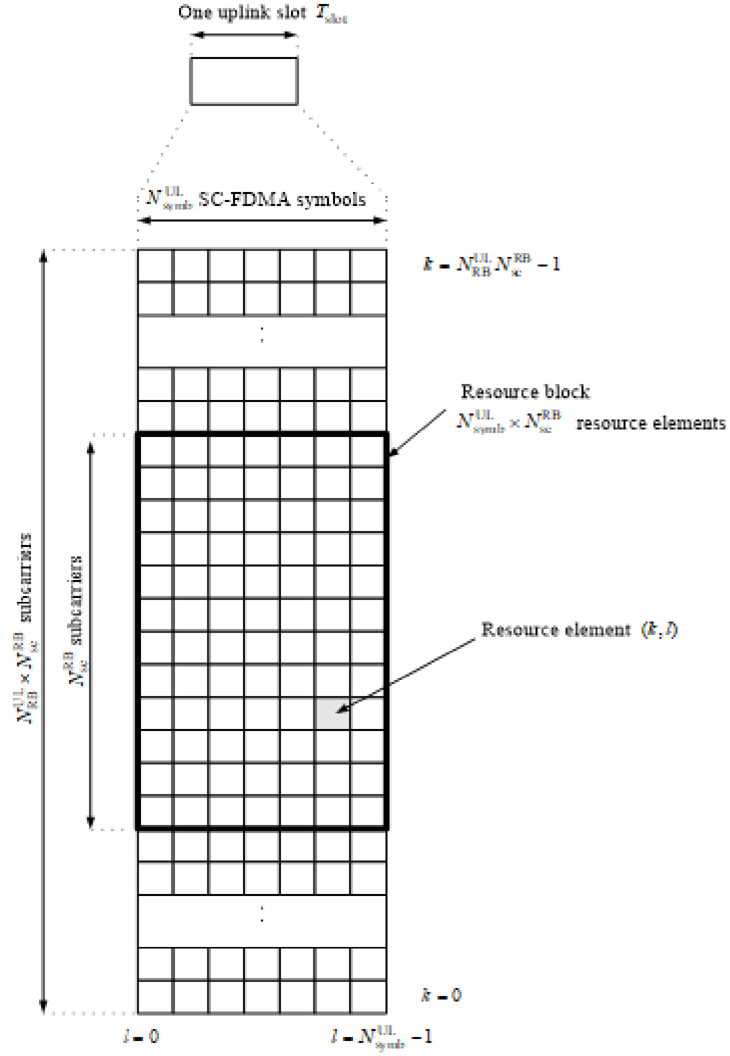
$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \leq N_{\mathrm{RB}}^{\mathrm{UL}} \leq N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

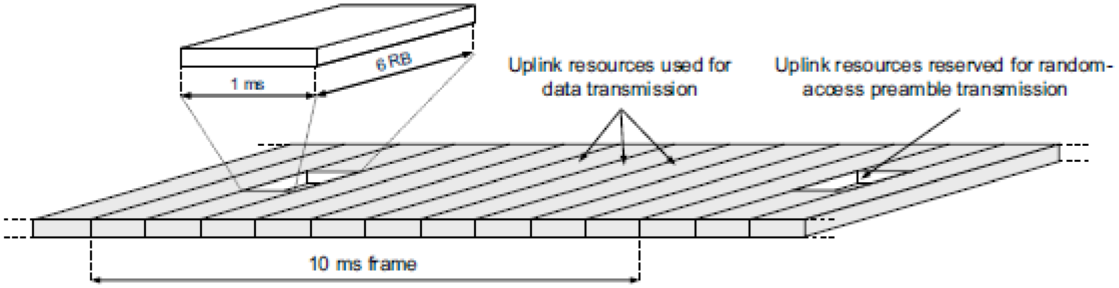
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 1(b)

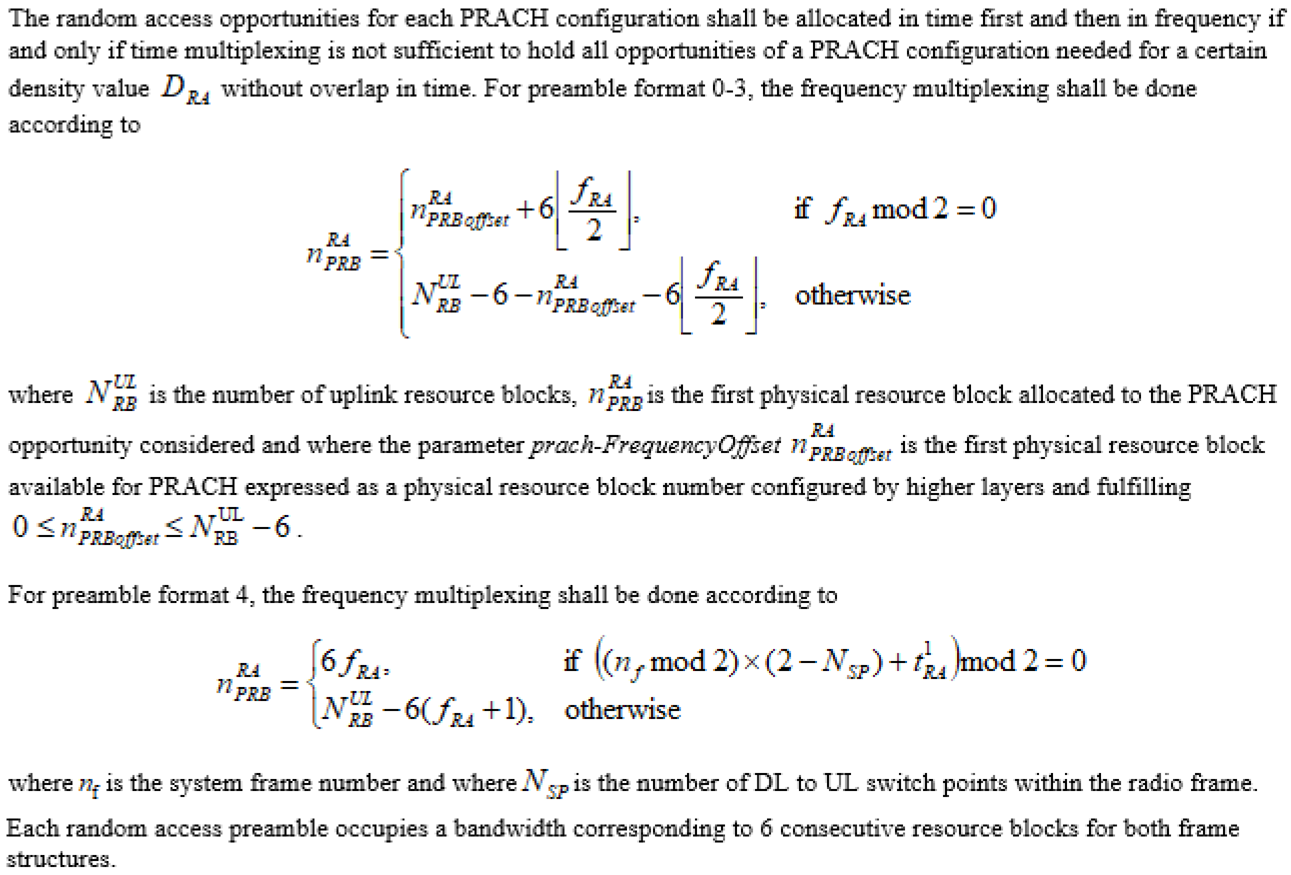
"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

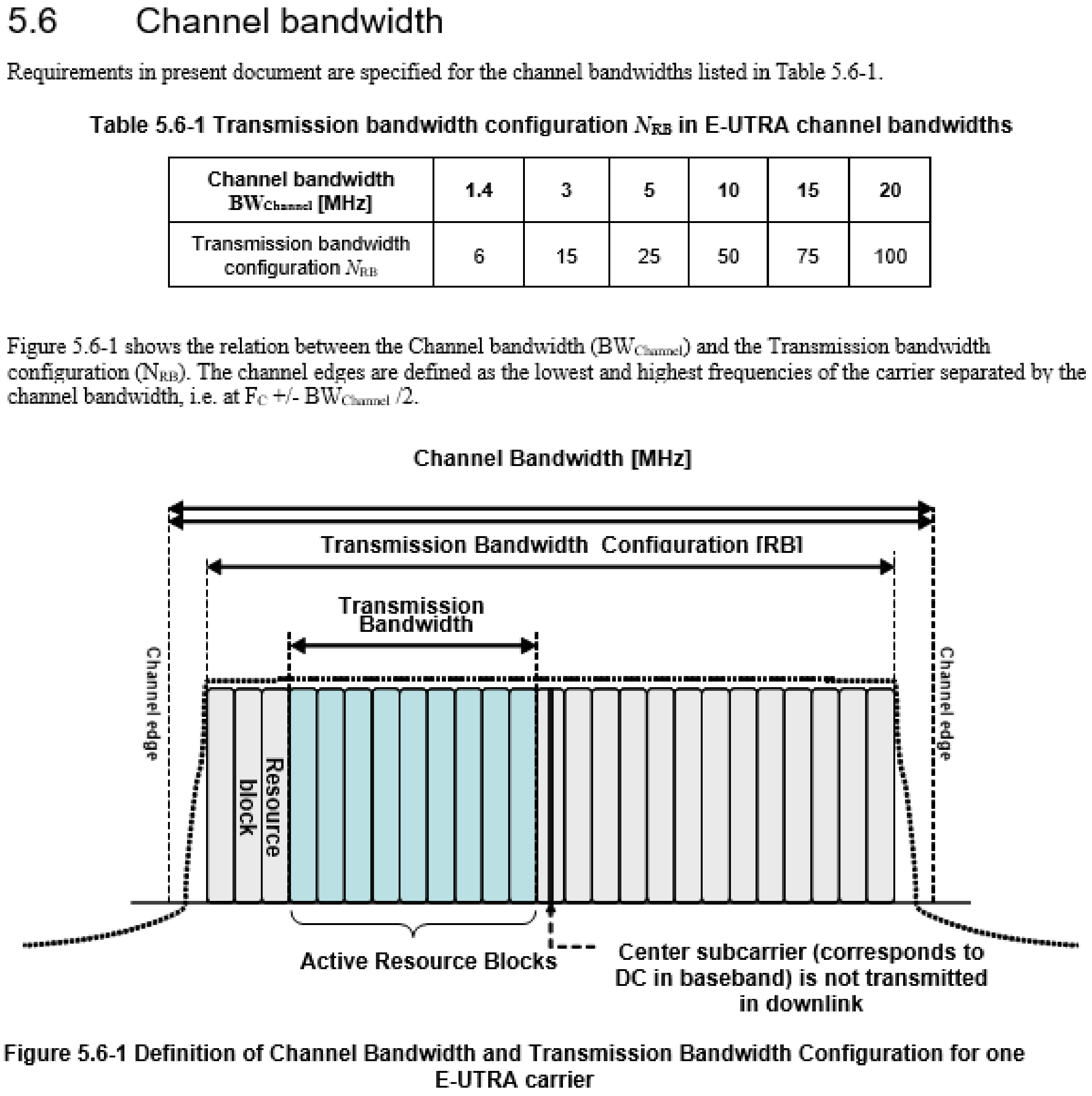
US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	Tesla’s Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

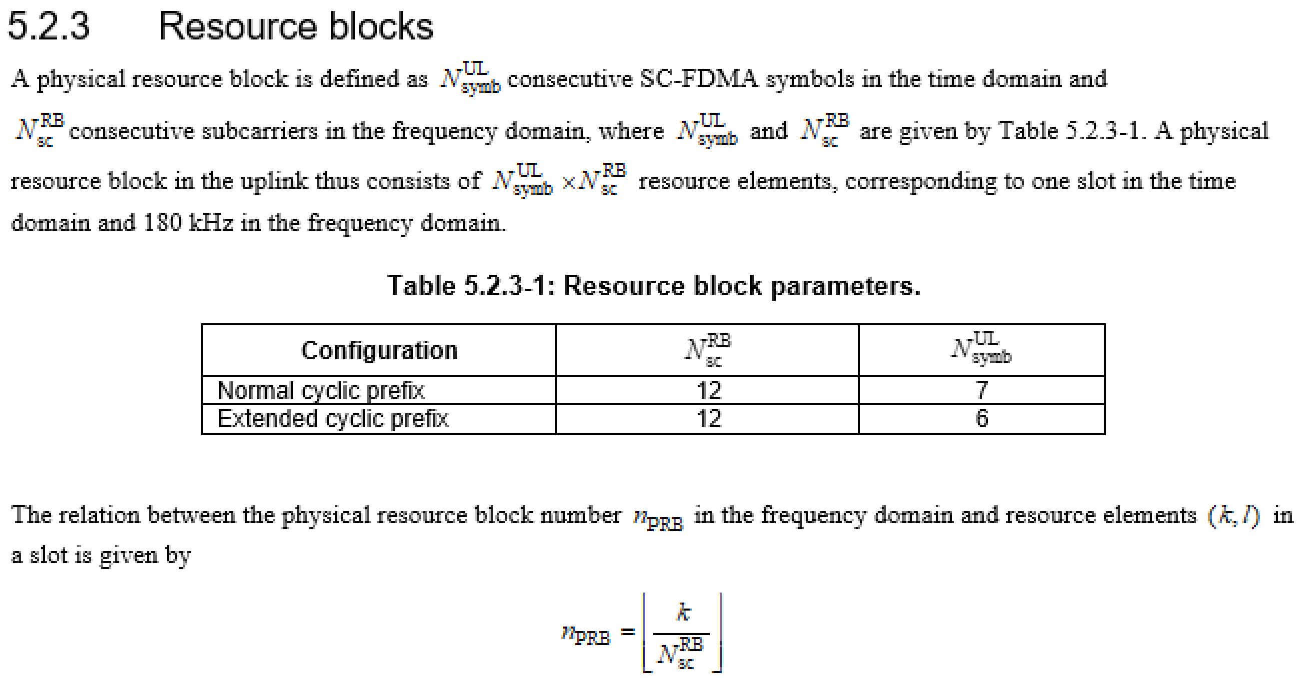
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.2.3 Resource blocks

A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

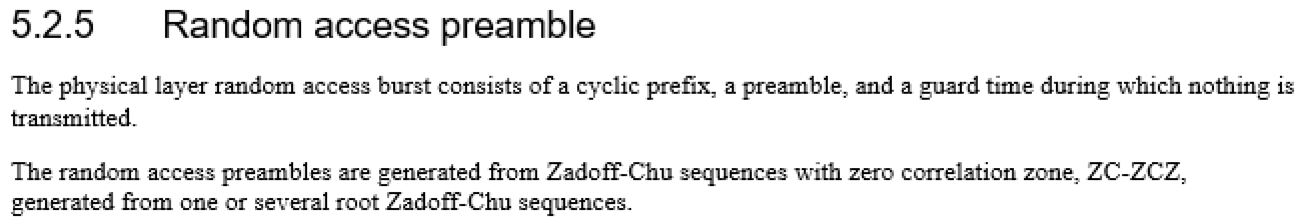
Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\mathrm{PRB}} = \left\lfloor \frac{k}{N_{\mathrm{sc}}^{\mathrm{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

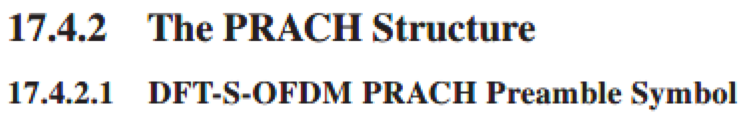


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

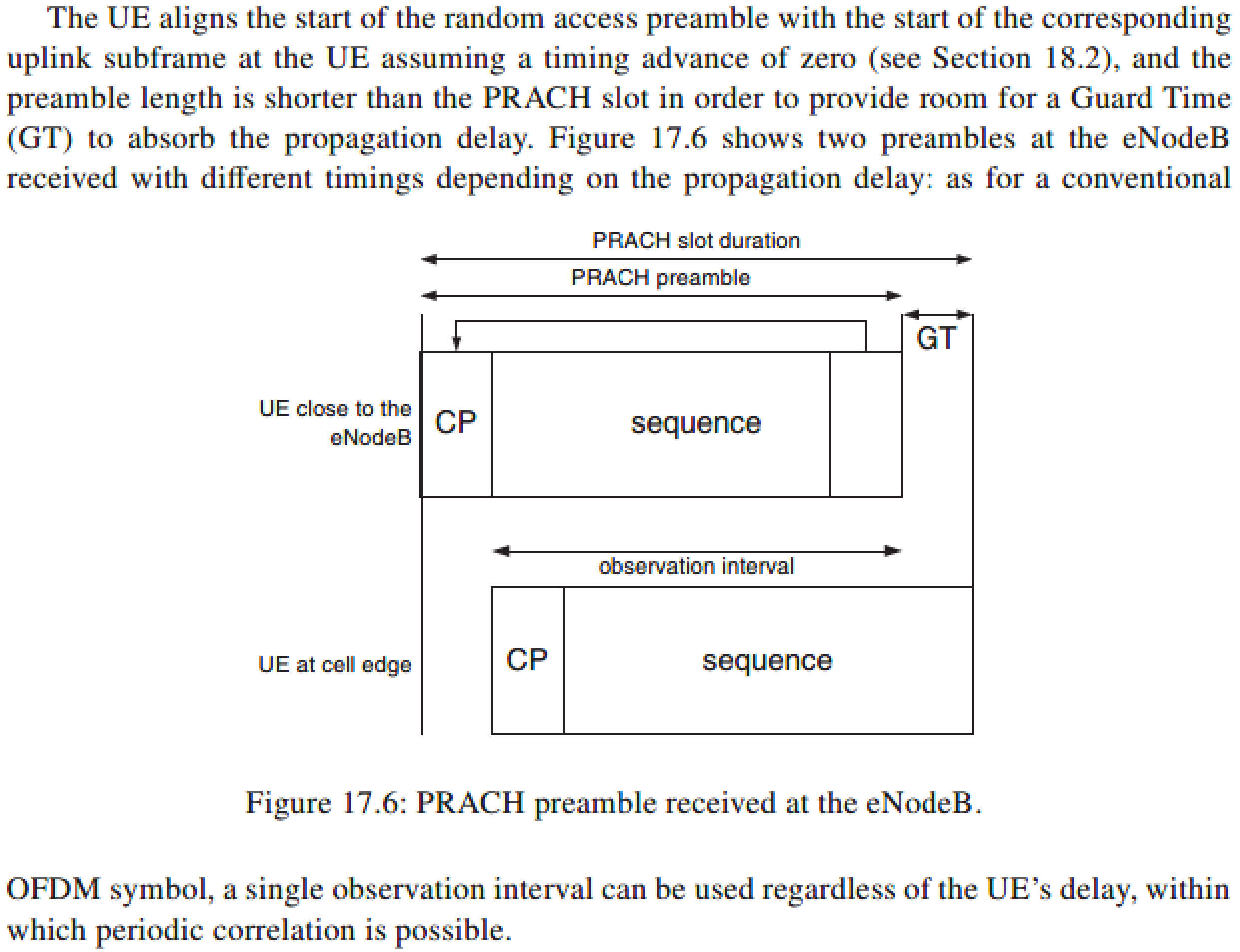


17.4.2 The PRACH Structure

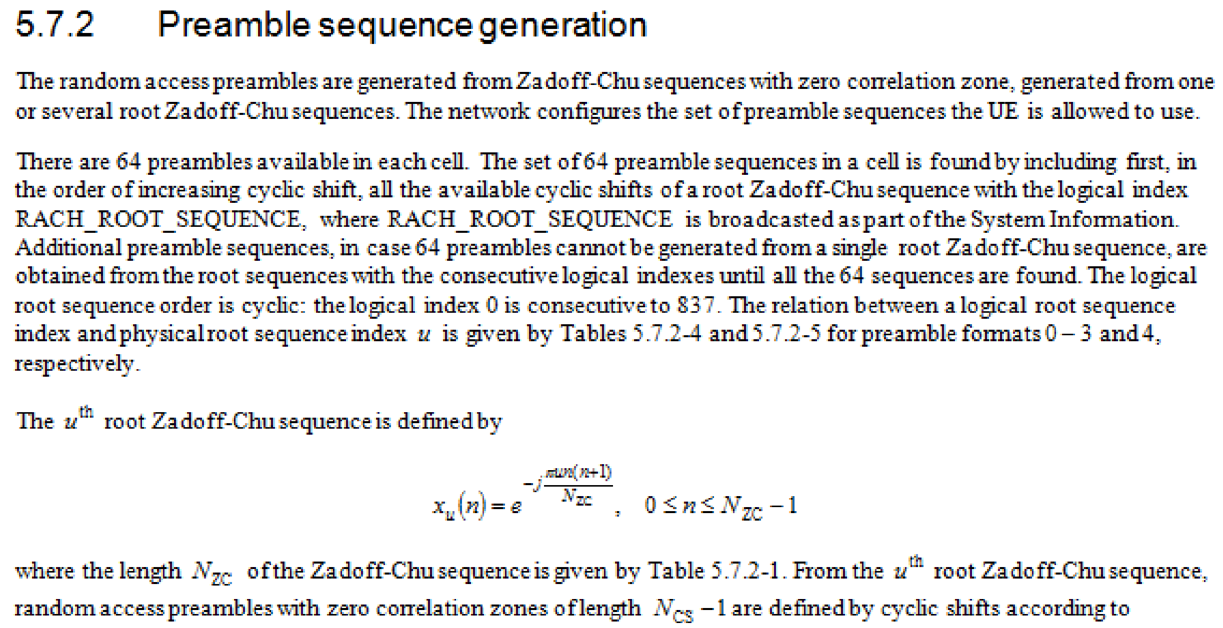
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

...

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. Figure 17.6: PRACH preamble received at the eNodeB. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

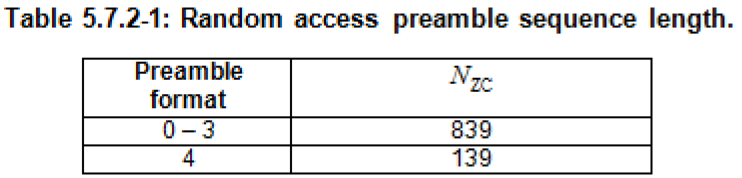
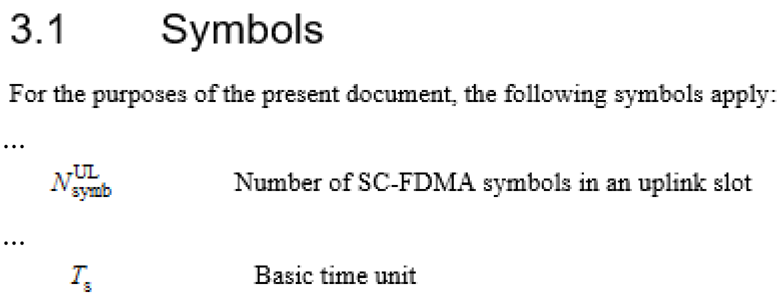
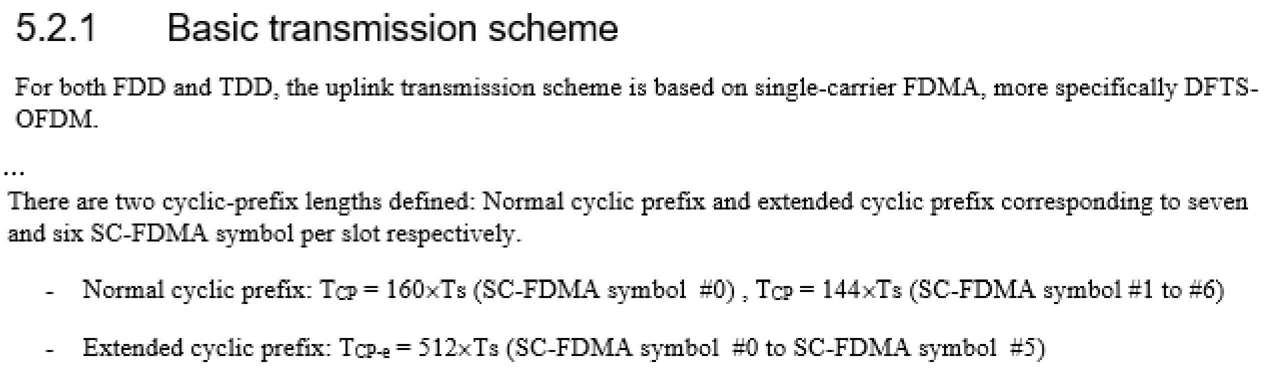


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using Tesla's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (Ts) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 *Ts or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\mathrm{symb}}^{\mathrm{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_{s} Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

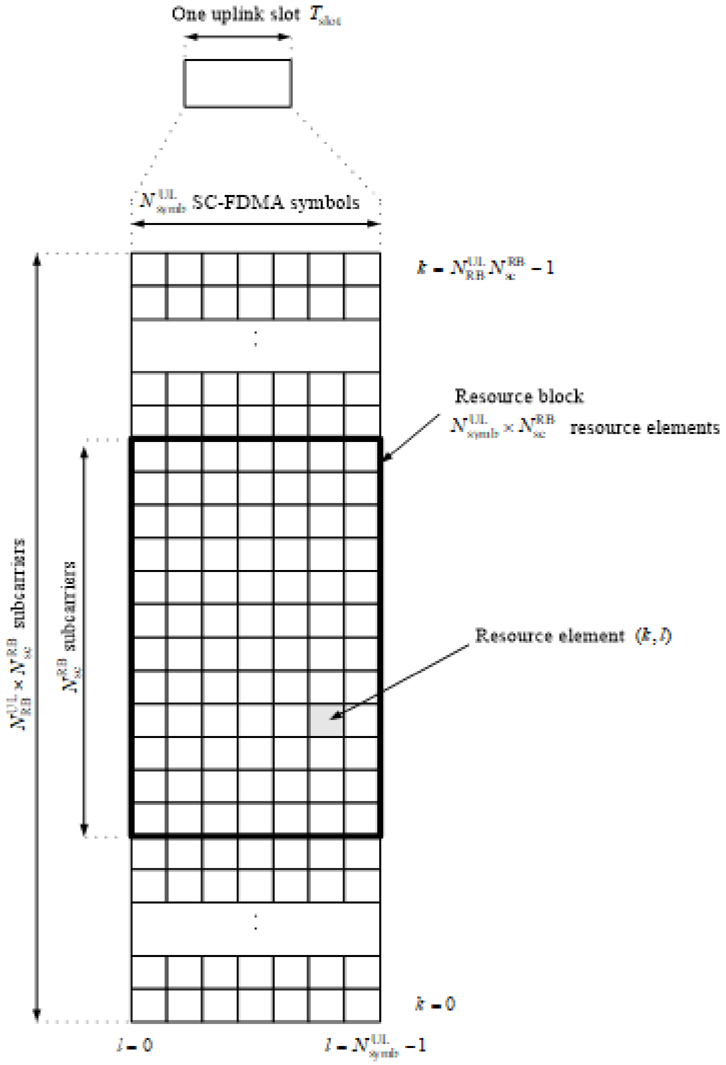
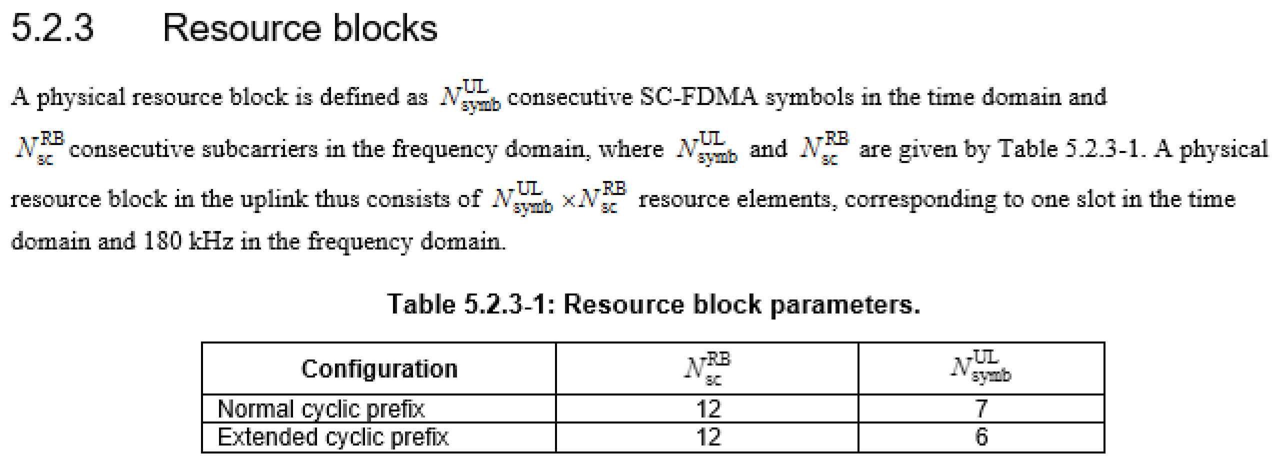


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

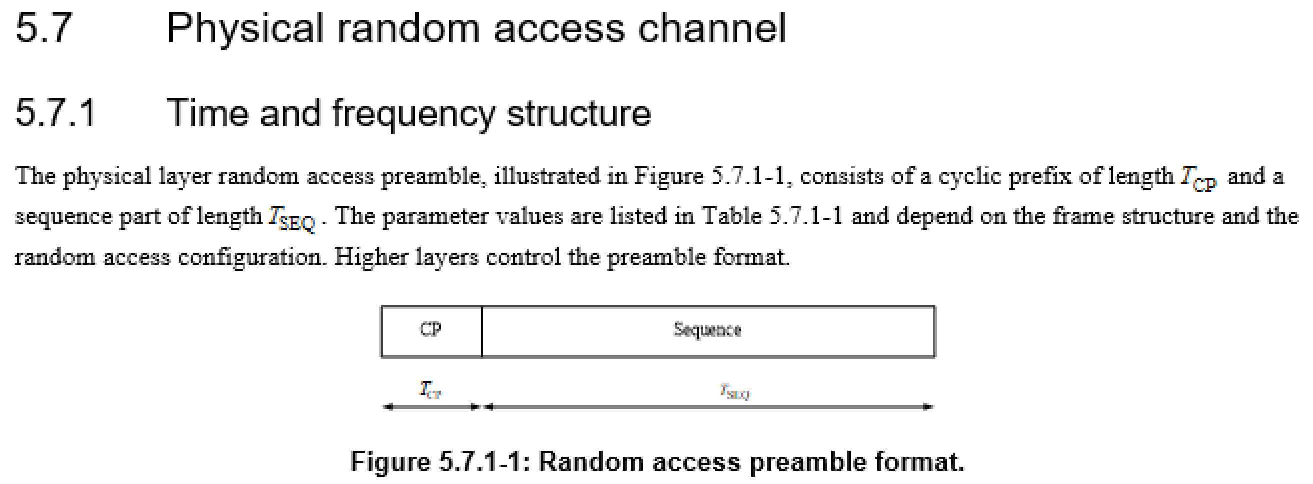
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)

"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

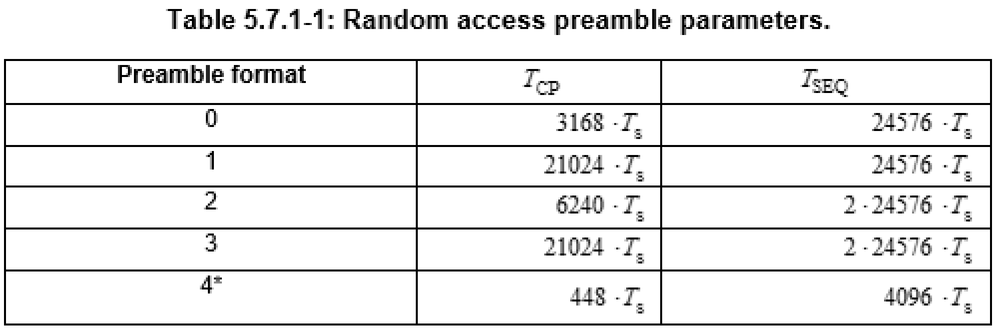
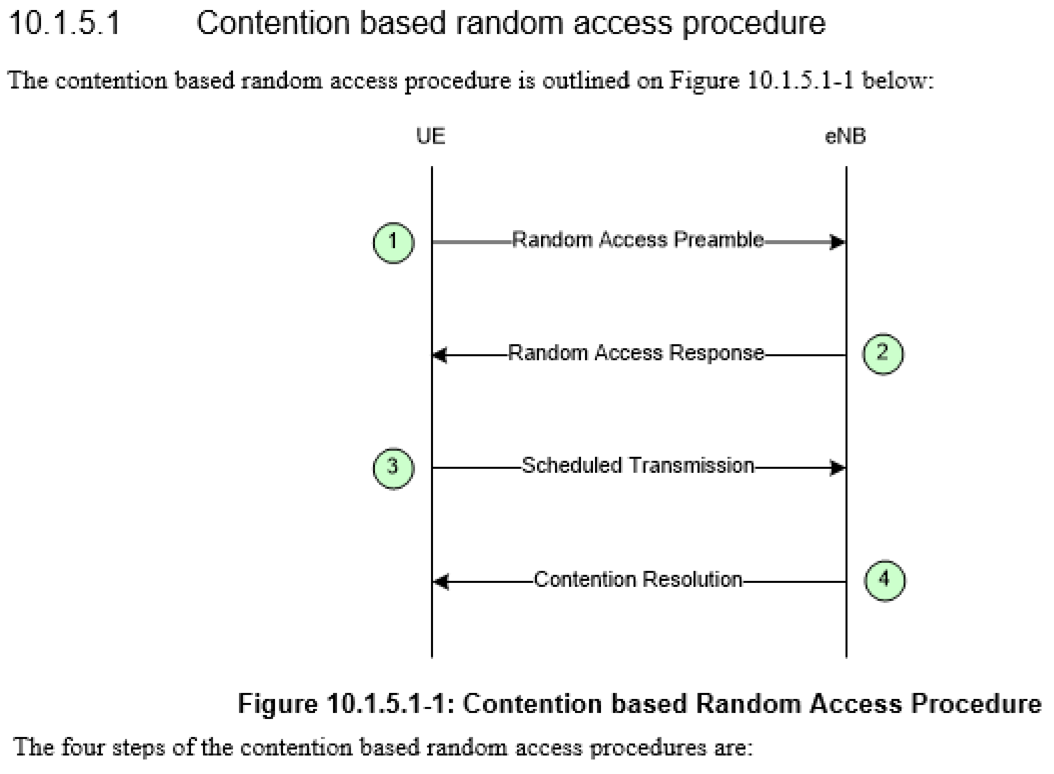
<table>
<tr>
<td></td>
<td>


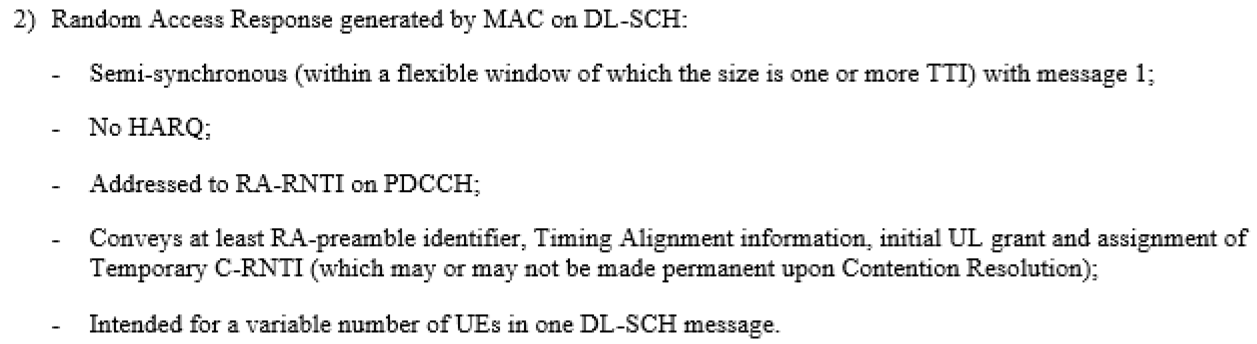
Table 5.7.1-1: Random access preamble parameters.

<table>
<tr><th>Preamble format</th><th>T_{CP}</th><th>T_{SEQ}</th></tr>
<tr><td>0</td><td>$3168 \cdot T_s$</td><td>$24576 \cdot T_s$</td></tr>
<tr><td>1</td><td>$21024 \cdot T_s$</td><td>$24576 \cdot T_s$</td></tr>
<tr><td>2</td><td>$6240 \cdot T_s$</td><td>$2 \cdot 24576 \cdot T_s$</td></tr>
<tr><td>3</td><td>$21024 \cdot T_s$</td><td>$2 \cdot 24576 \cdot T_s$</td></tr>
<tr><td>4*</td><td>$448 \cdot T_s$</td><td>$4096 \cdot T_s$</td></tr>
</table>

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.
</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

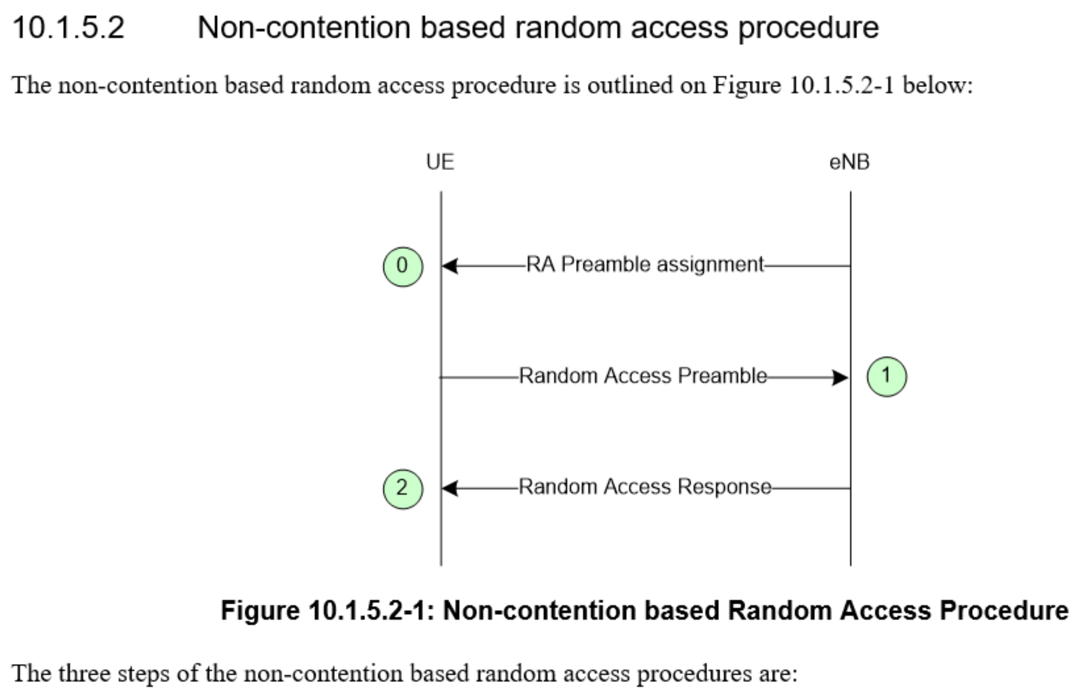
a receiver configured to receive, from the base station, a response message.	Tesla's Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



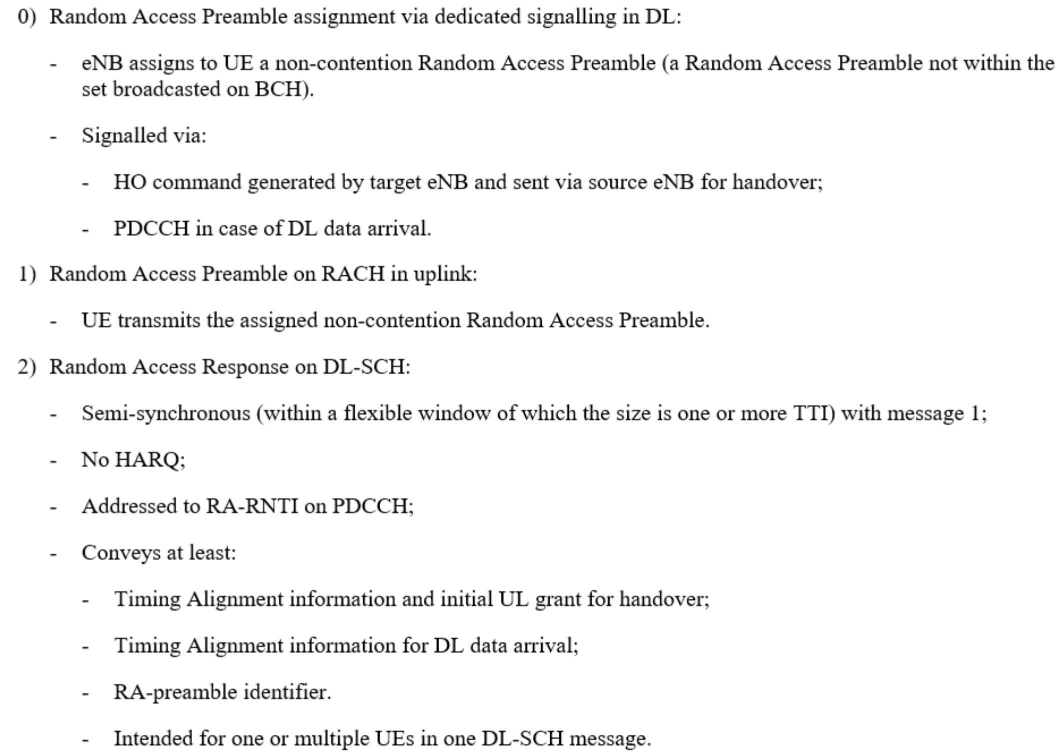
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

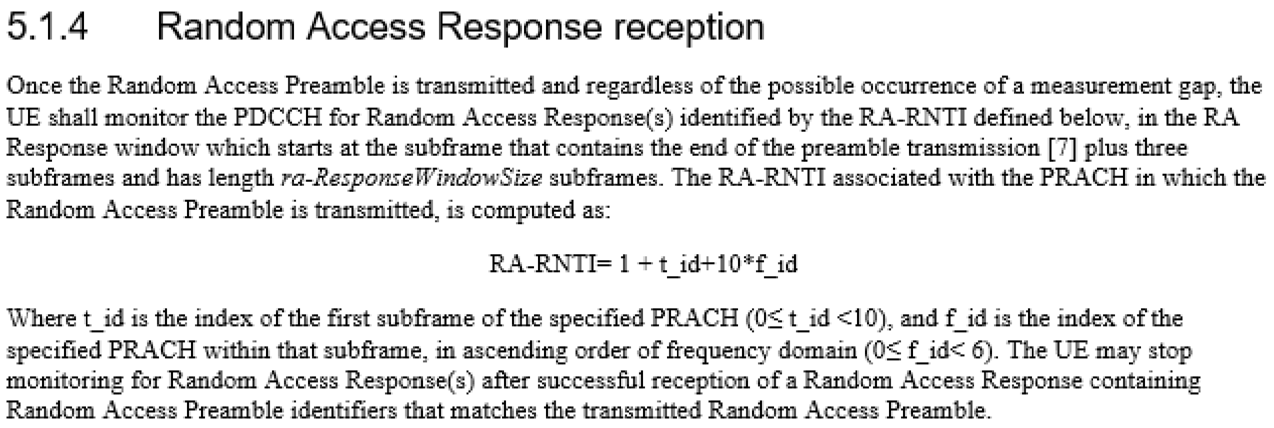


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

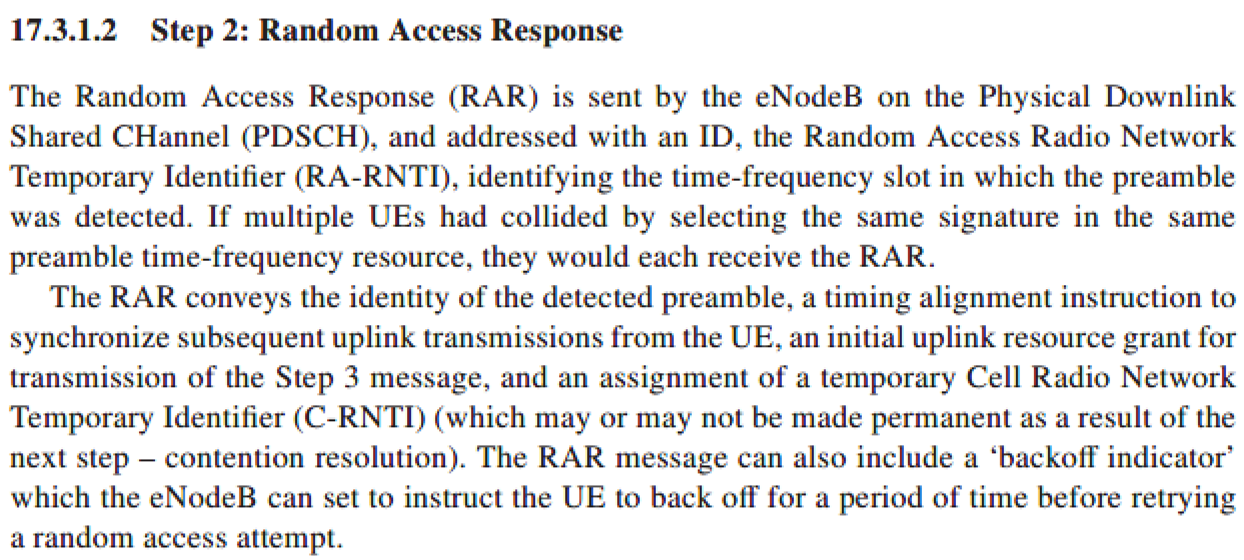
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

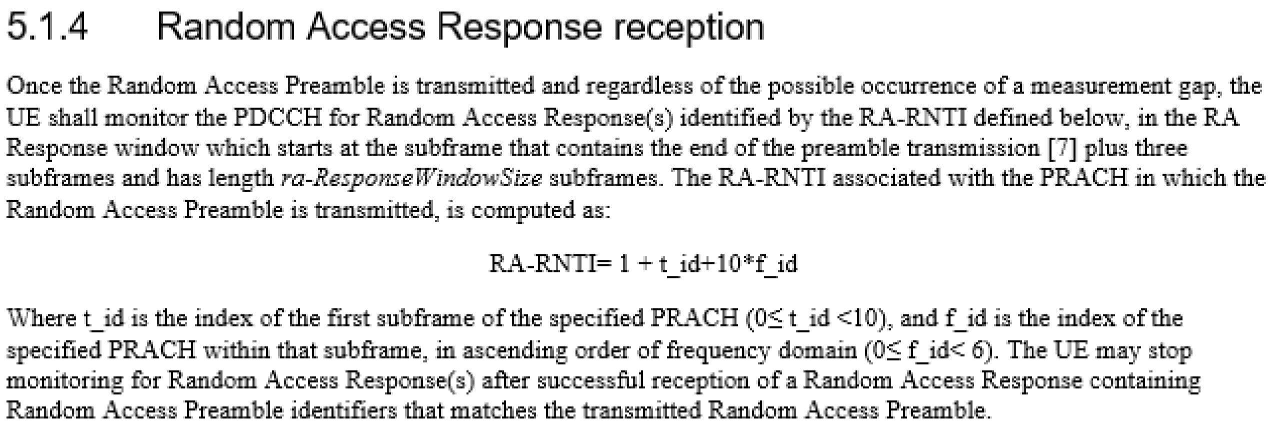
US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

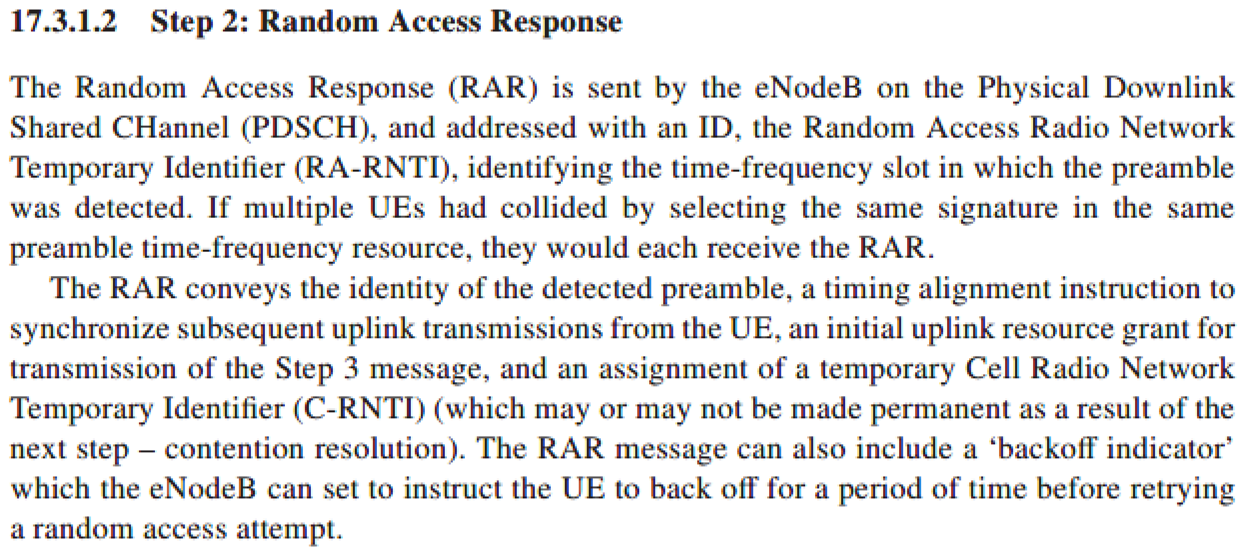
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

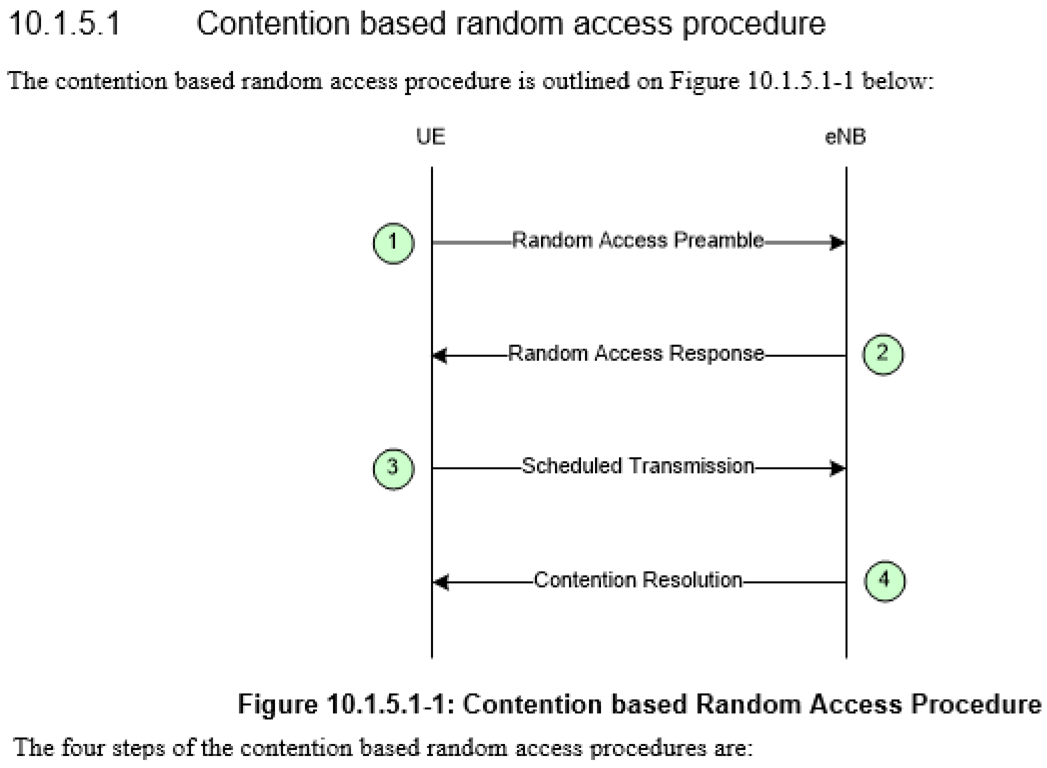
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of Tesla’s Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $RA\text{-}RNTI= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

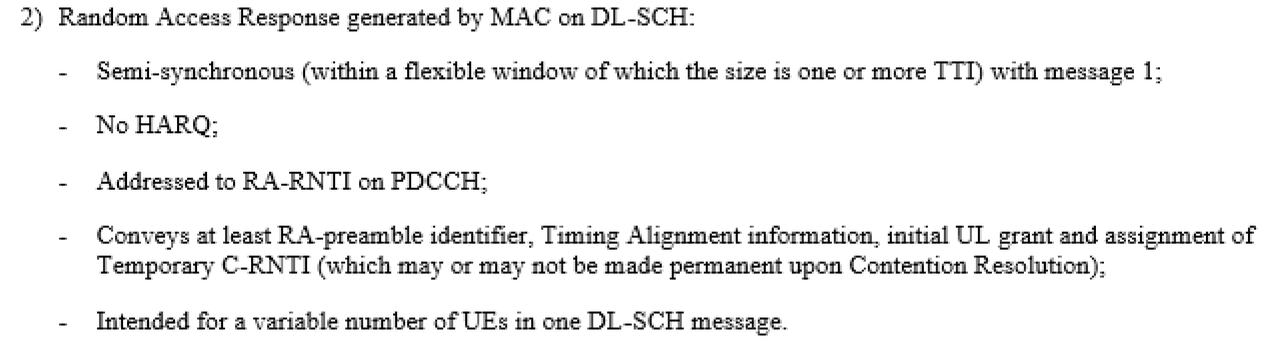
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in Tesla's Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

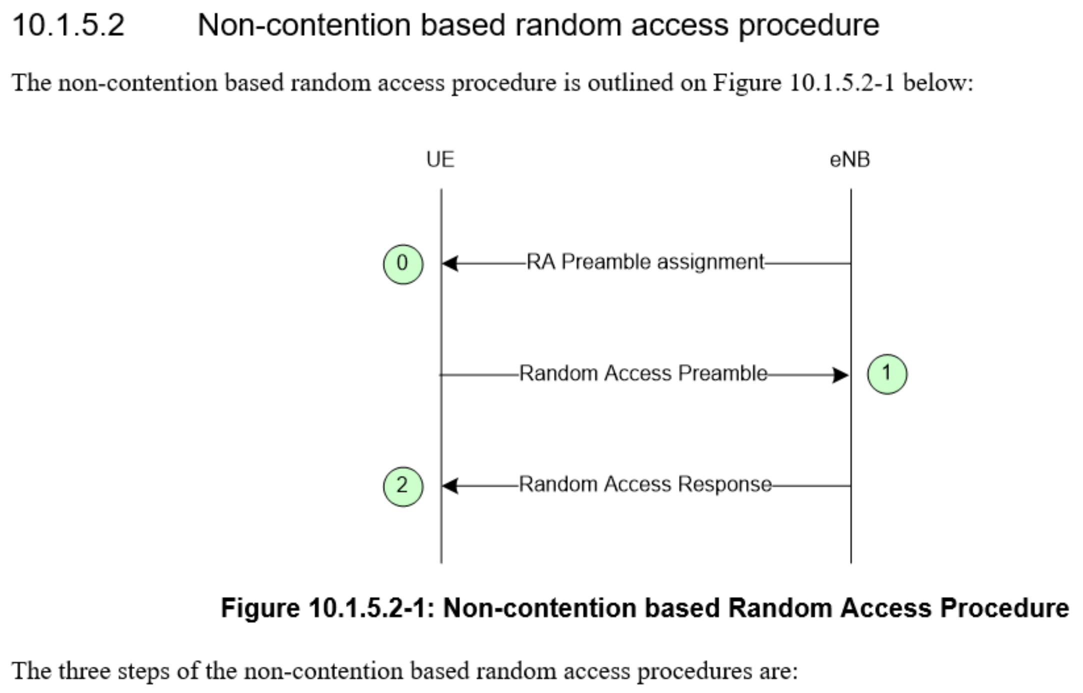
US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



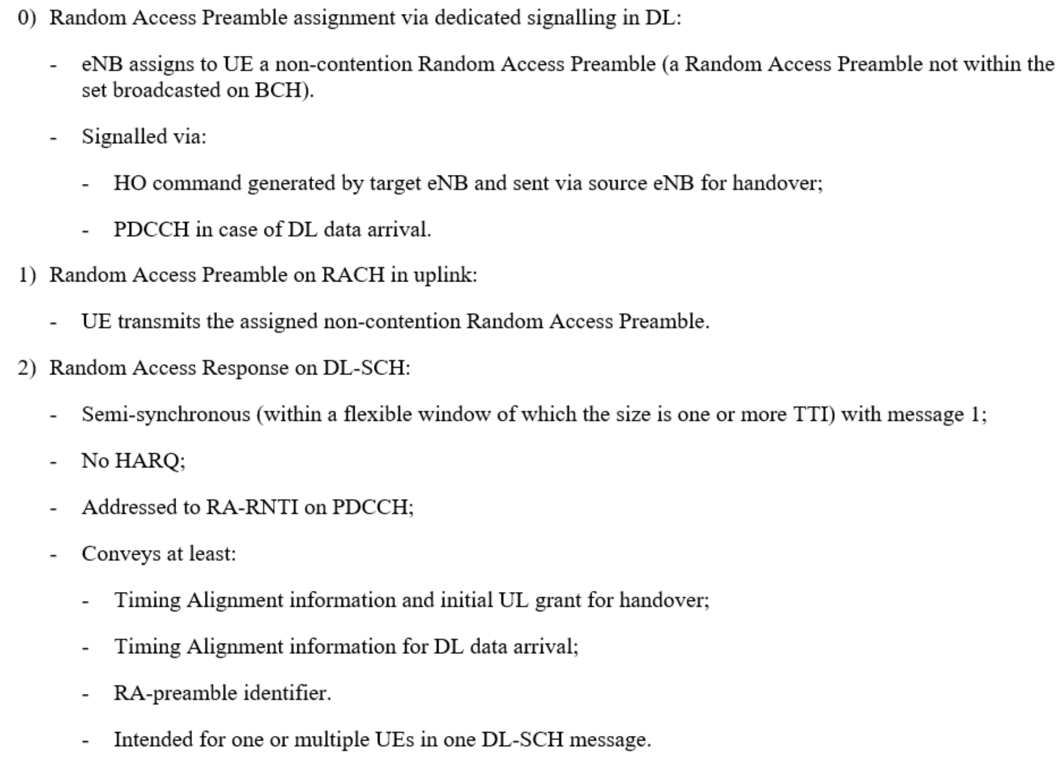
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

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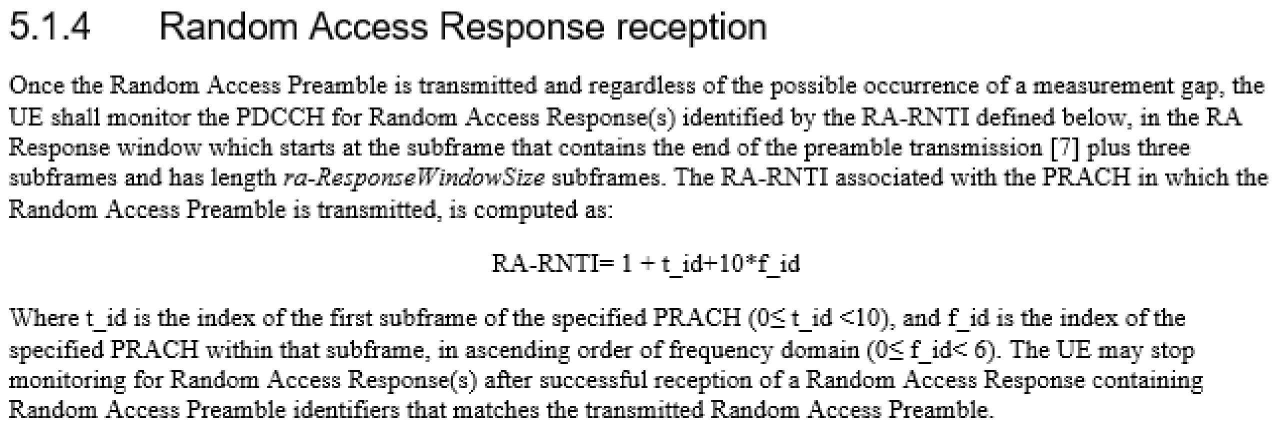
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

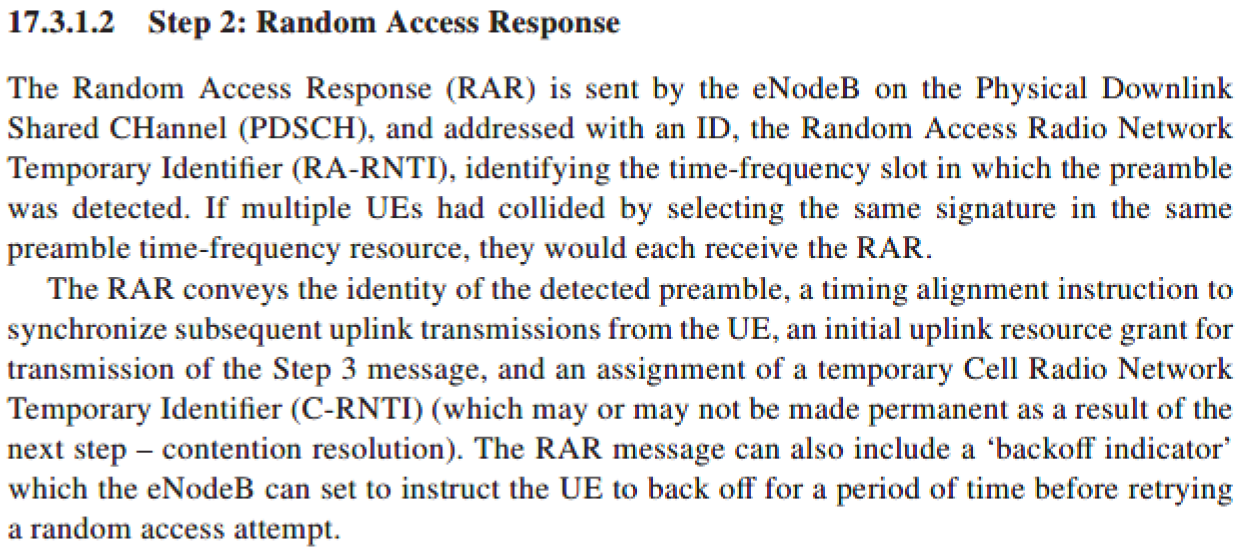
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

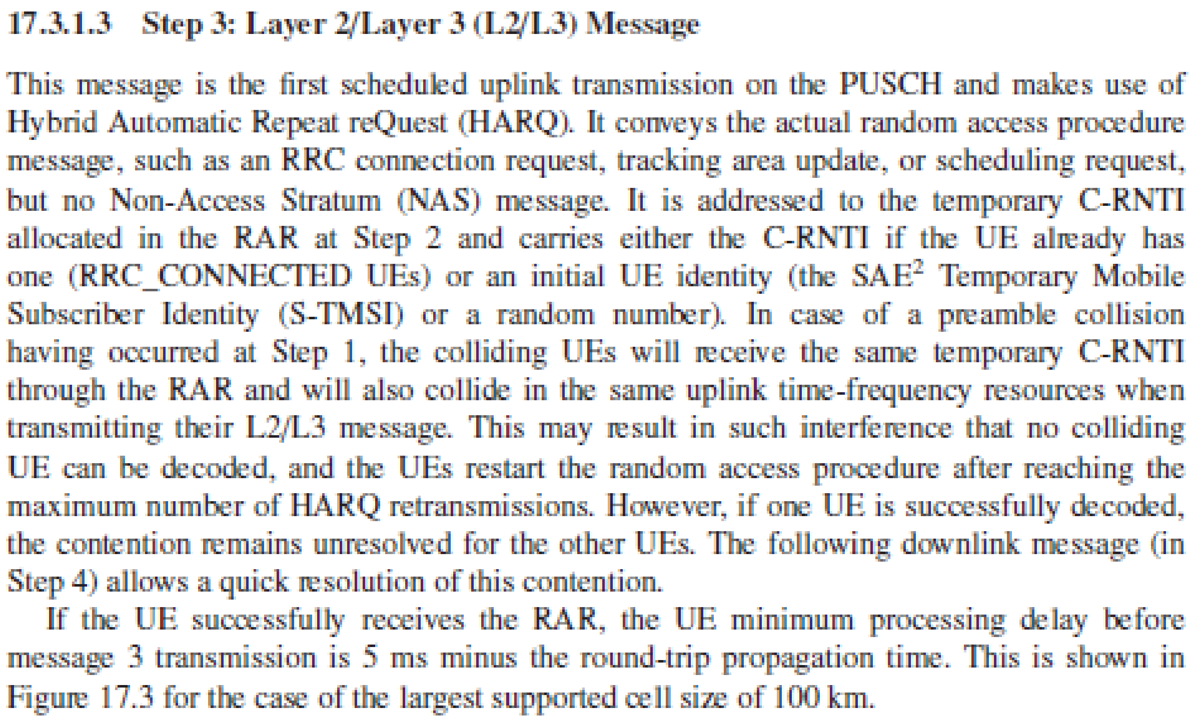
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

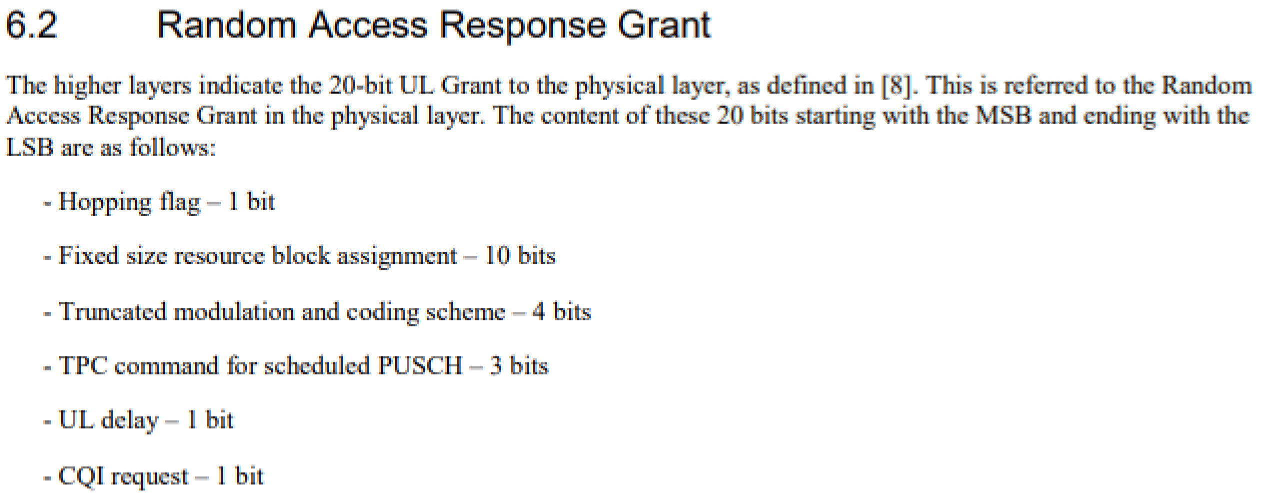
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of Tesla's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
“The mobile station of claim 2, wherein the response message includes power adjustment information and”

The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

> Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

> Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

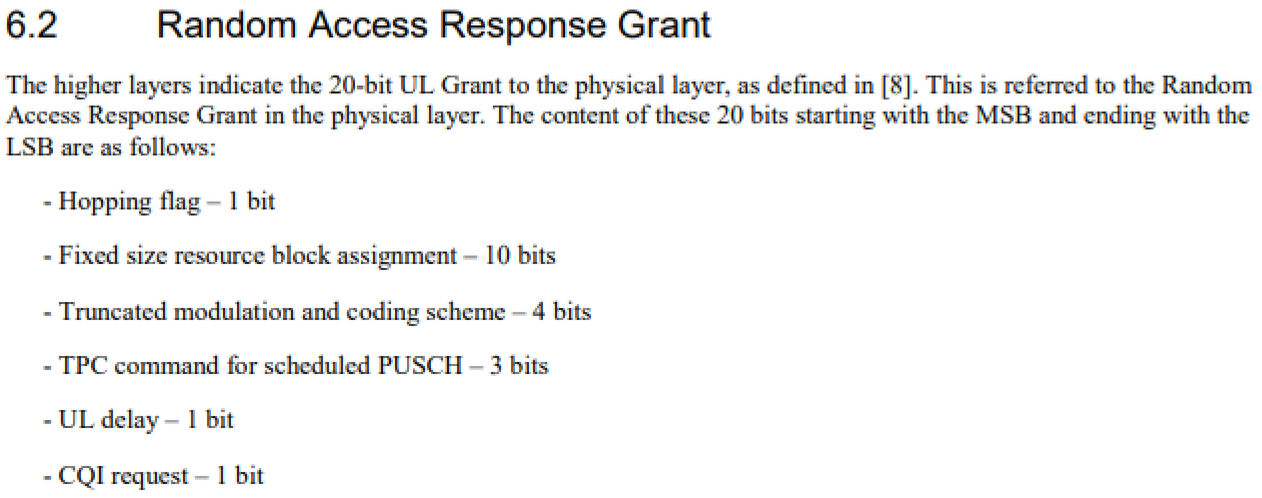
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

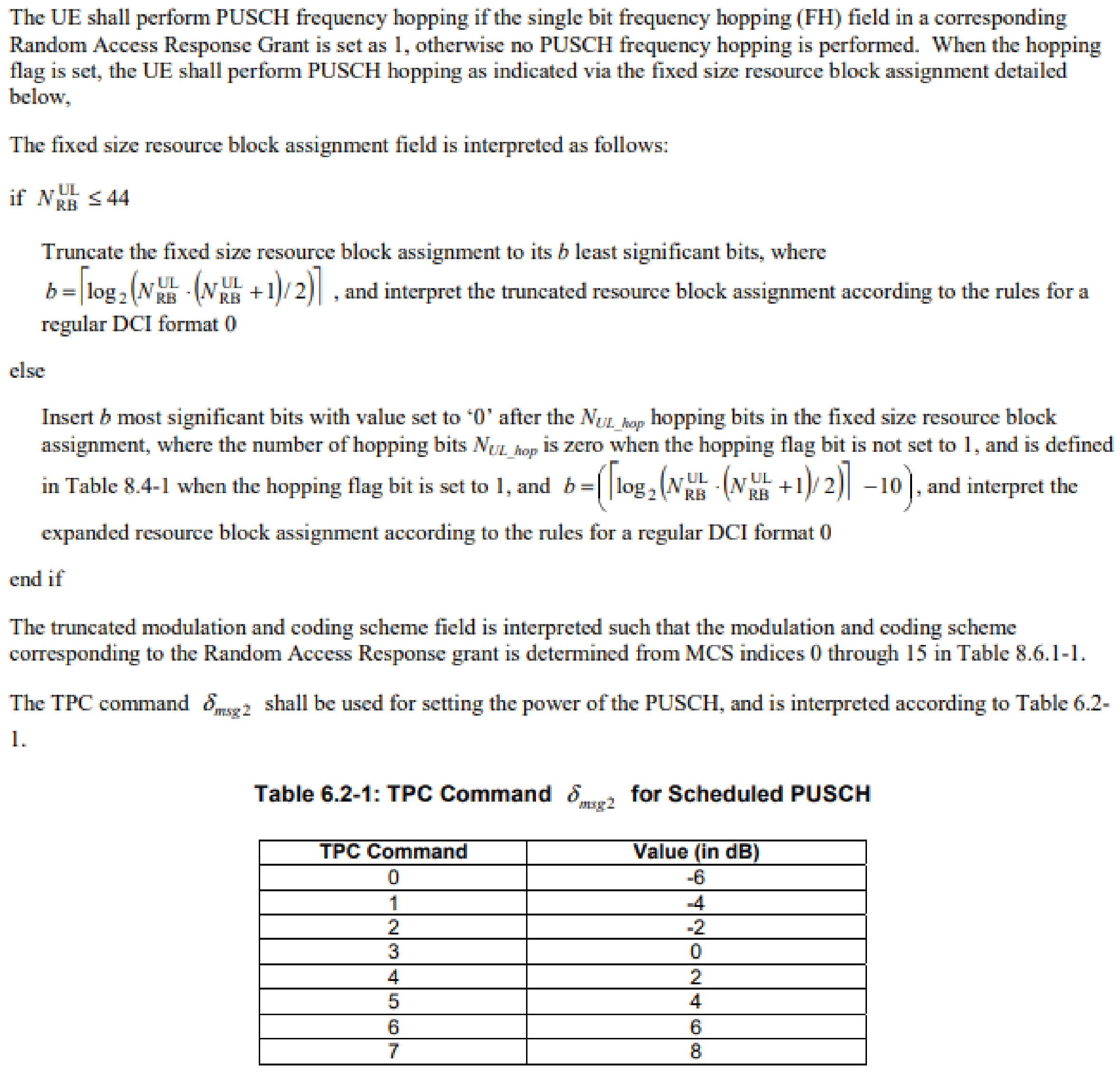
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of Tesla’s Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

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TPC Command	Value (in dB)
0	-6
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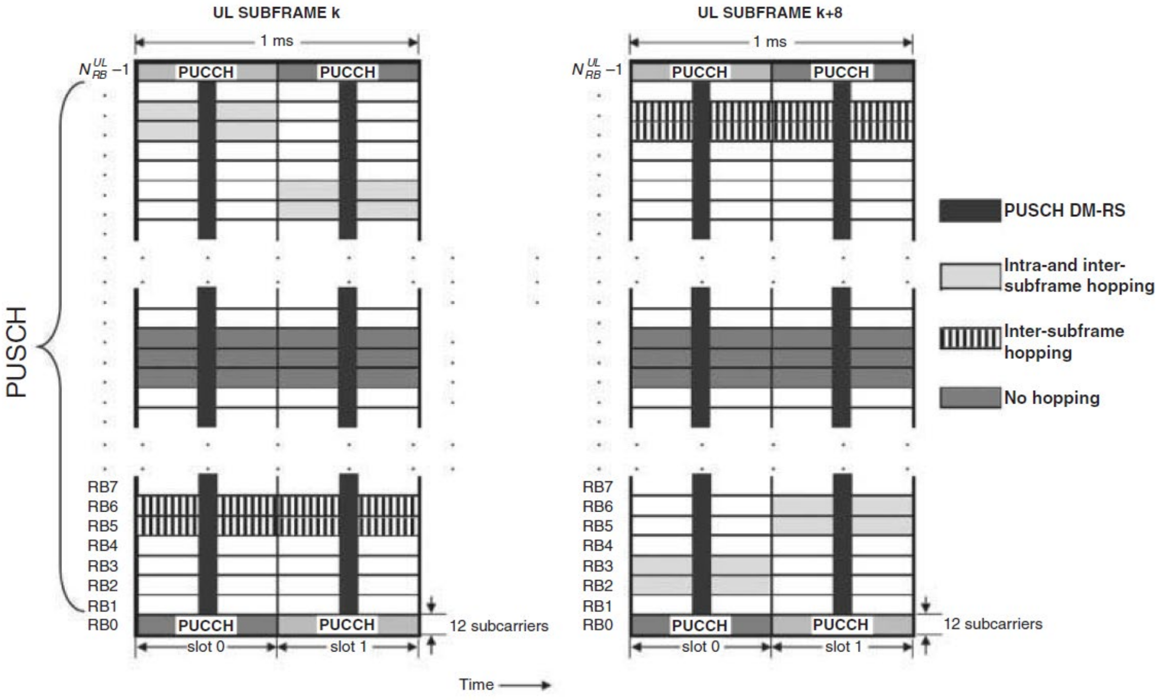
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of Tesla’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

<table>
<tr>
<td></td>
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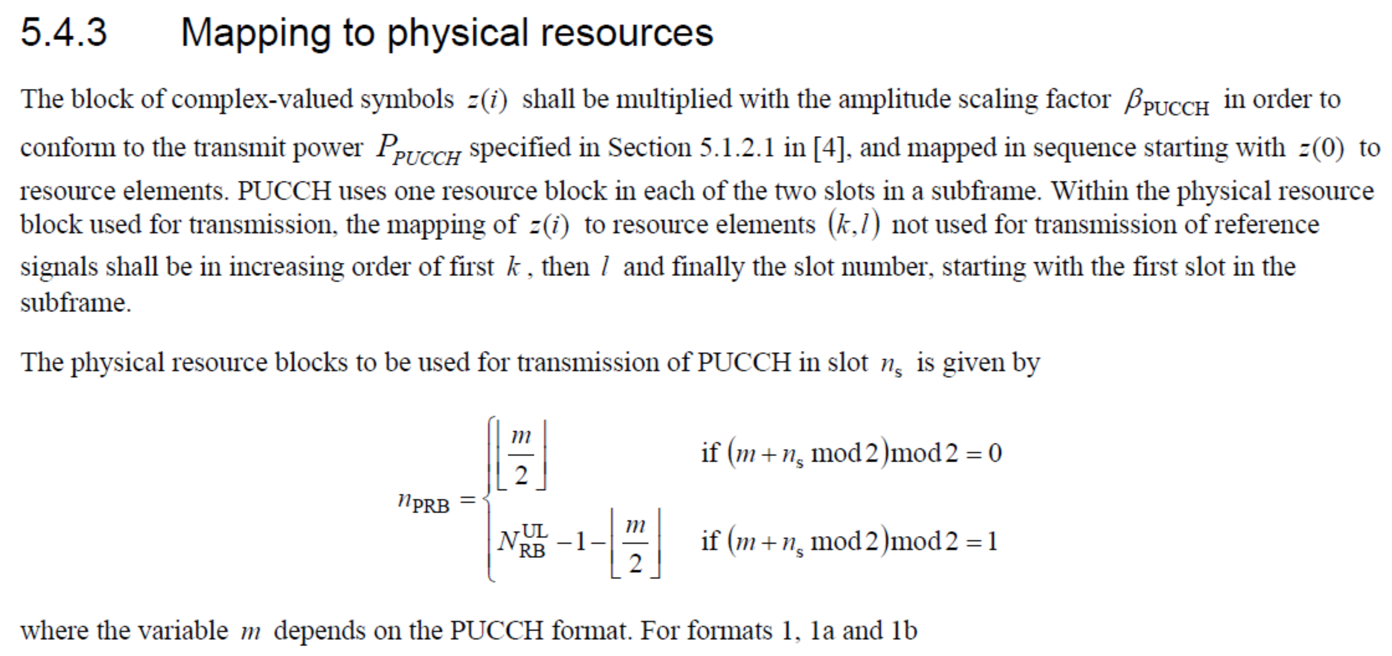


5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b
</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

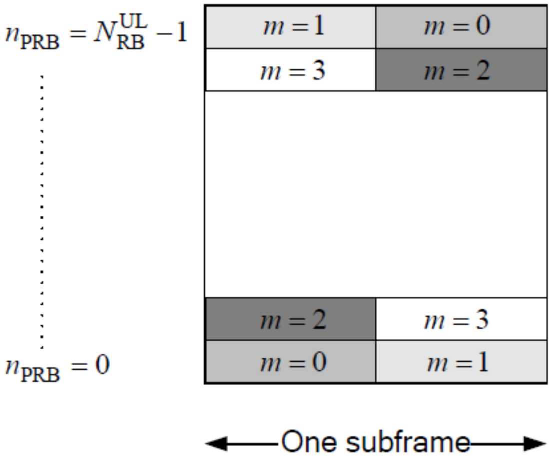
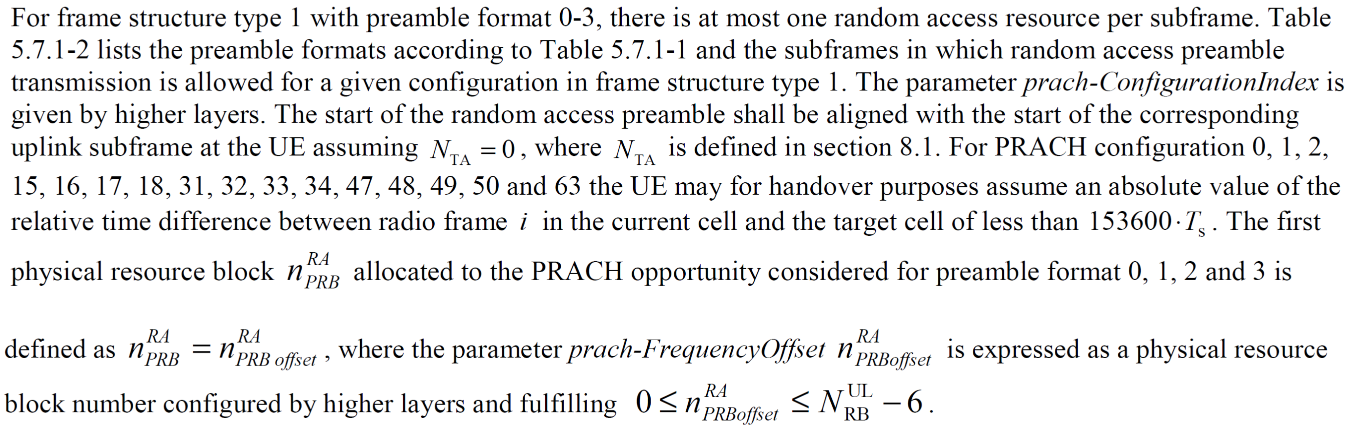


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

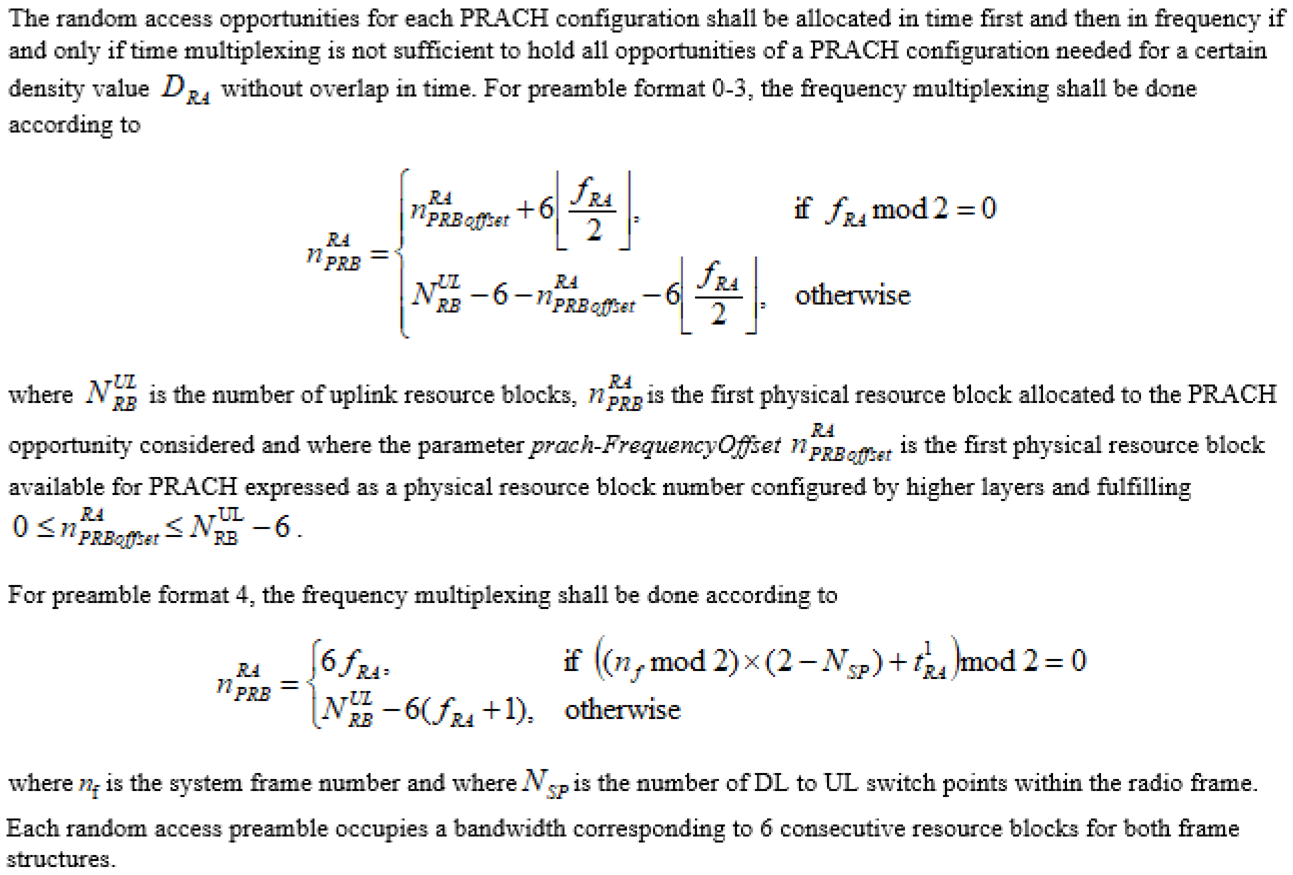
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure …  For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$. …

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 4

“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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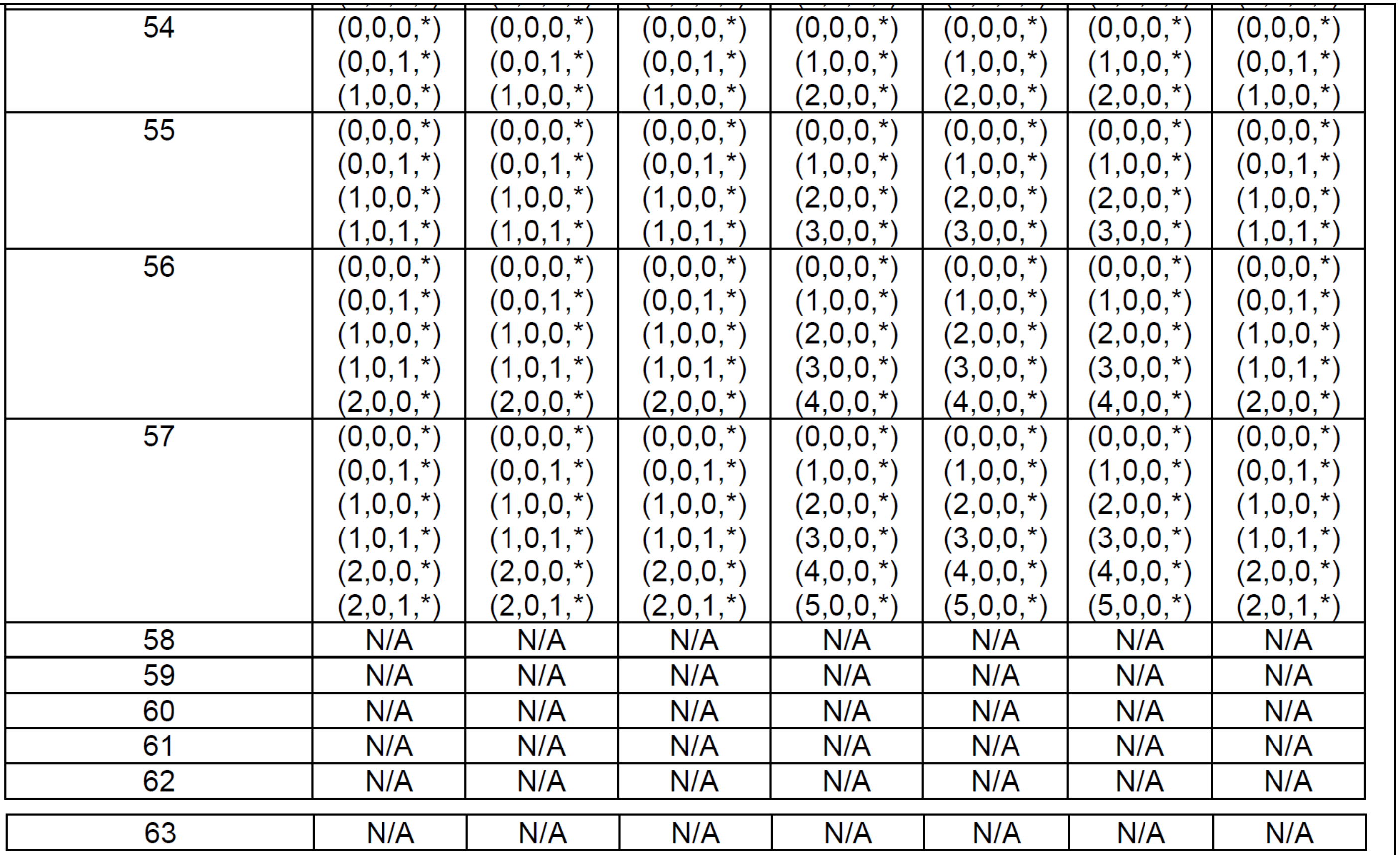
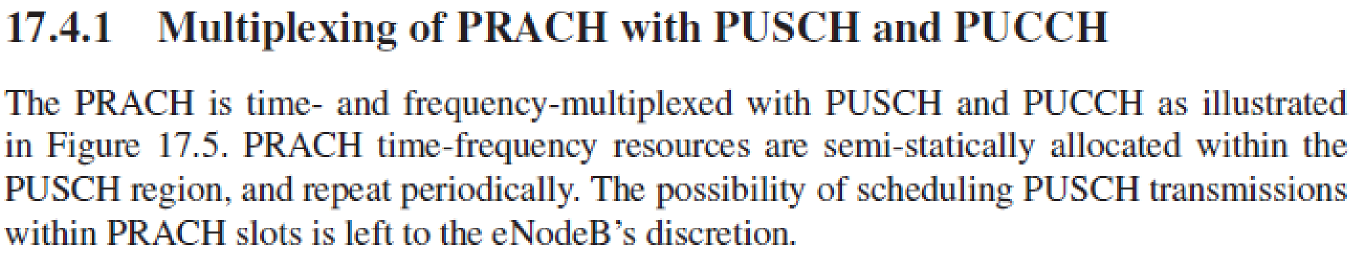
US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

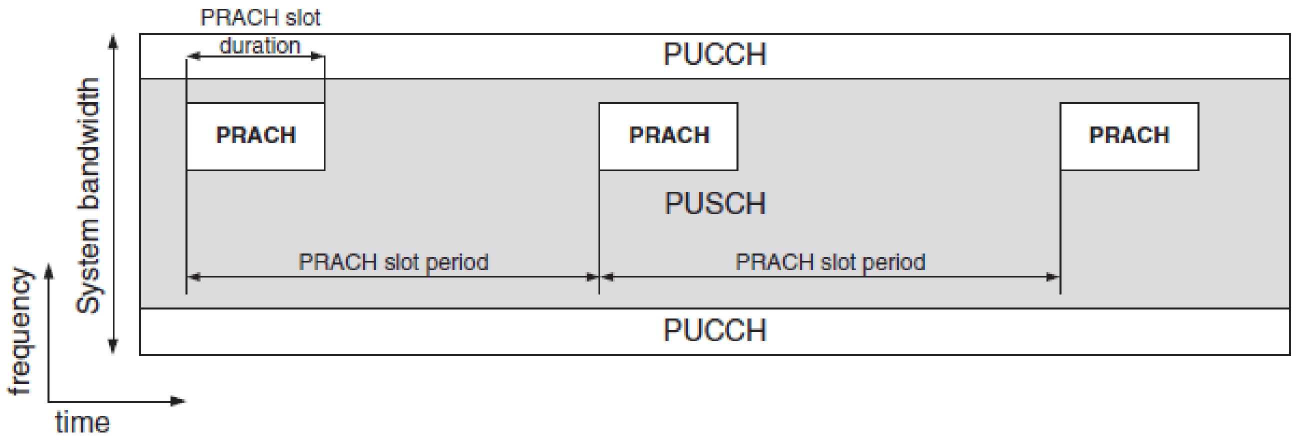
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



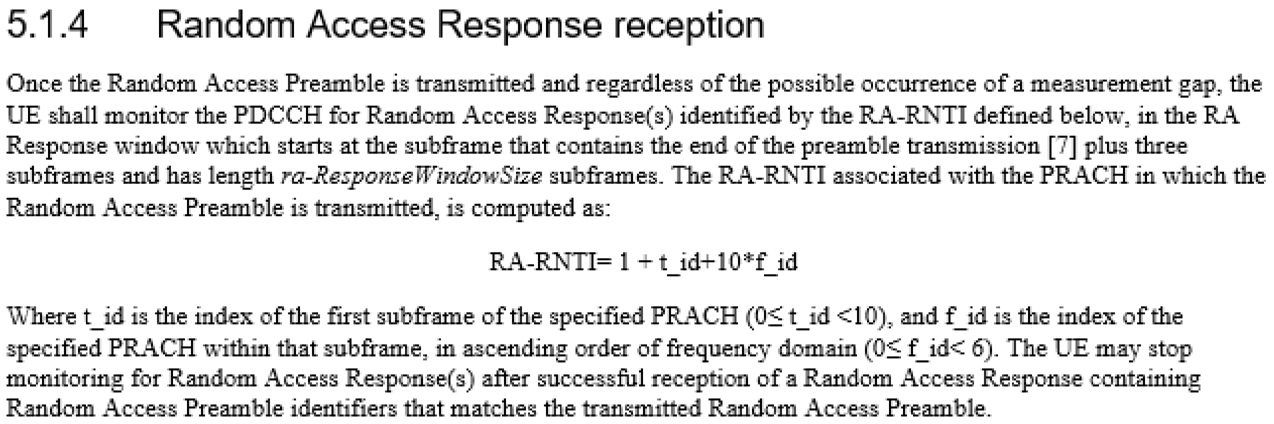
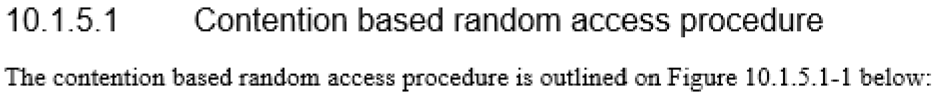
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

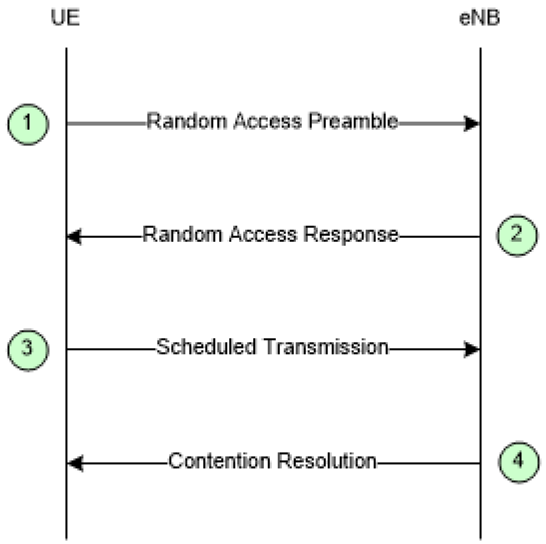
US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

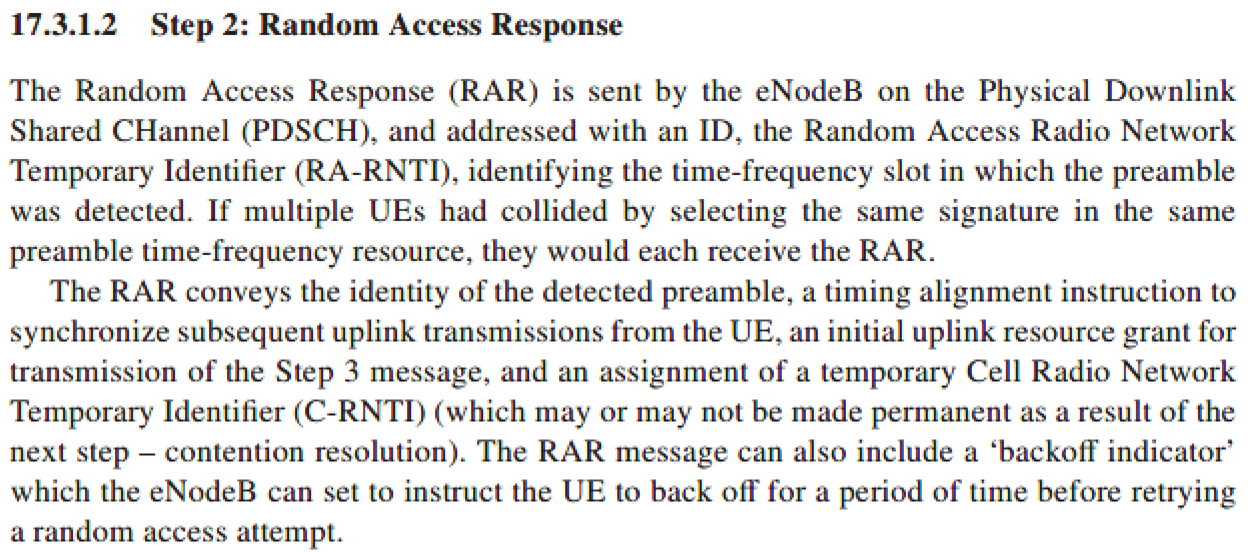
US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Tesla’s Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  **5.1.4 Random Access Response reception** Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **10.1.5.1 Contention based random access procedure** The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

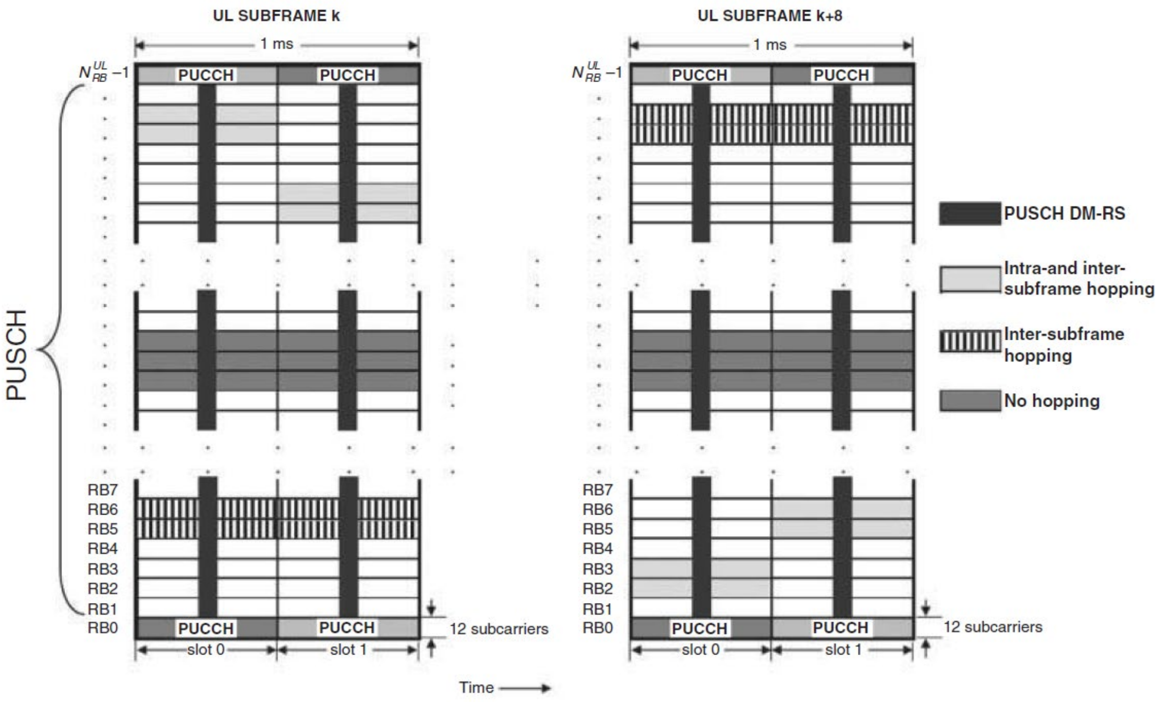
US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

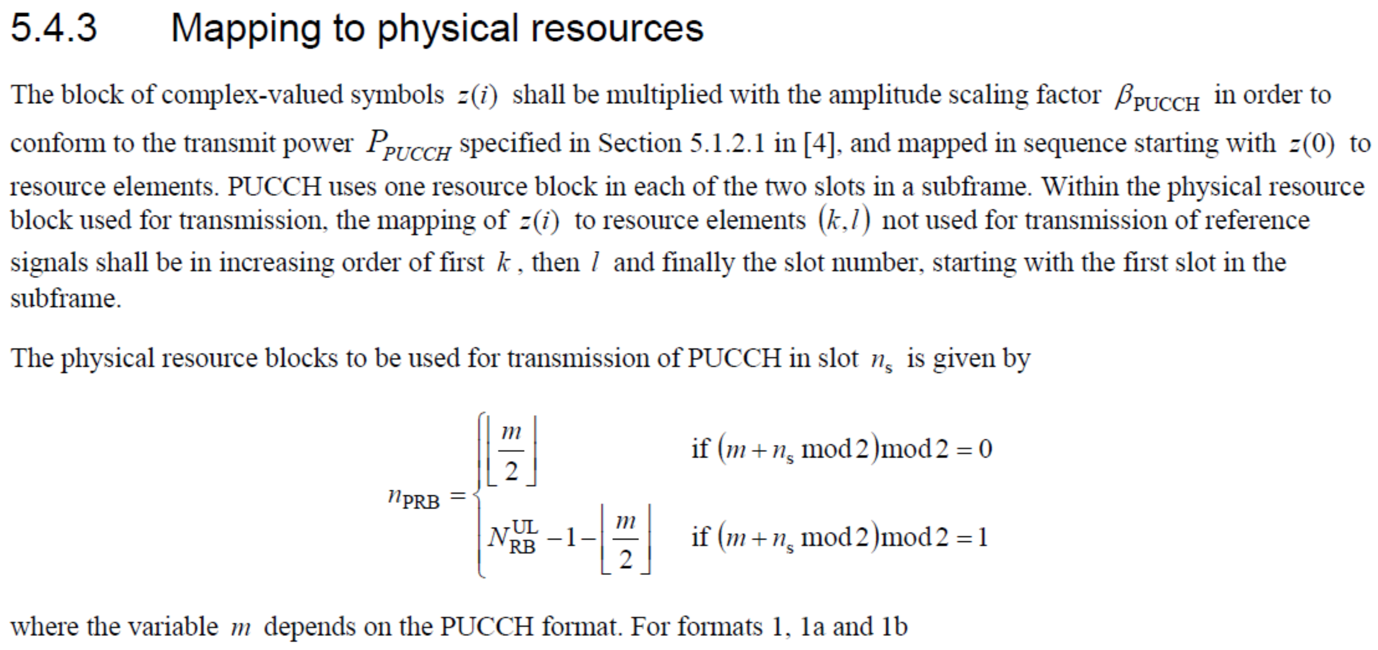
US Patent No. 10,833,908: Claim 6
"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Tesla's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

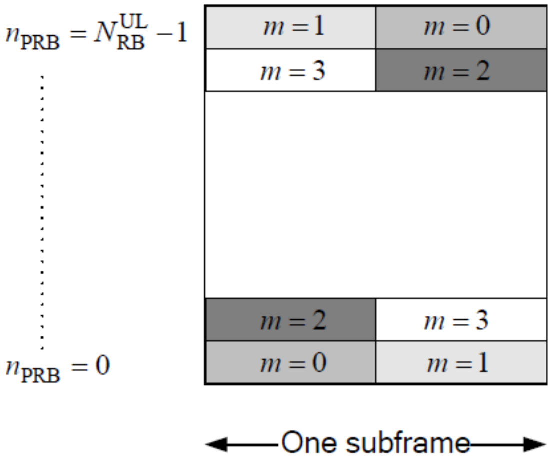
US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Tesla's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

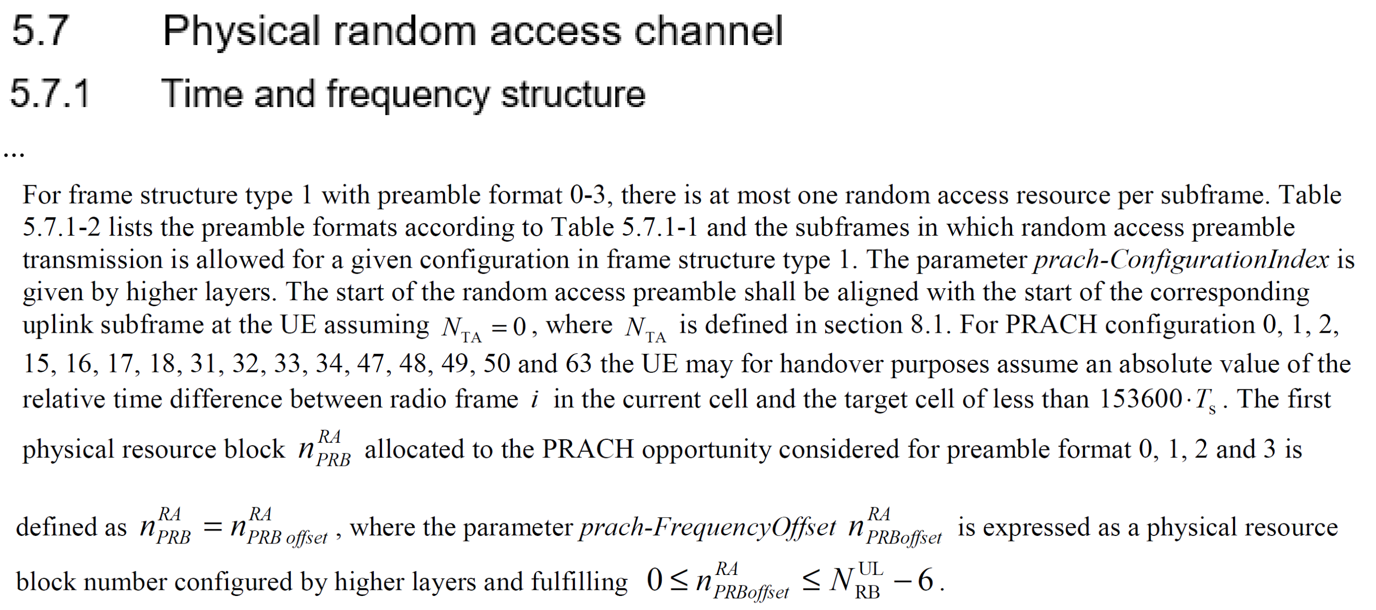
US Patent No. 10,833,908: Claim 7
“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

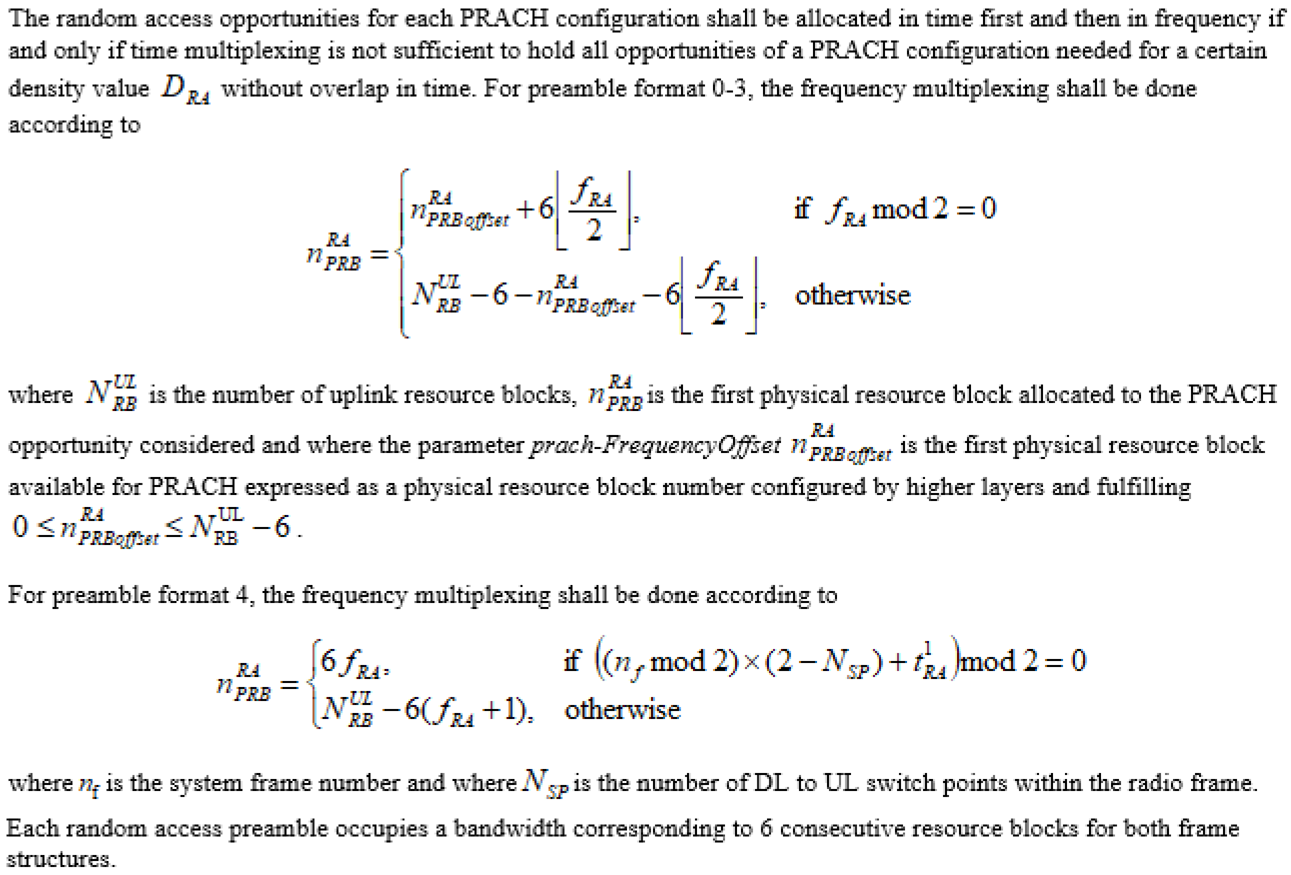
	$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \frac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \frac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$ $c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$ and for formats 2, 2a and 2b $m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$ Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1. In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.  **Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21. The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_s$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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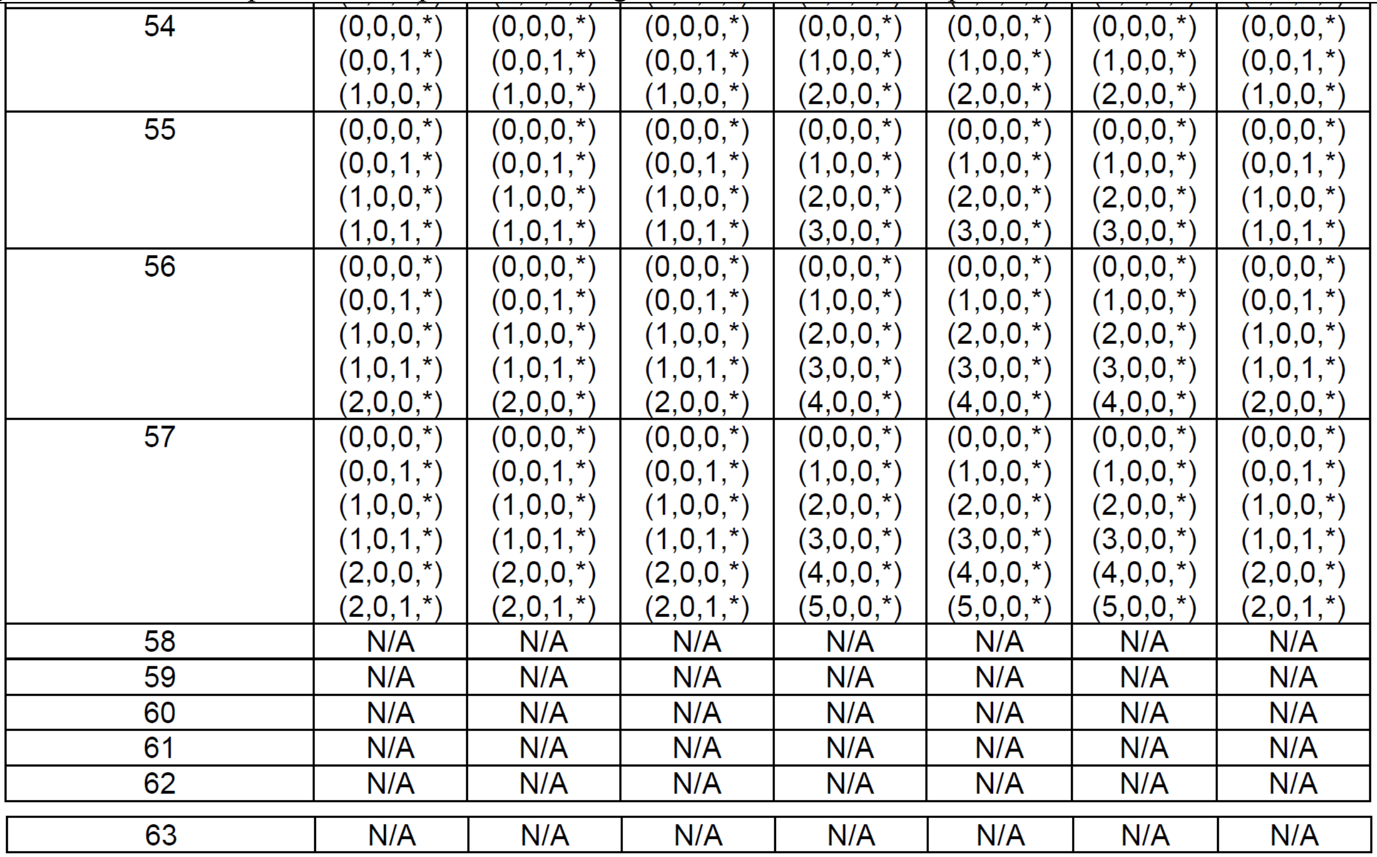
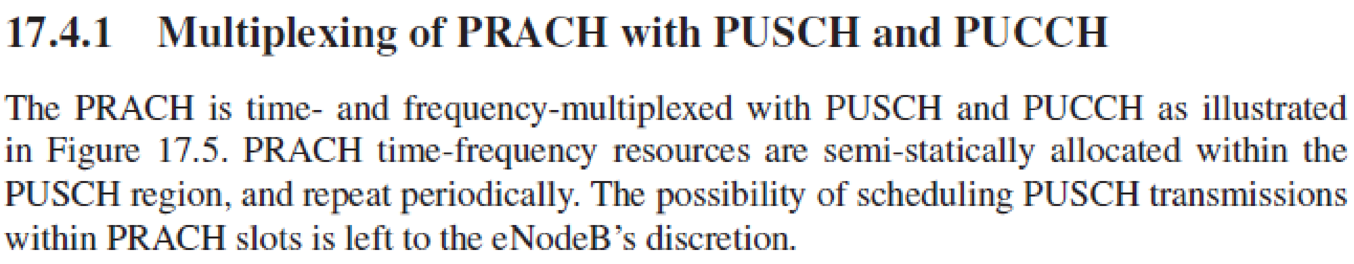


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

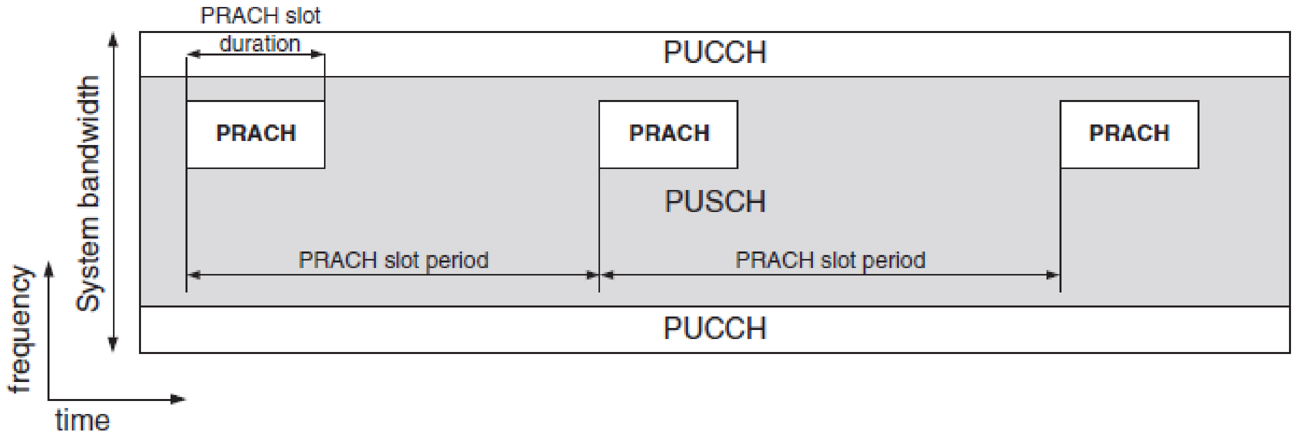


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

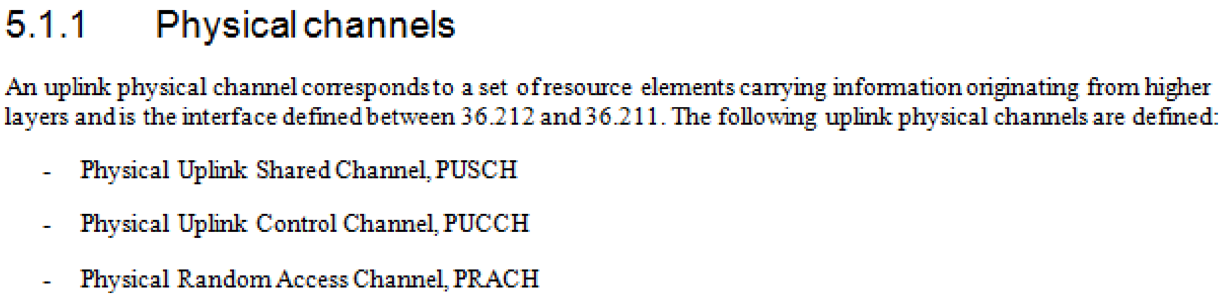
US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

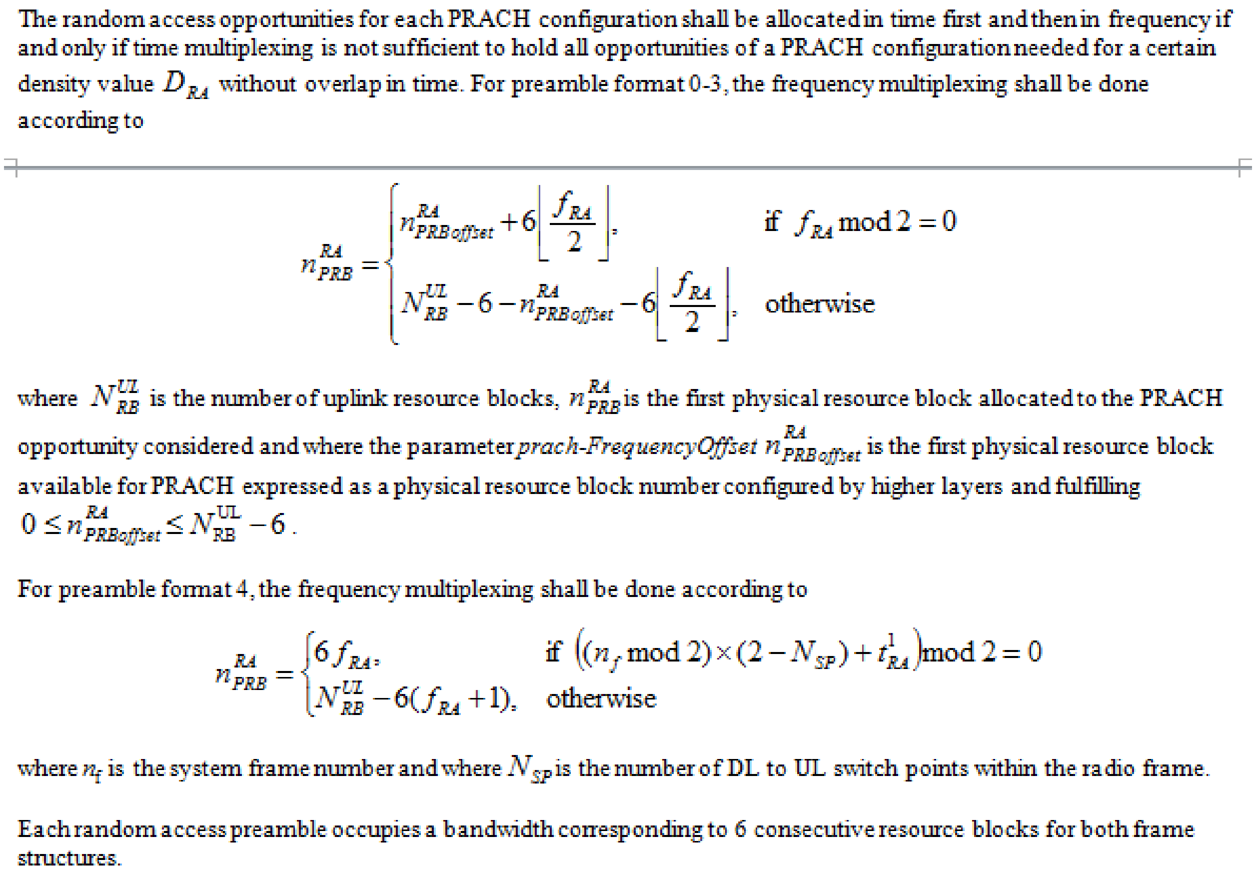
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 8

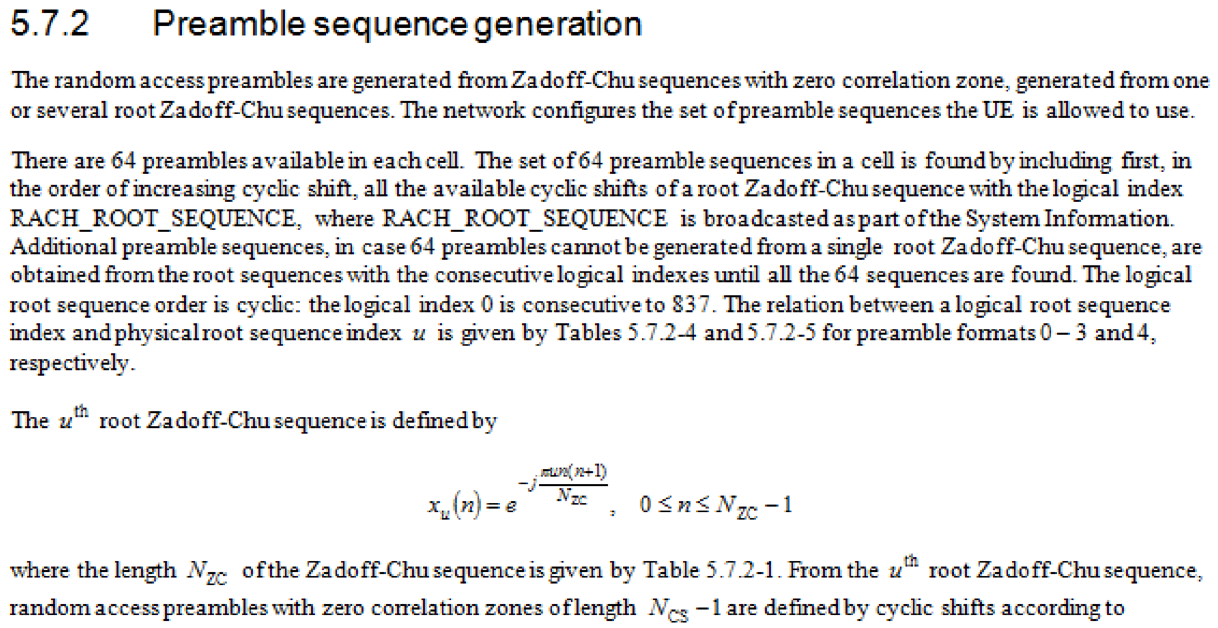
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Tesla’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

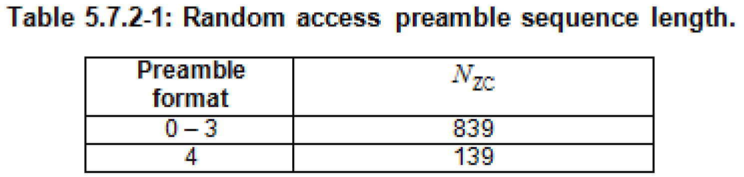
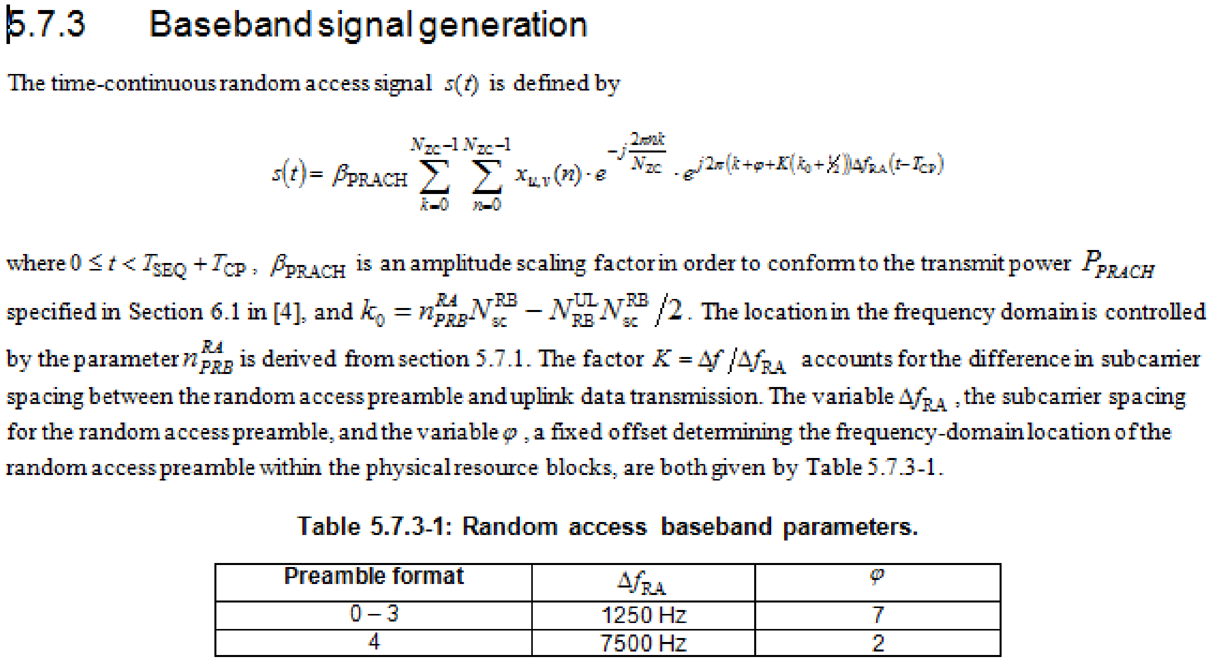


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

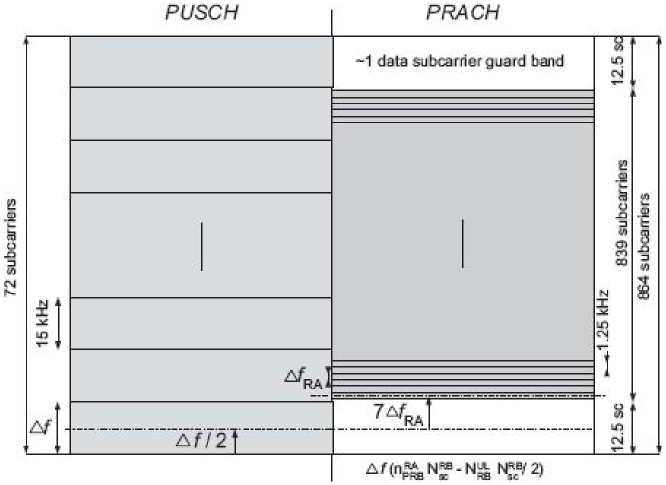
where $0 \le t < T_{\mathrm{SEQ}} + T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}} - N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

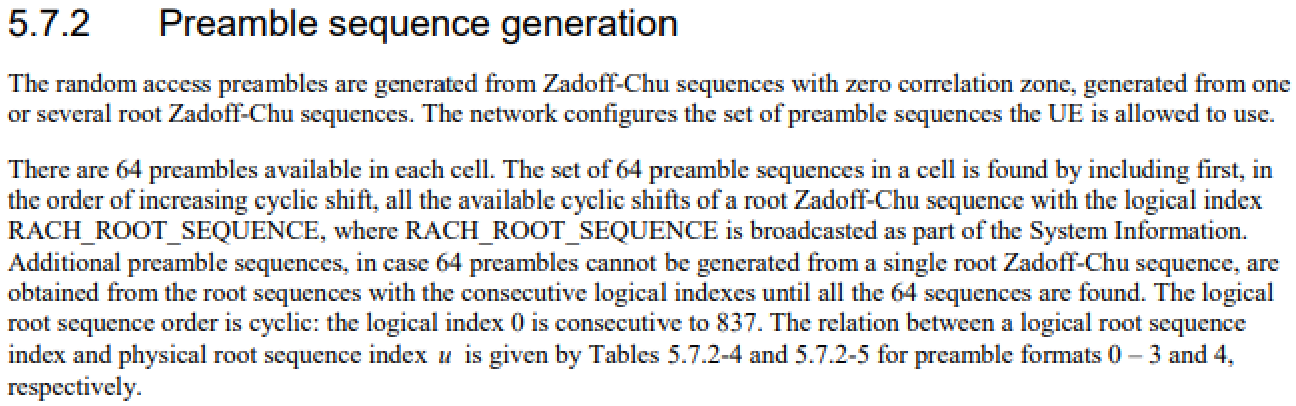
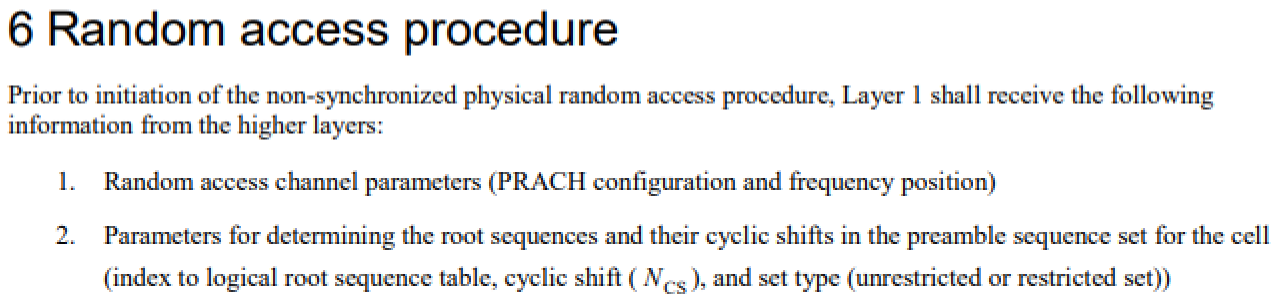
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 9
“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Tesla’s Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information. 5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39. 6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

US Patent No. 10,833,908: Claim 9

“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

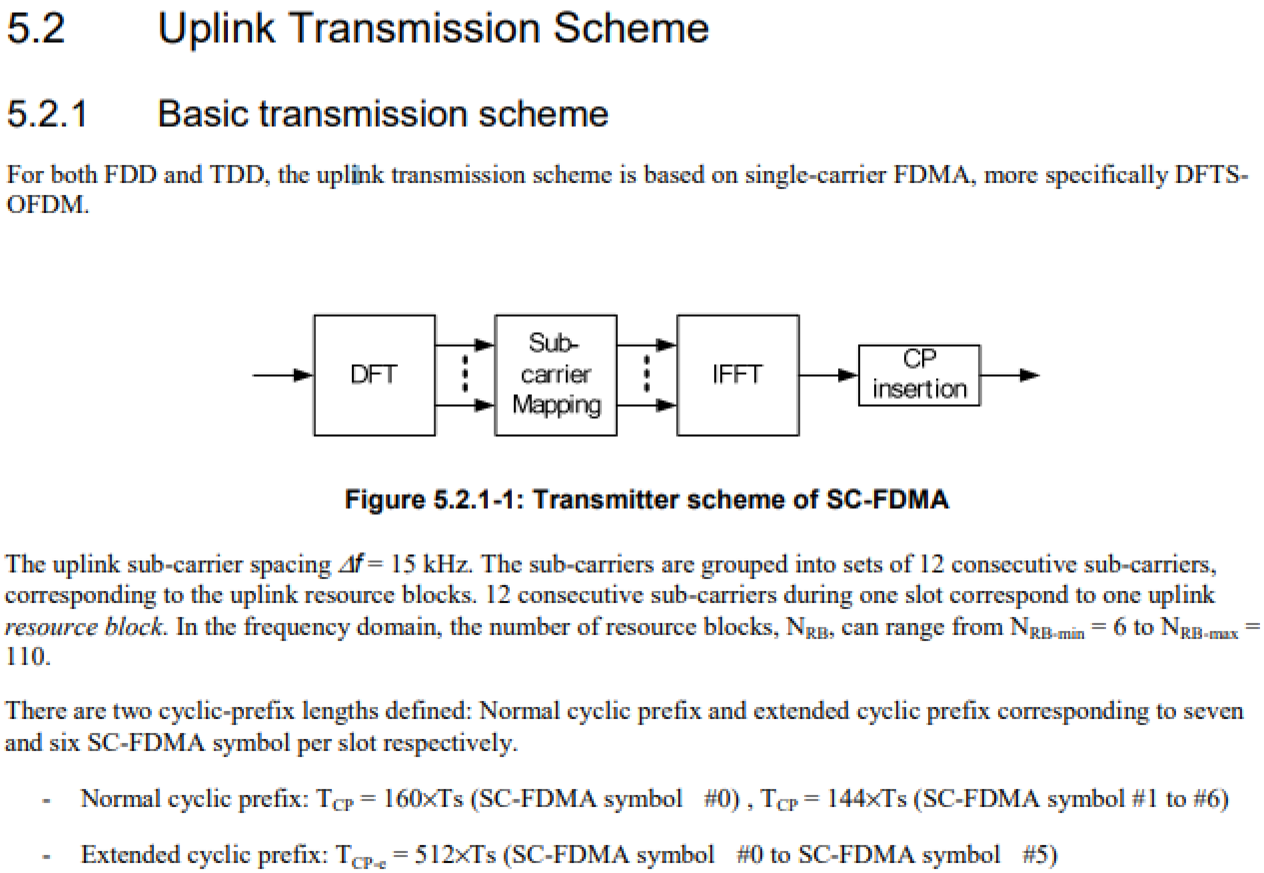
"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

<table>
<tr>
<td>10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.</td>
<td>

See Claim 1.

Tesla's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,*

Tesla's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:



5.2 Uplink Transmission Scheme

5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

</td>
</tr>
</table>

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

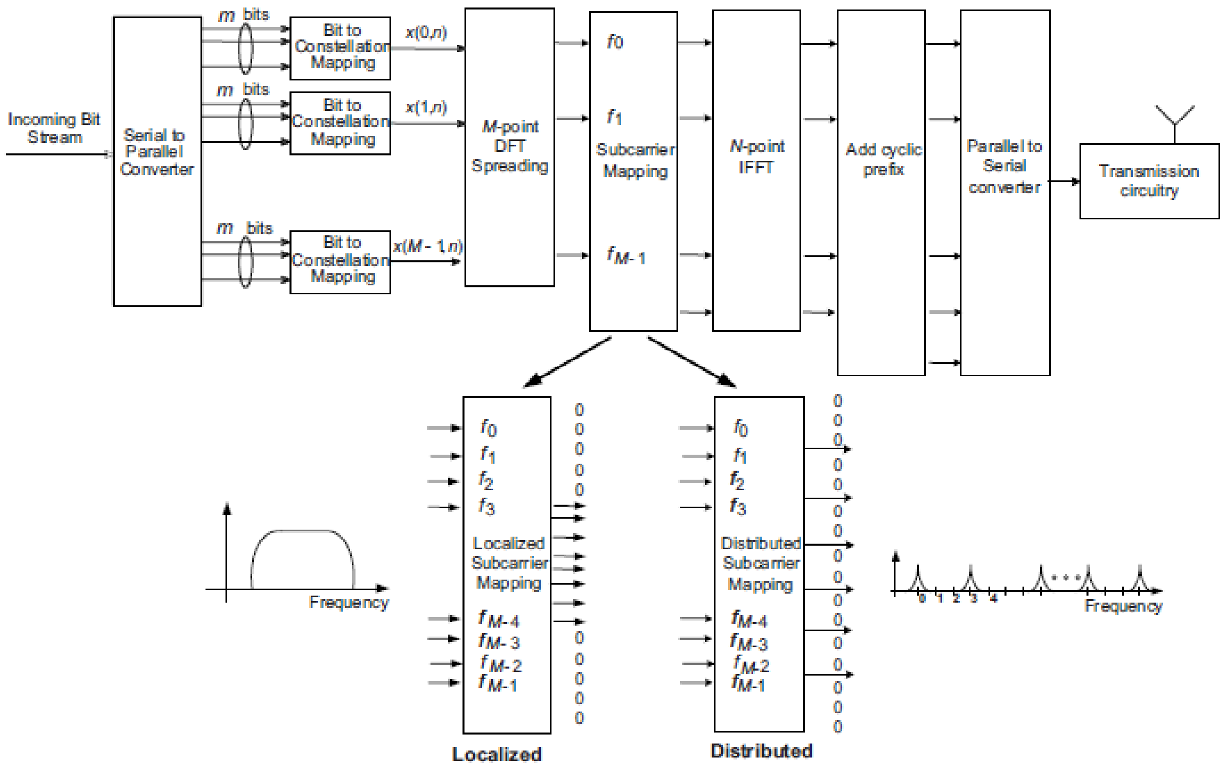
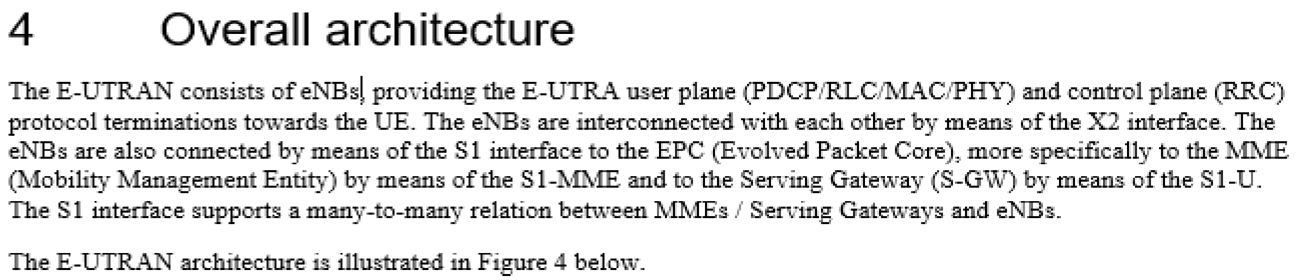


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, Tesla's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* Tesla's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Tesla offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

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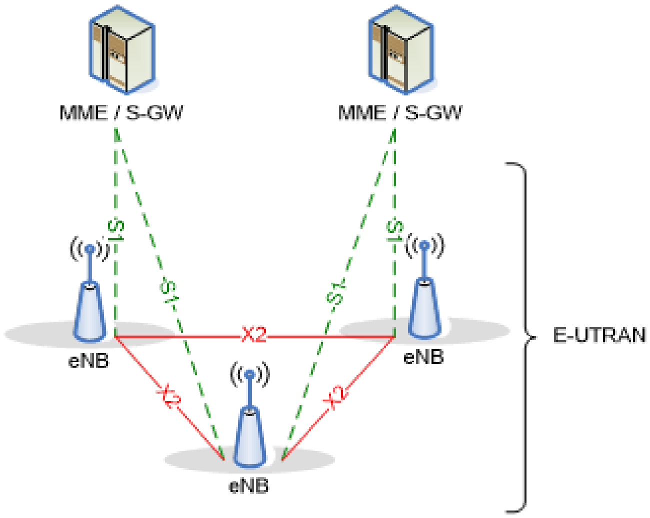


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

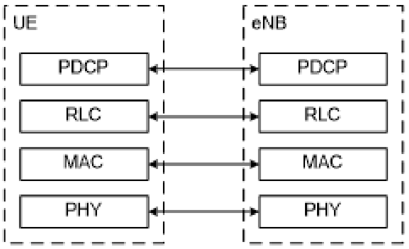


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

</td>
</tr>
</table>

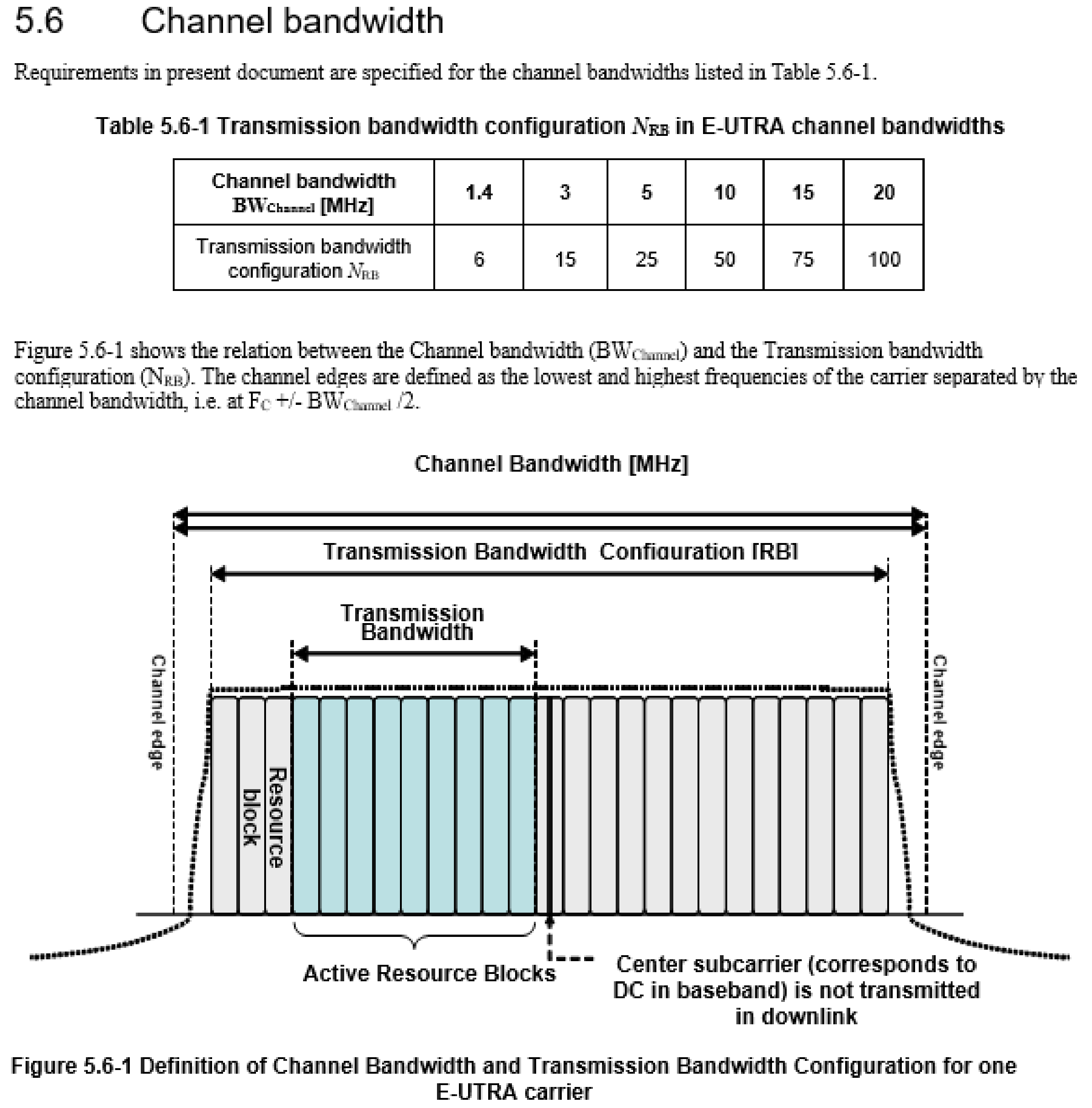
US Patent No. 10,833,908: Claim 11(b)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Tesla’s Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

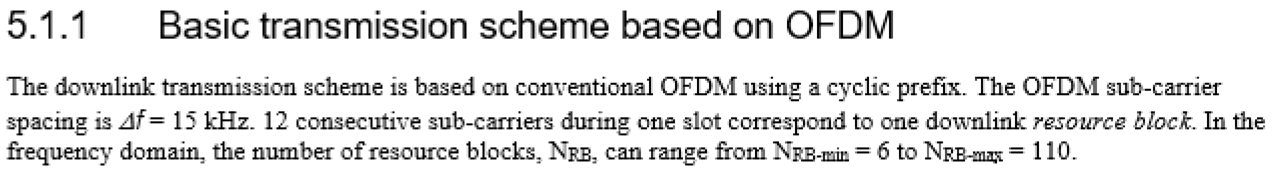
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

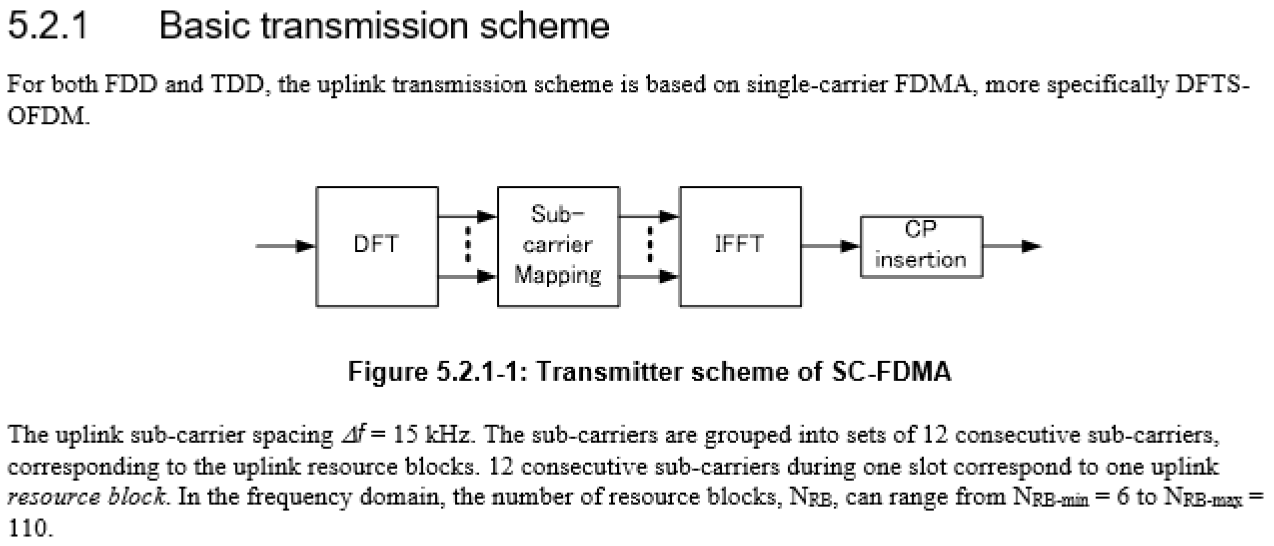
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

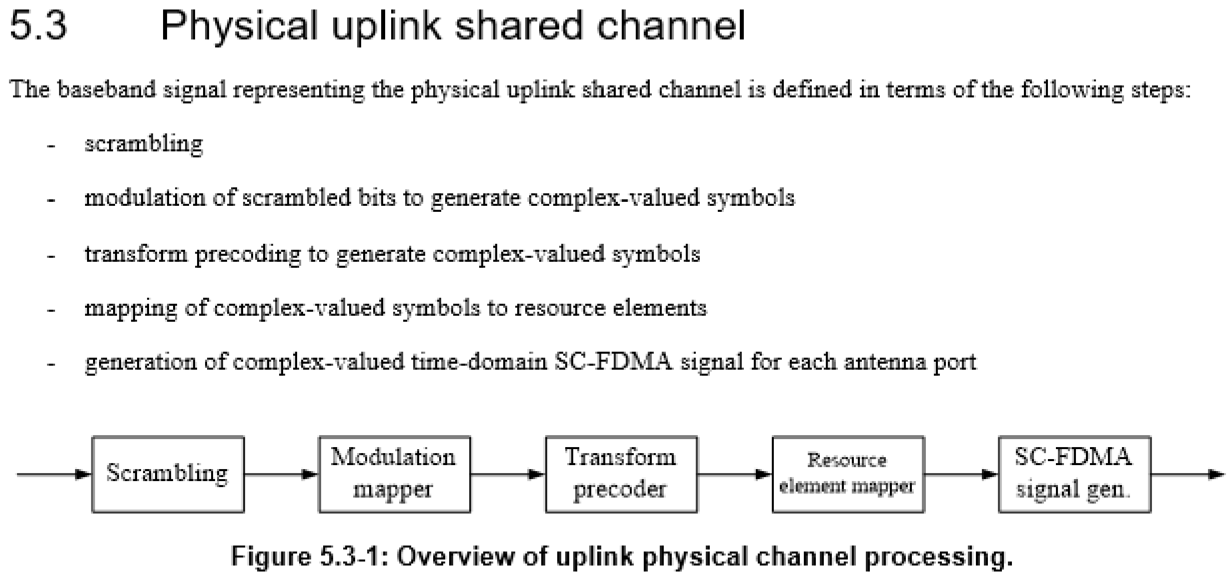
The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

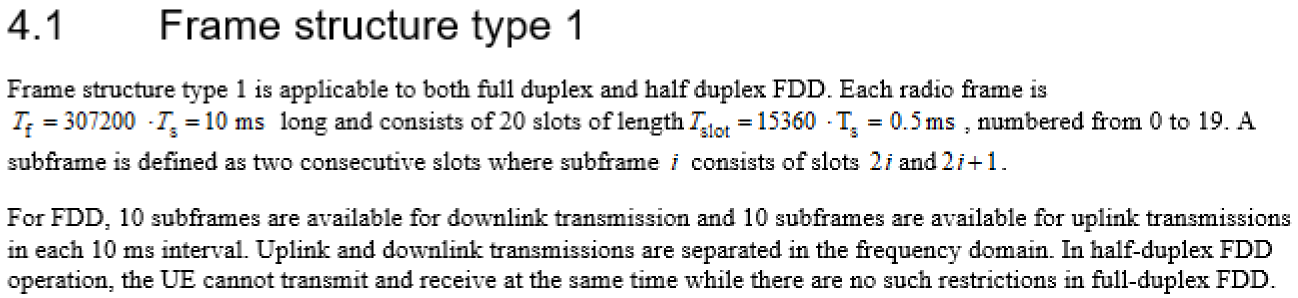
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\ \text{ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\ \text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

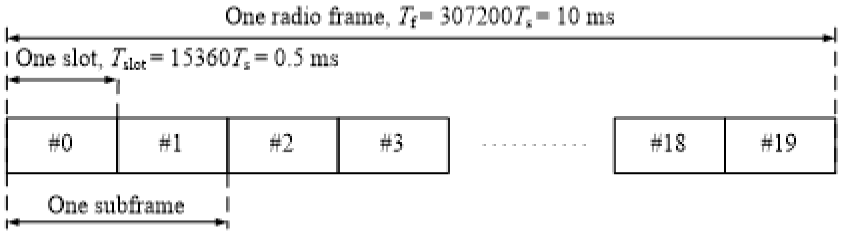
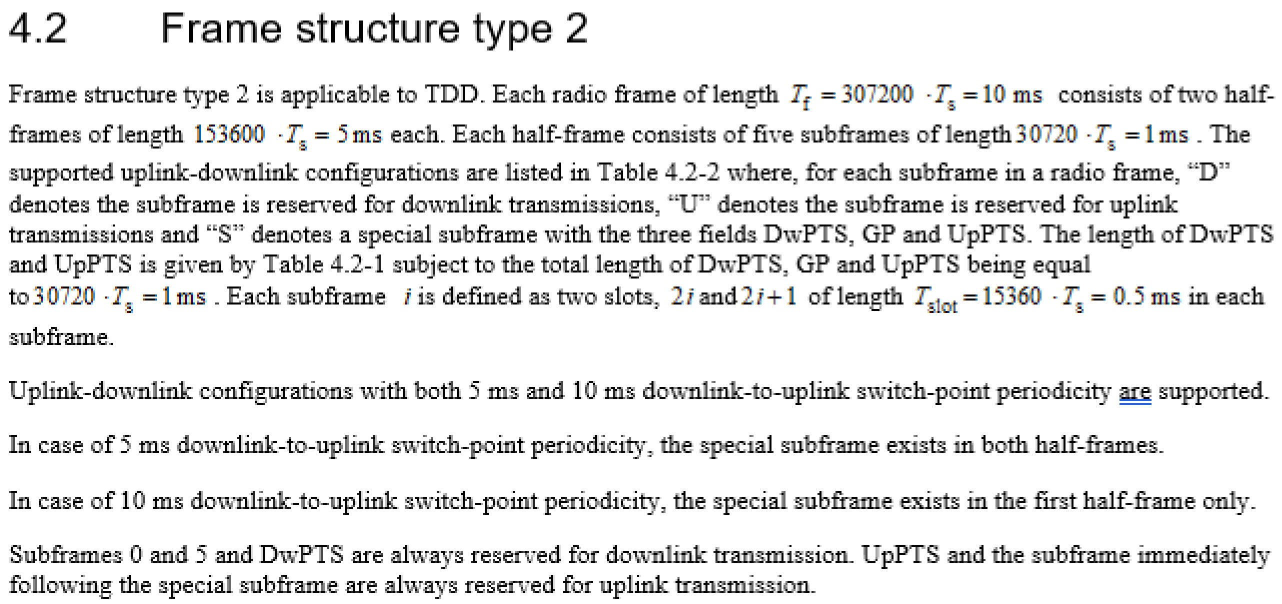


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms . The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms . Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

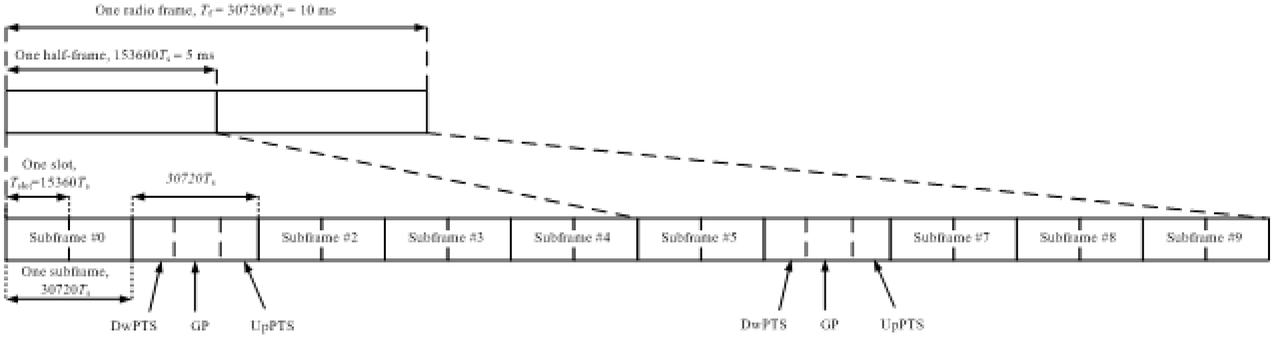
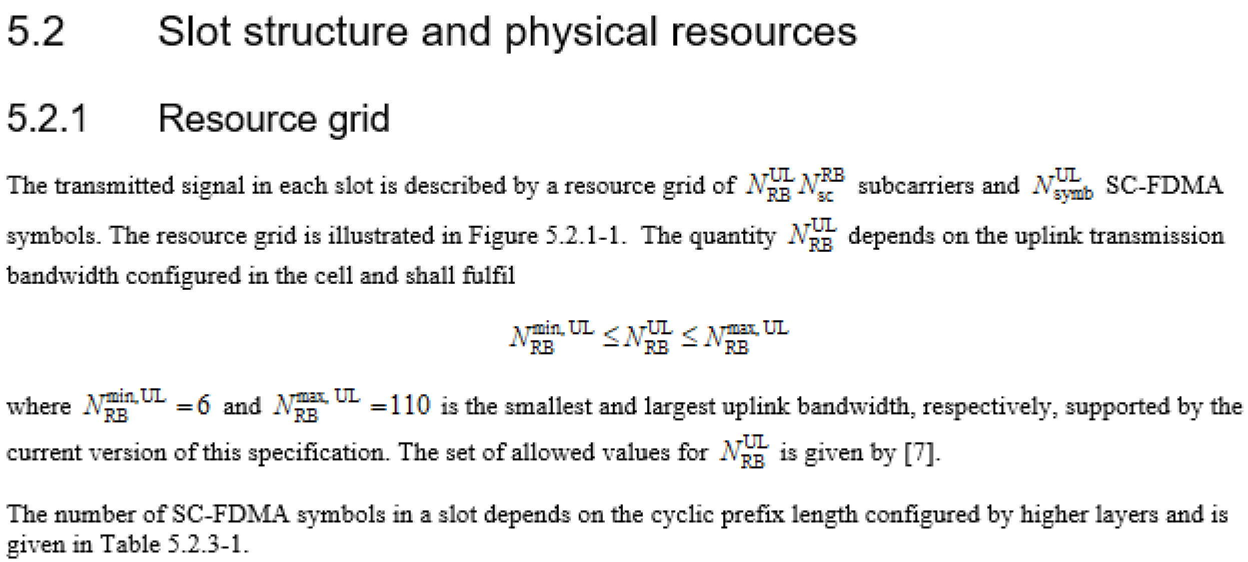


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

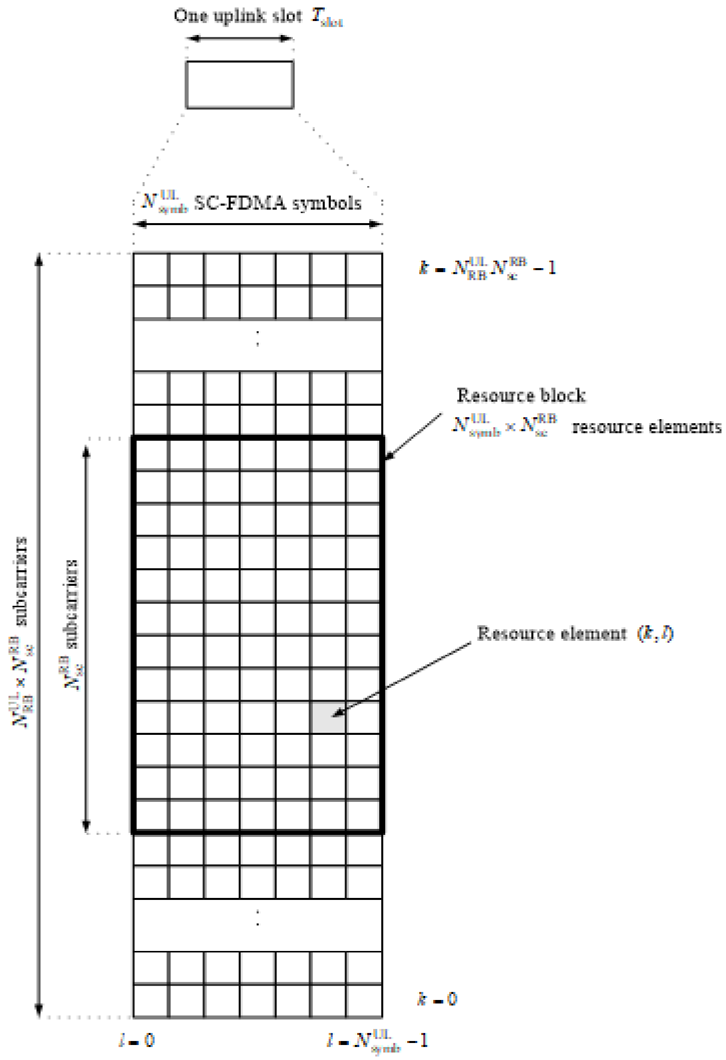
The transmitted signal in each slot is described by a resource grid of $N_{RB}^{UL} N_{sc}^{RB}$ subcarriers and N_{symb}^{UL} SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity N_{RB}^{UL} depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{RB}^{min,UL} \leq N_{RB}^{UL} \leq N_{RB}^{max,UL}$$

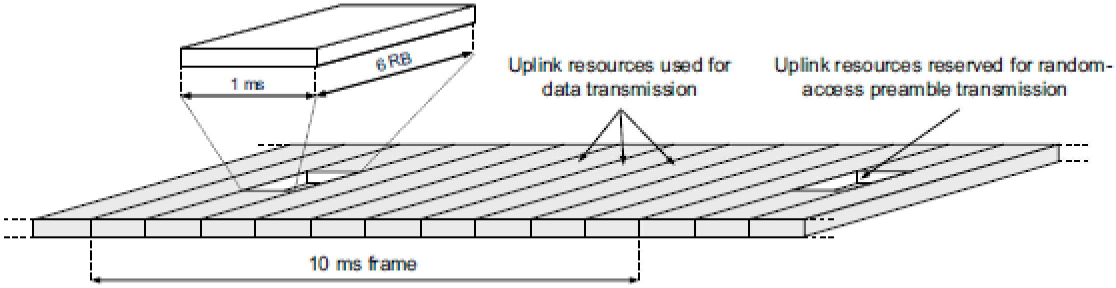
where $N_{RB}^{min,UL} = 6$ and $N_{RB}^{max,UL} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for N_{RB}^{UL} is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

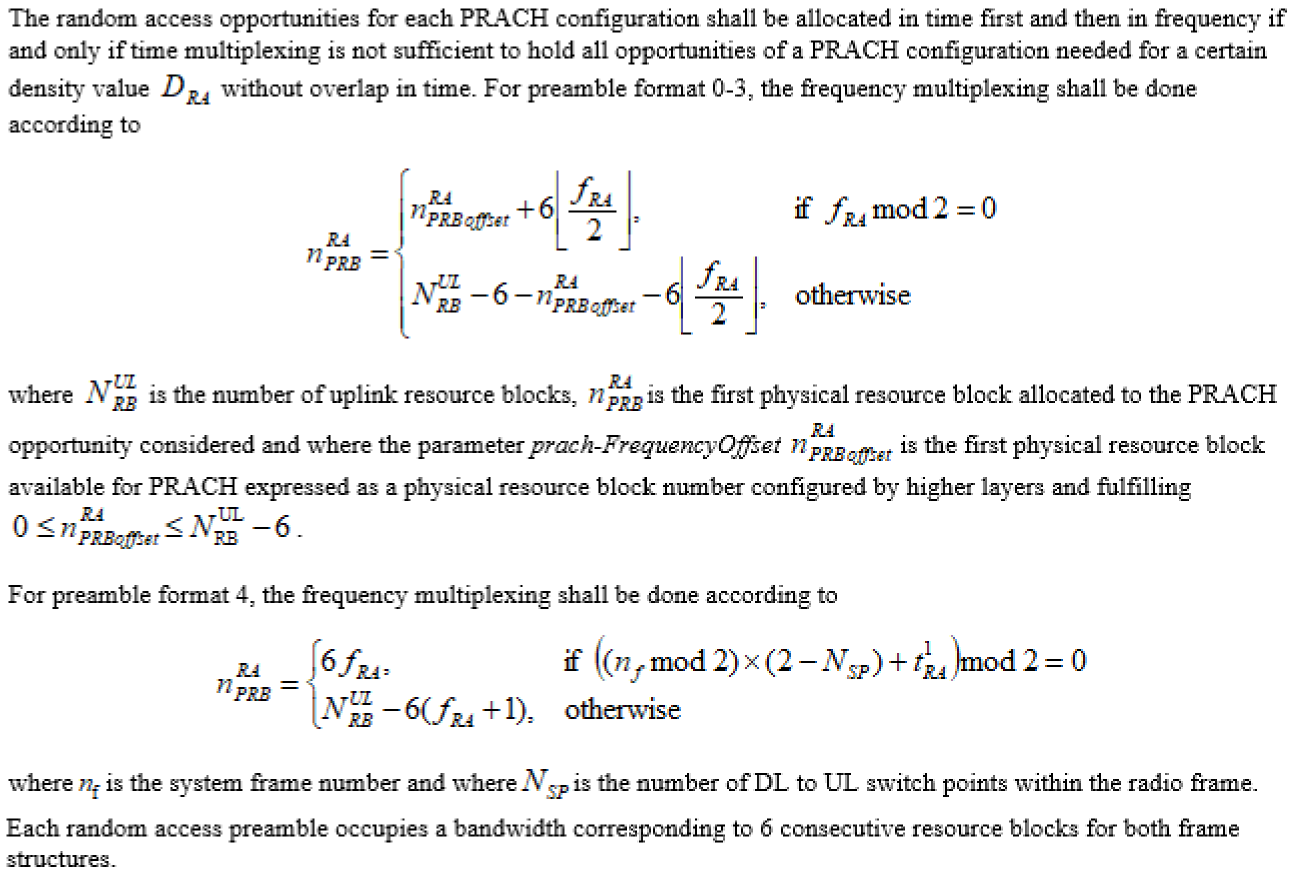
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	Tesla’s Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

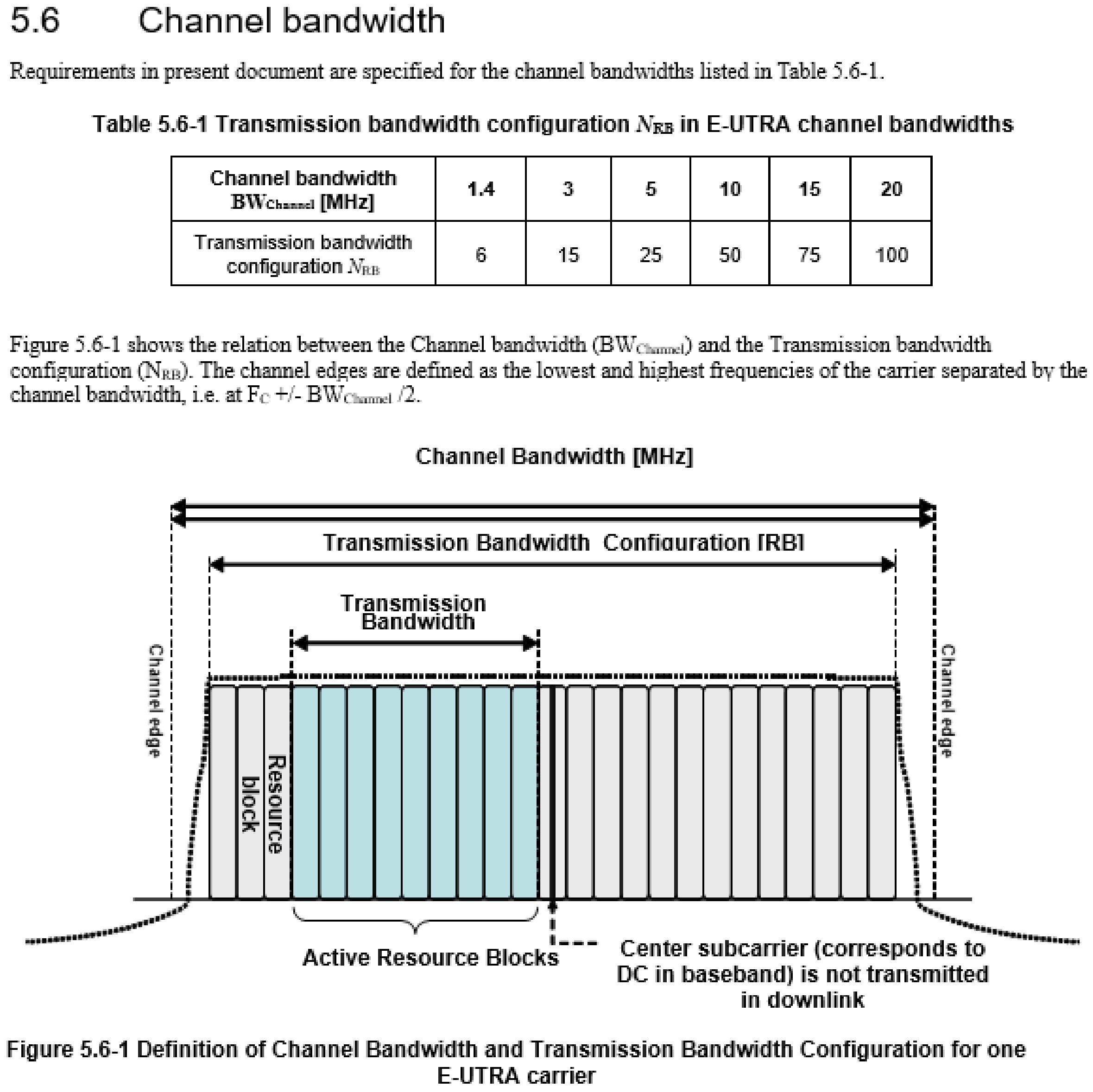
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

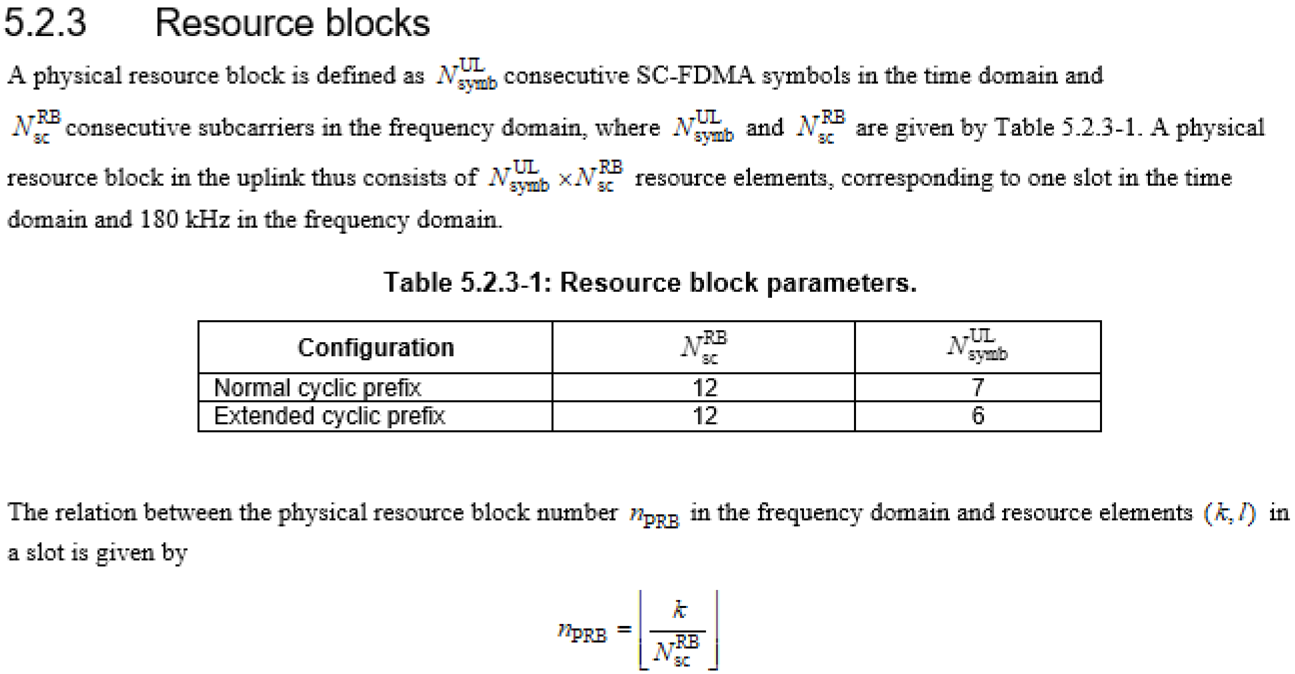
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

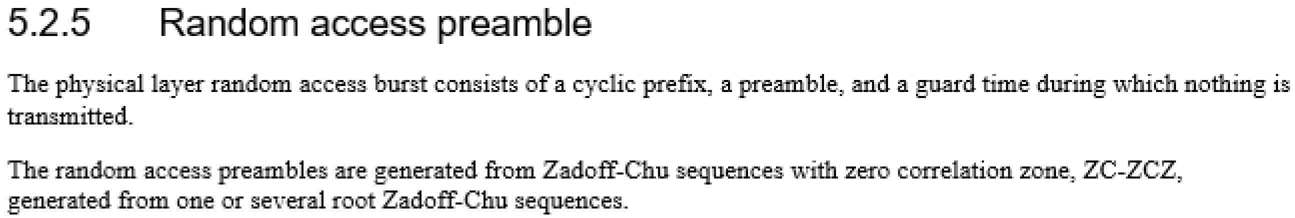
Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\mathrm{PRB}} = \left\lfloor \frac{k}{N_{\mathrm{sc}}^{\mathrm{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

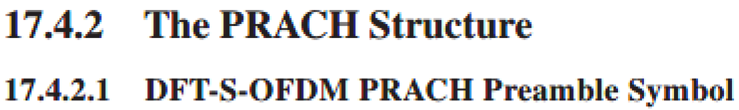


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.



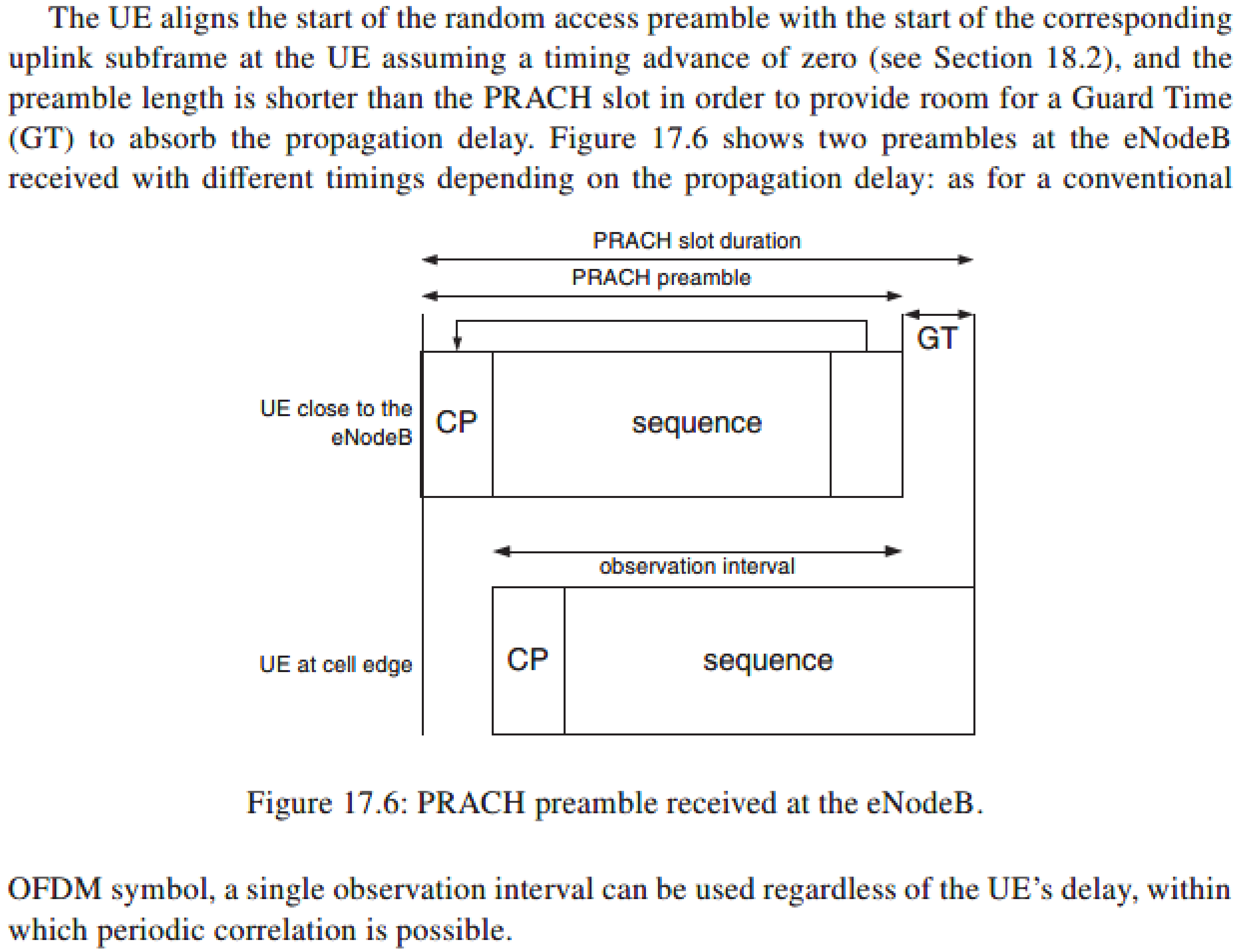
17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional

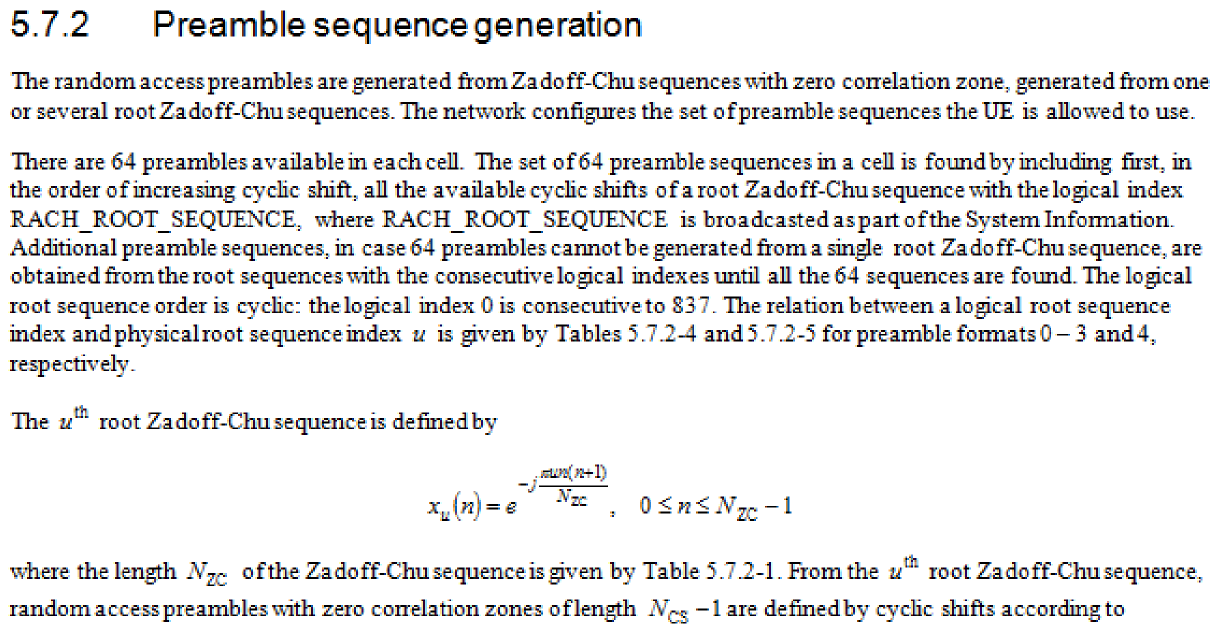
Figure 17.6: PRACH preamble received at the eNodeB.

OFDM symbol, a single observation interval can be used regardless of the UE's delay, within which periodic correlation is possible.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pgs. 377-378.

The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

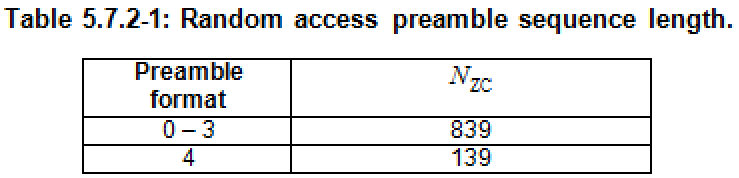


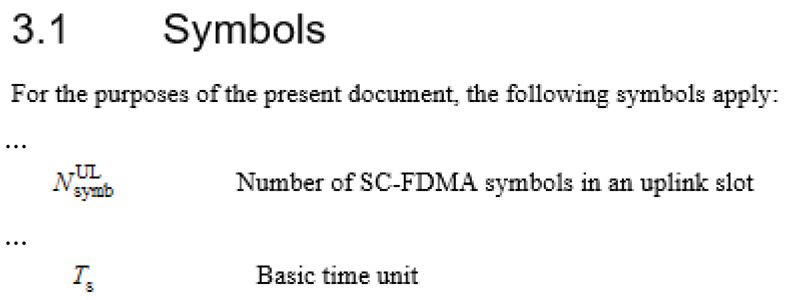
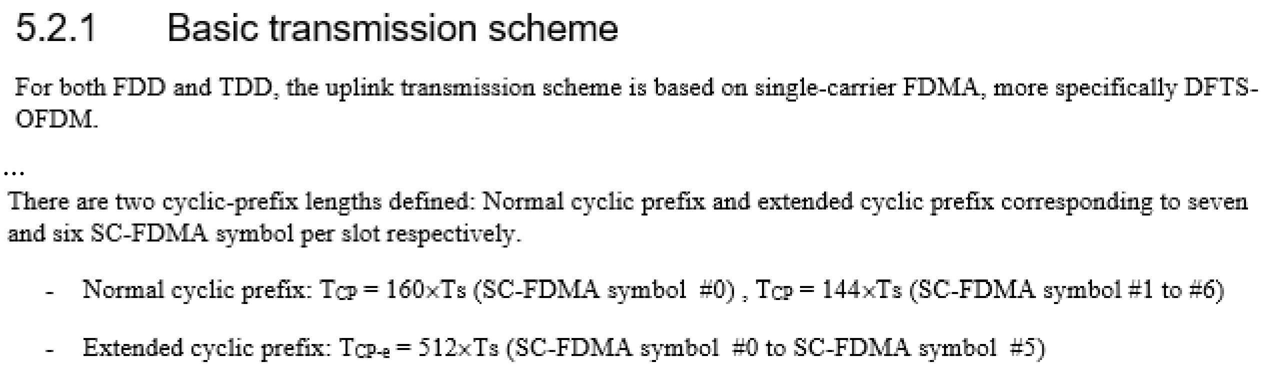
Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

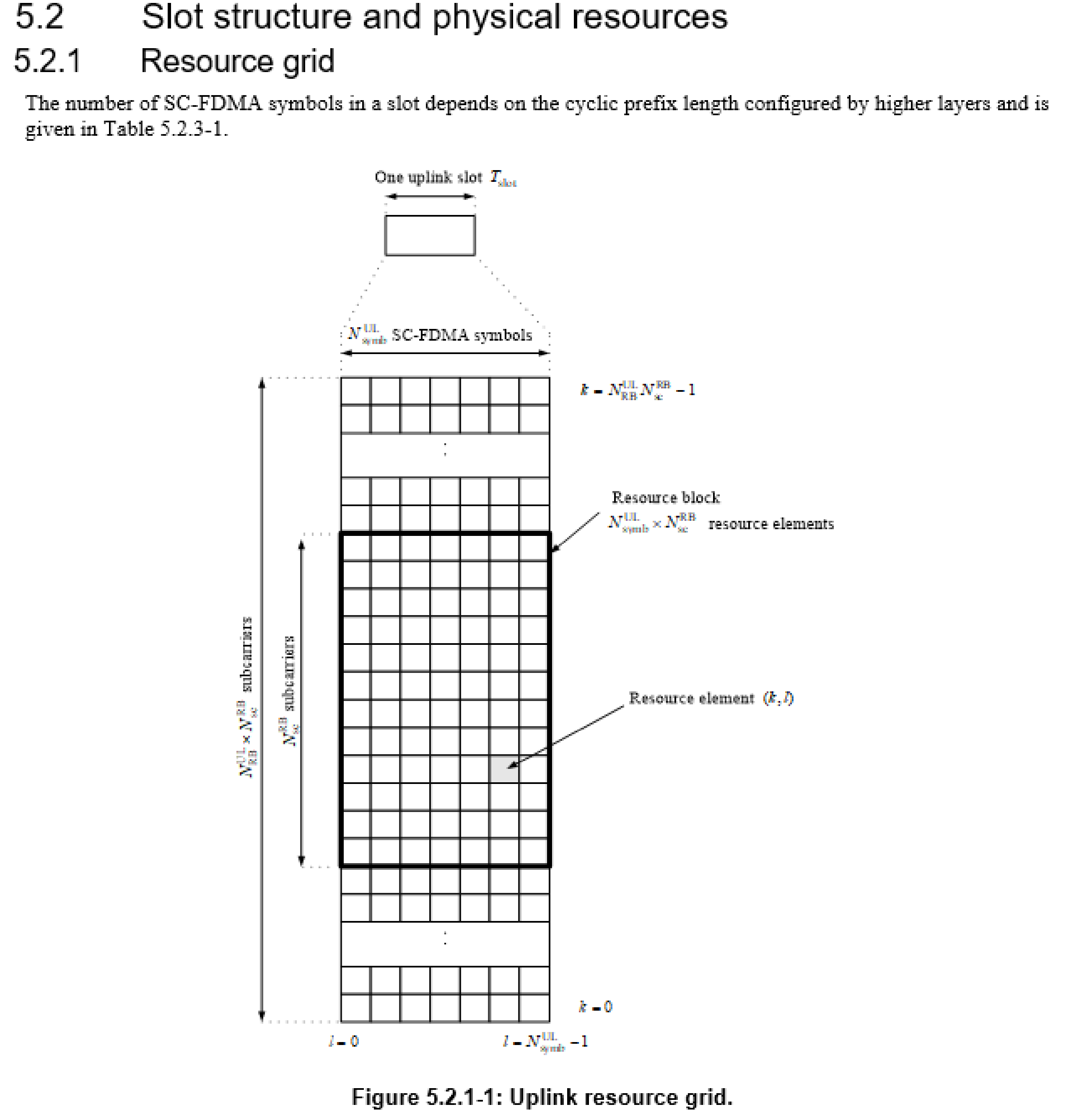
US Patent No. 10,833,908: Claim 11(d)

“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Tesla’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\mathrm{symb}}^{\mathrm{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_{s} Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP-e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)

"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



5.2 Slot structure and physical resources

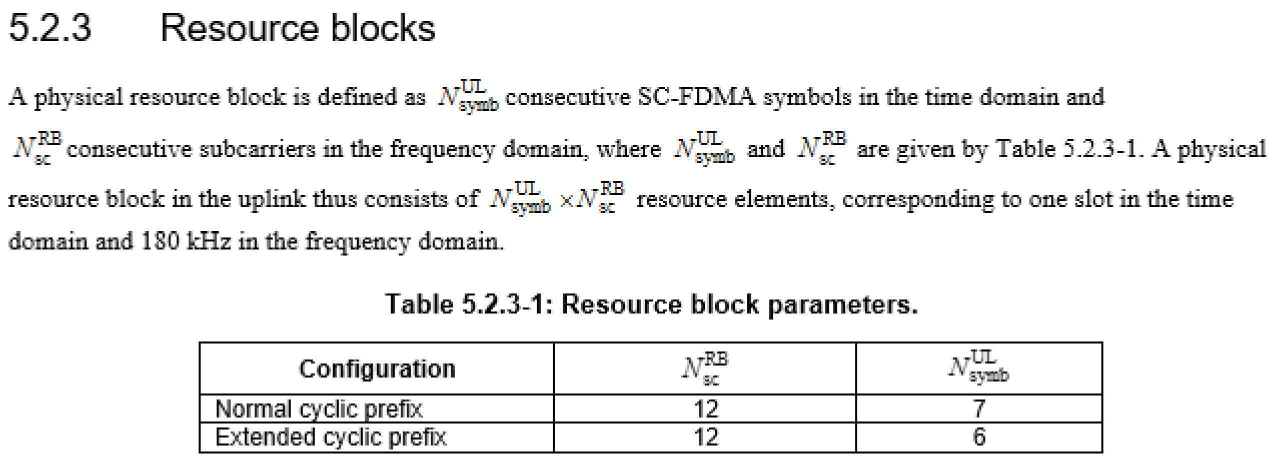
5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

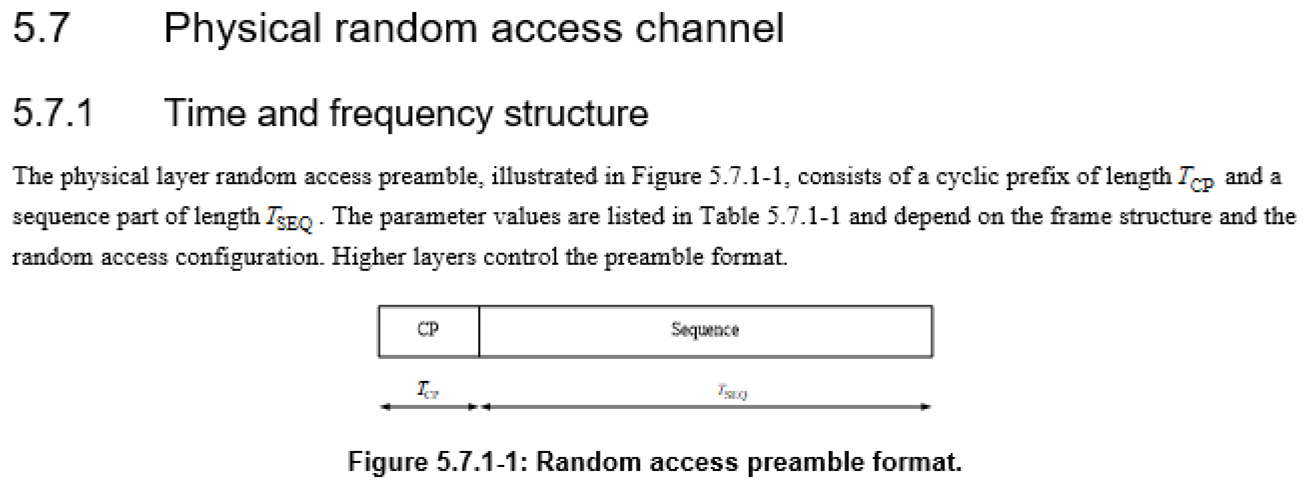
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

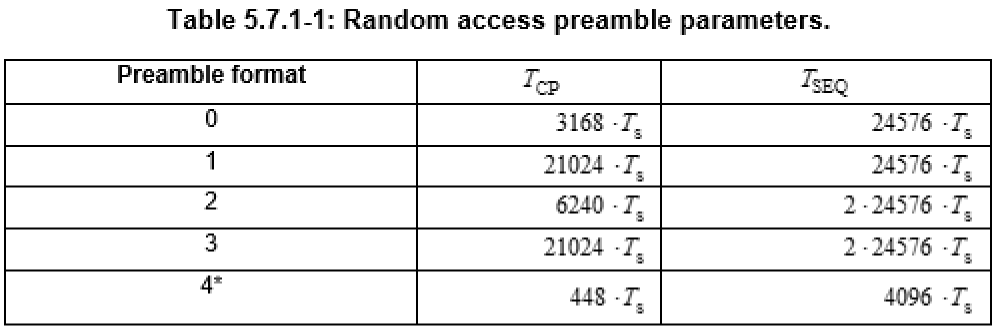
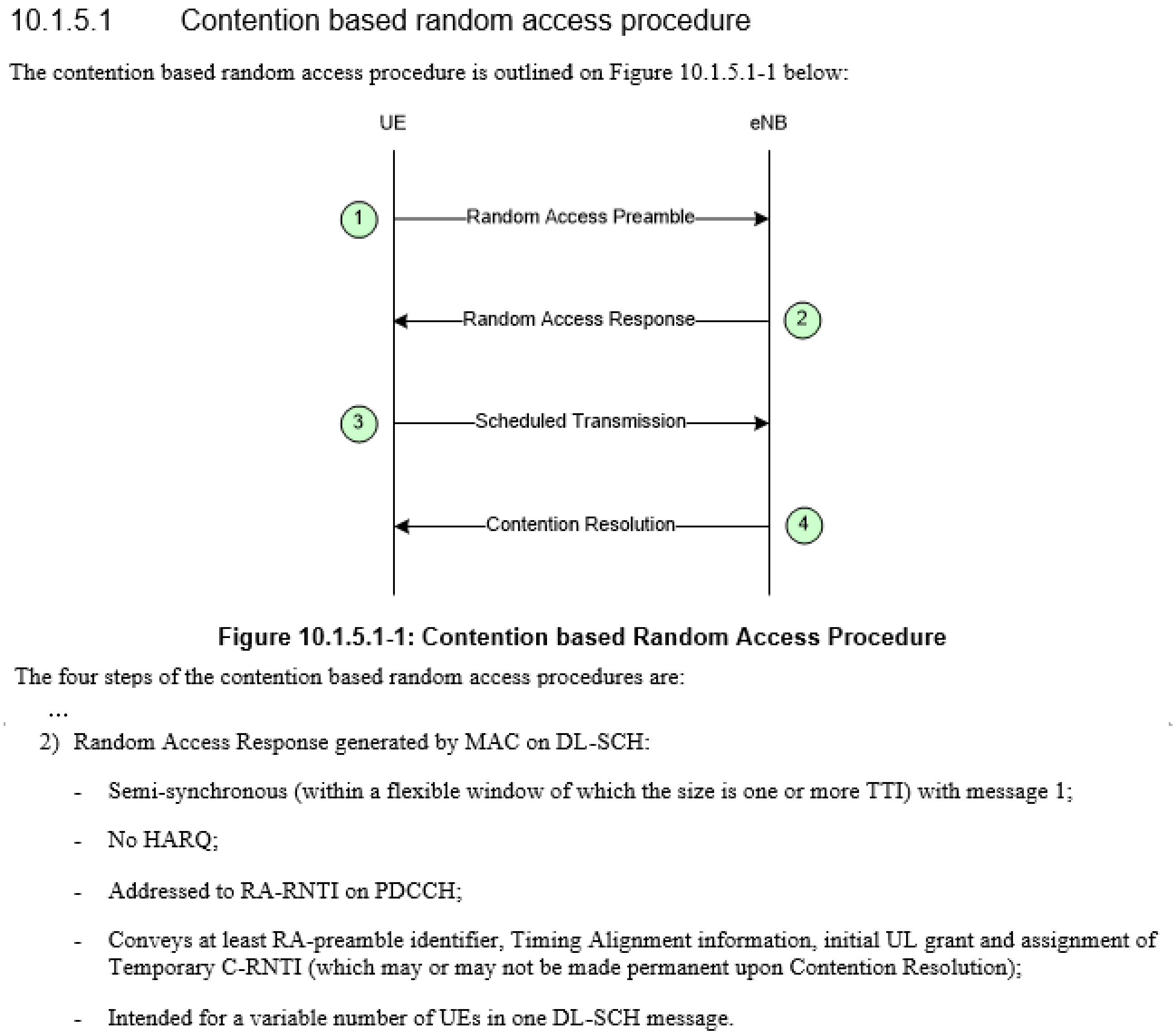


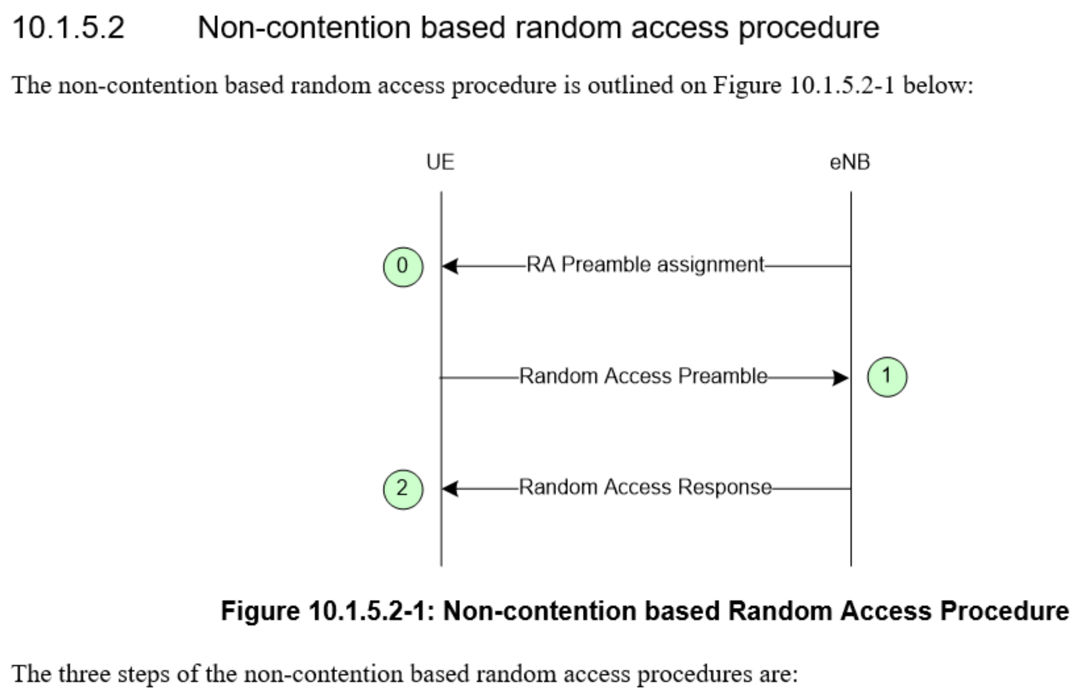
Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

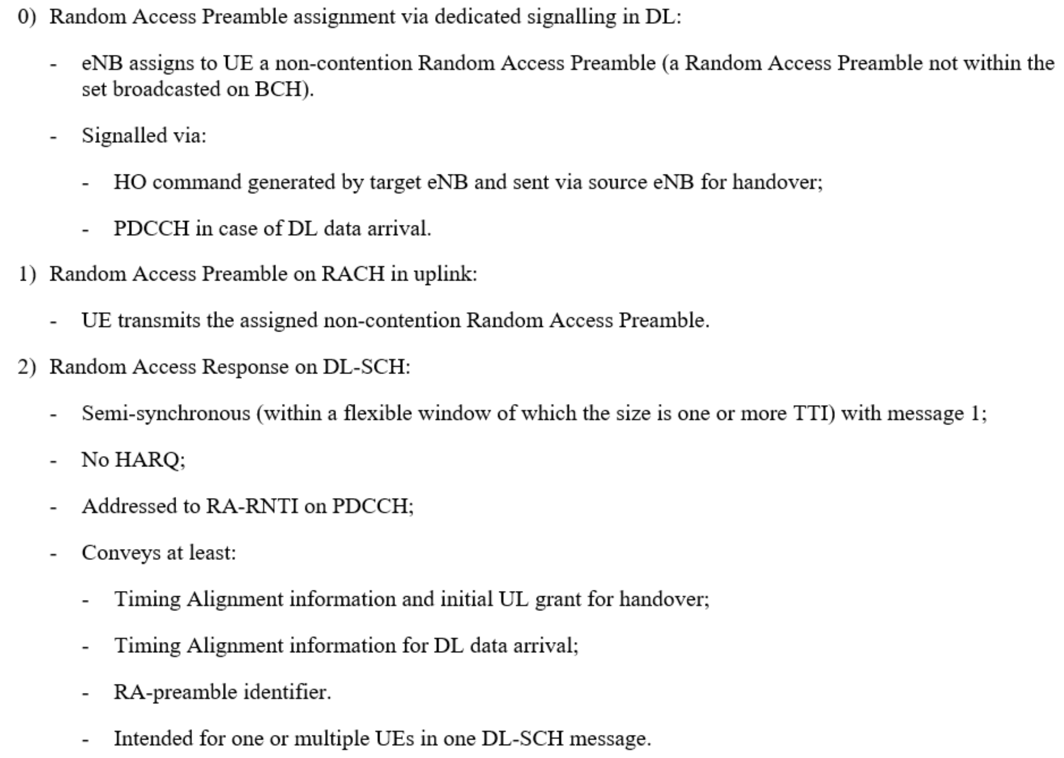
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

receiving, from the base station, a response message. ;	Tesla's Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.  10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below: **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

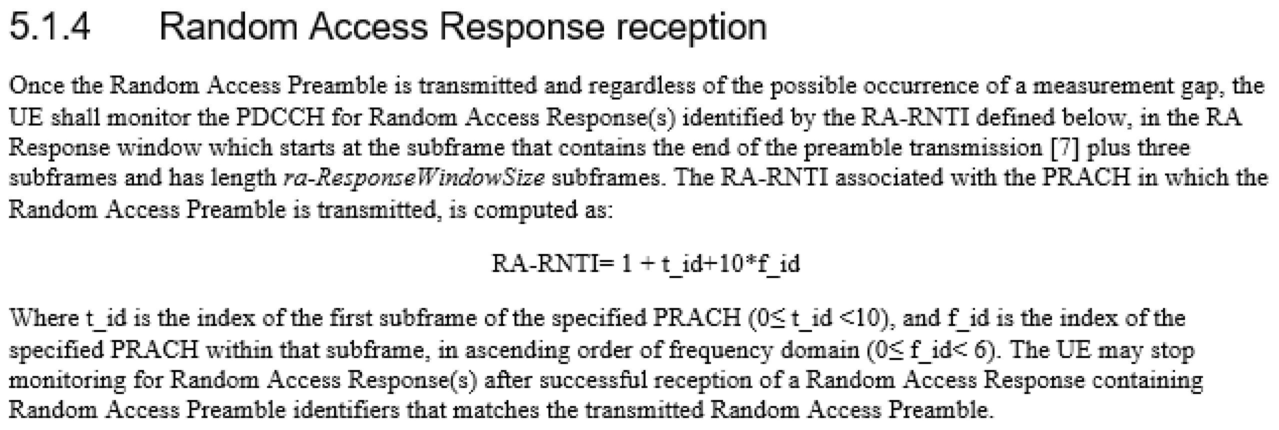


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

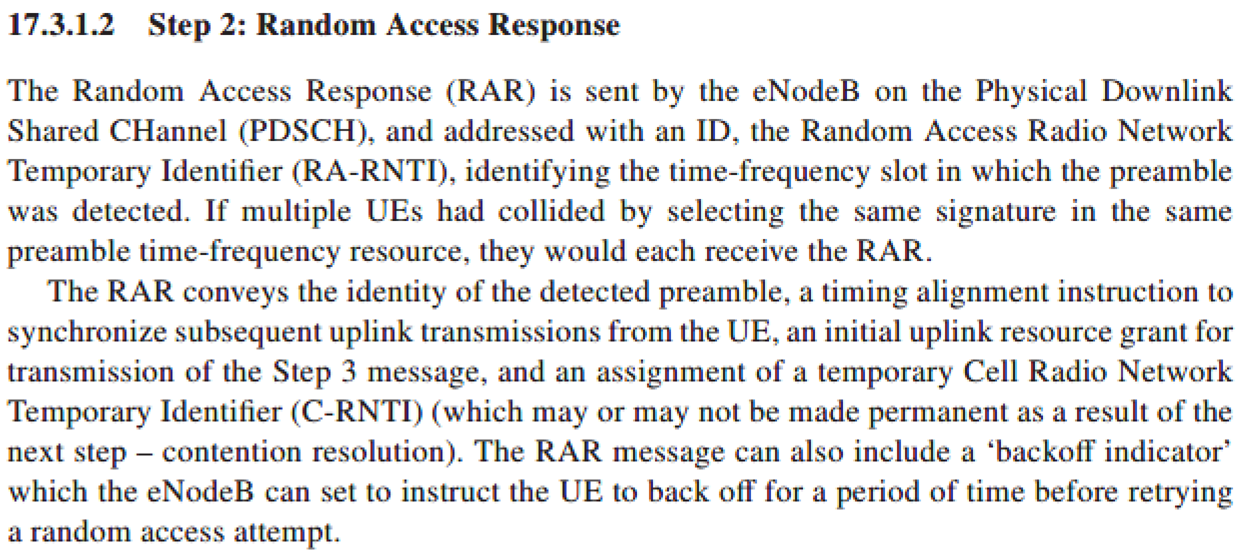
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

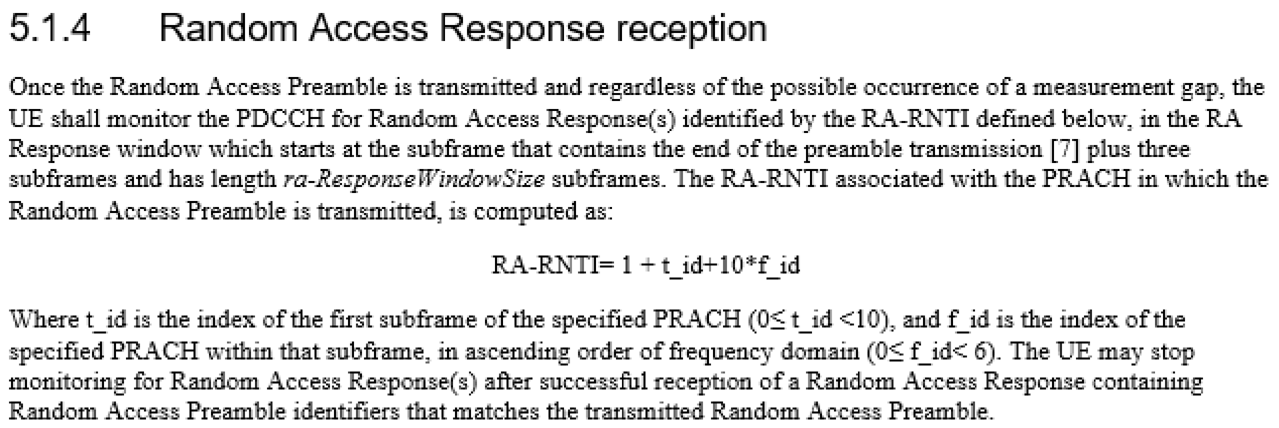
US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

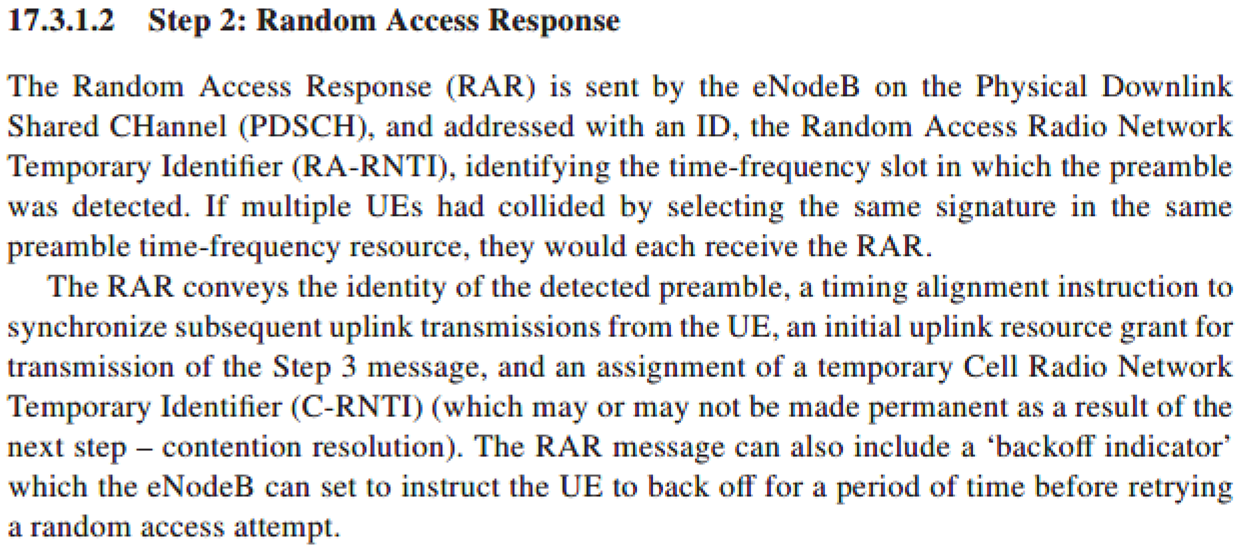
US Patent No. 10,833,908: Claim 12(a)
“The method claim 11, further comprising:”

12. The method claim 11, further comprising:	*See* Claim 11.

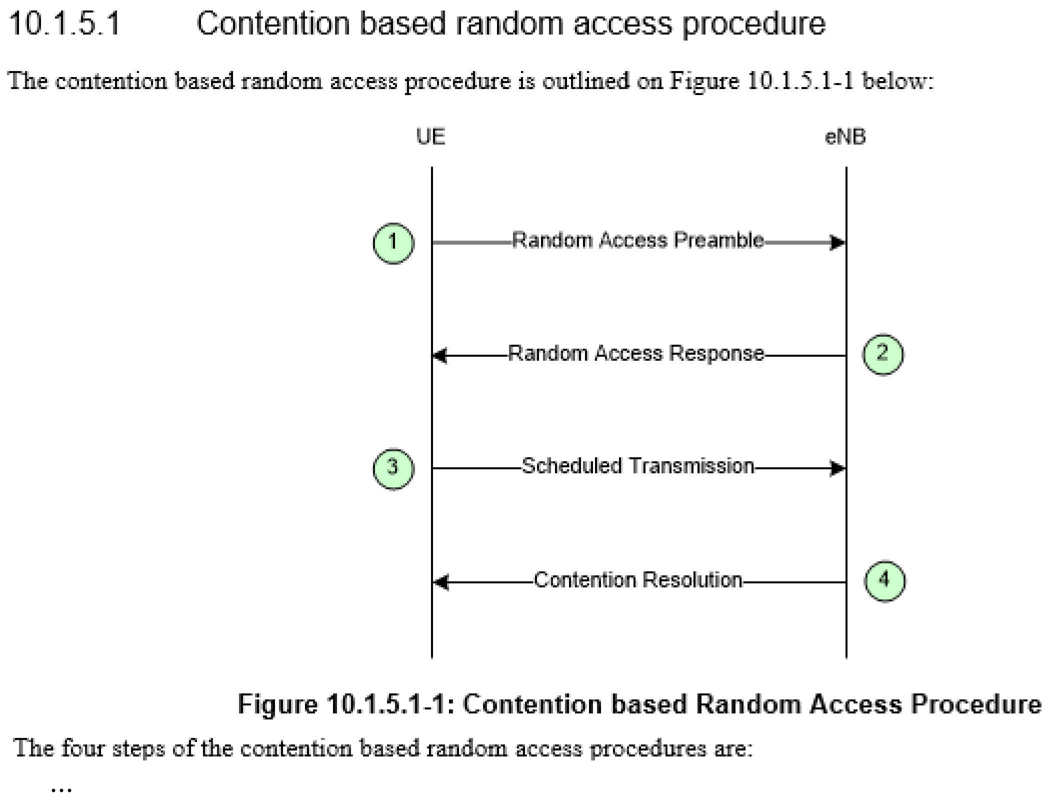
US Patent No. 10,833,908: Claim 12(b)
"determining if the response message identifies the sequence associated with the base station in the random access signal; and"

determining if the response message identifies the sequence associated with the base station in the random access signal; and	Tesla's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$ Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Tesla's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

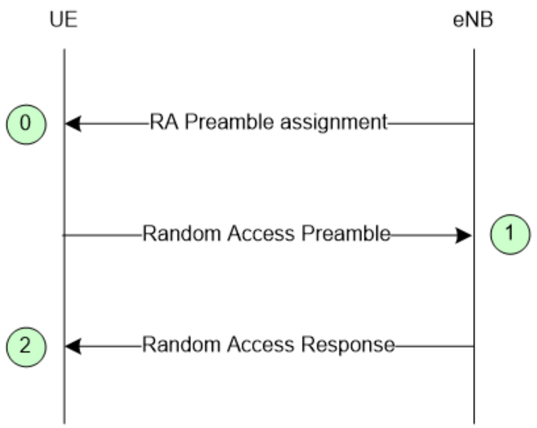
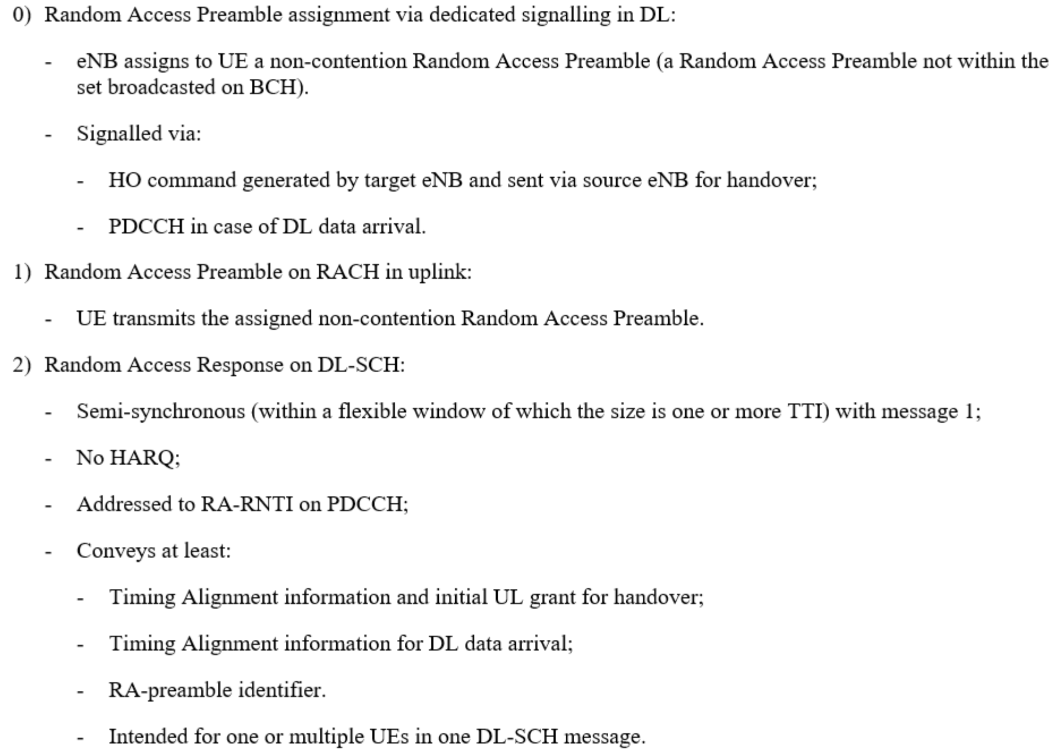


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 12(c)

“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

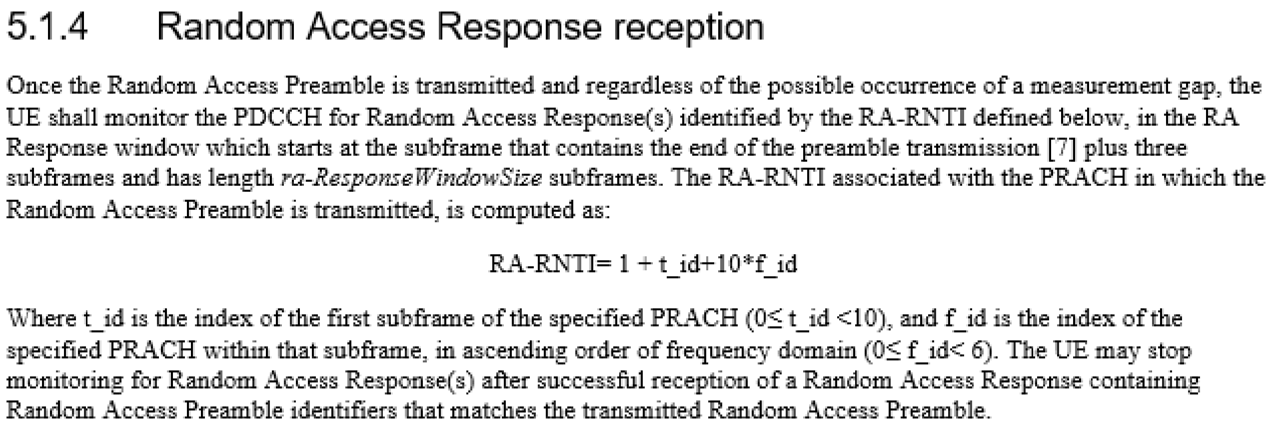
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

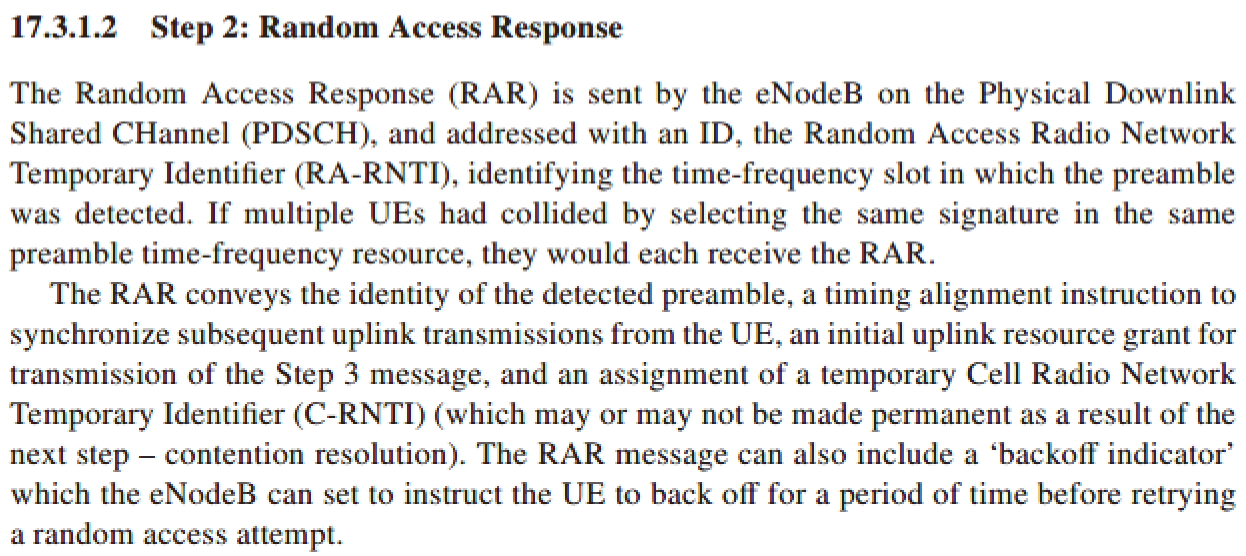
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

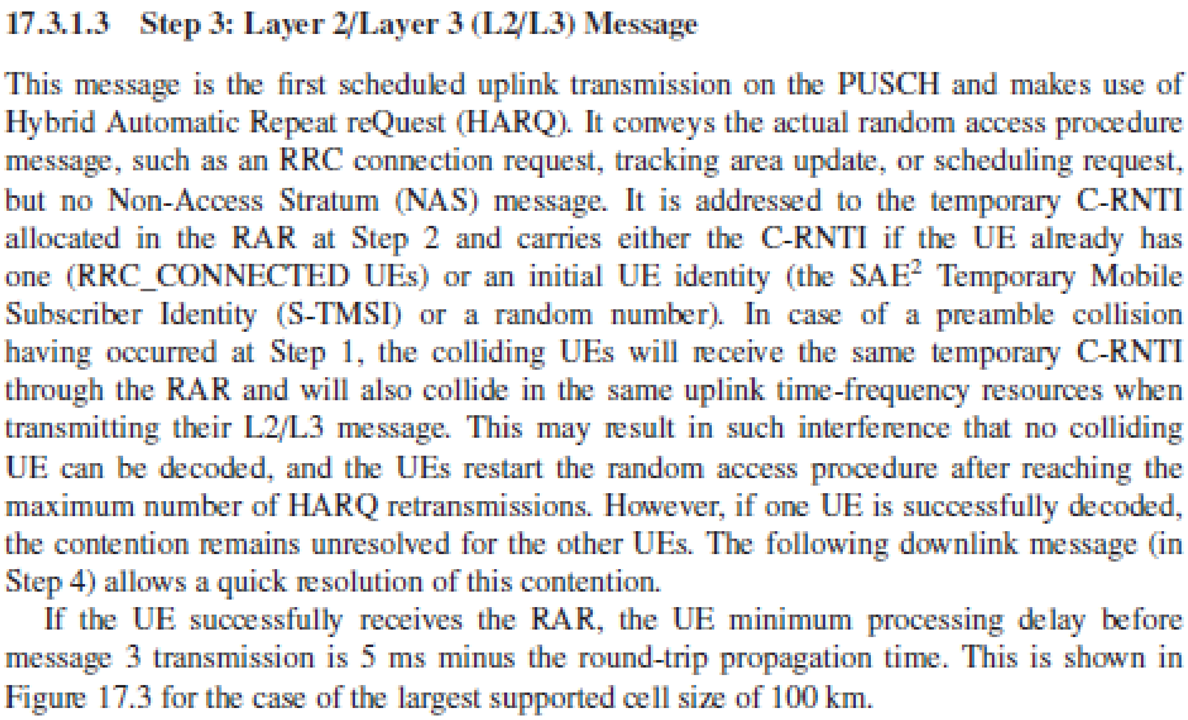
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

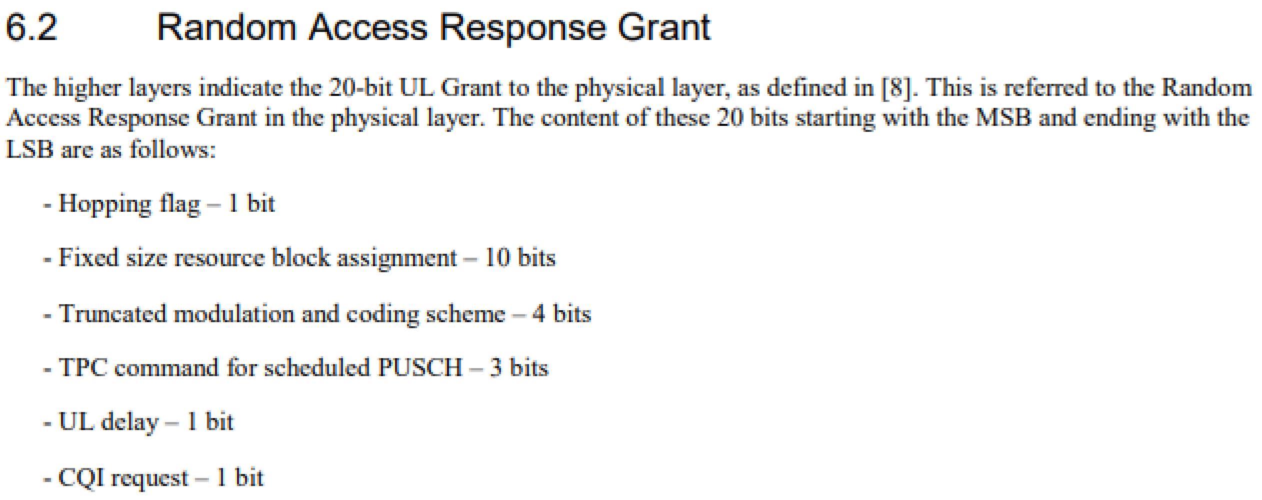
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

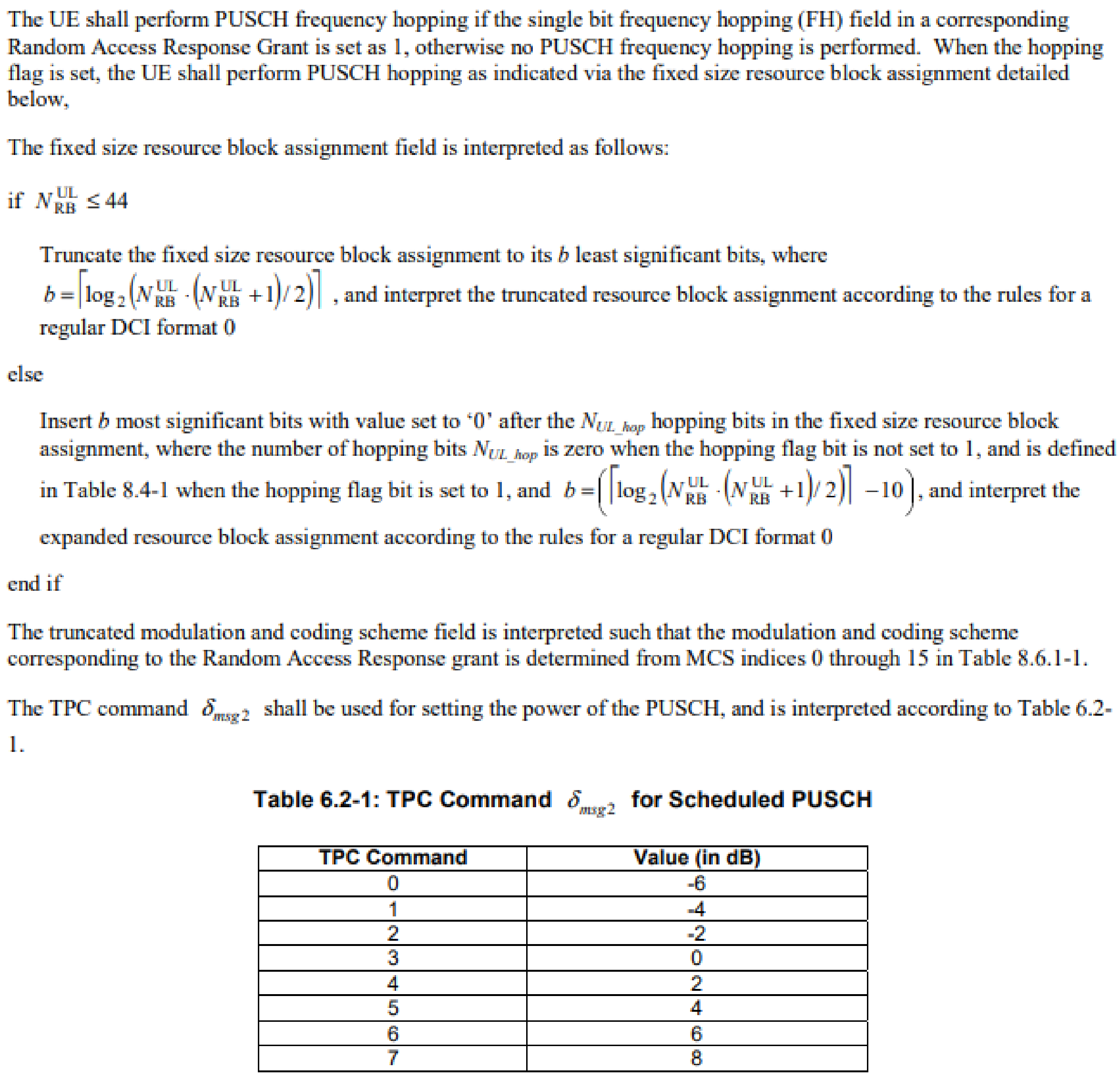
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 13(a)
"The method of claim 12, wherein the response message includes power adjustment information and"

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by Tesla's Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)
"The method of claim 12, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b=\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b=\left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil -10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

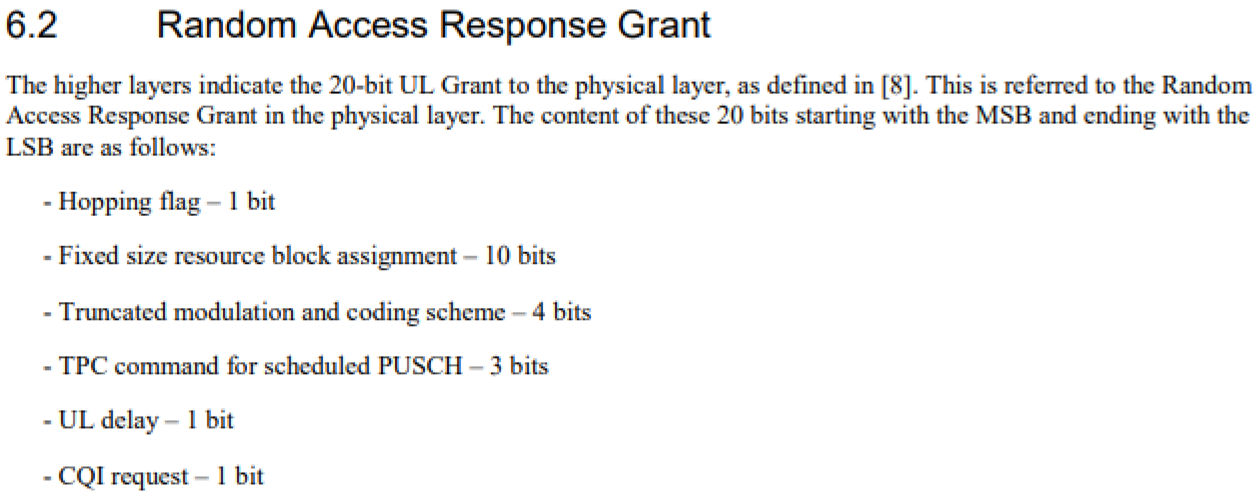
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

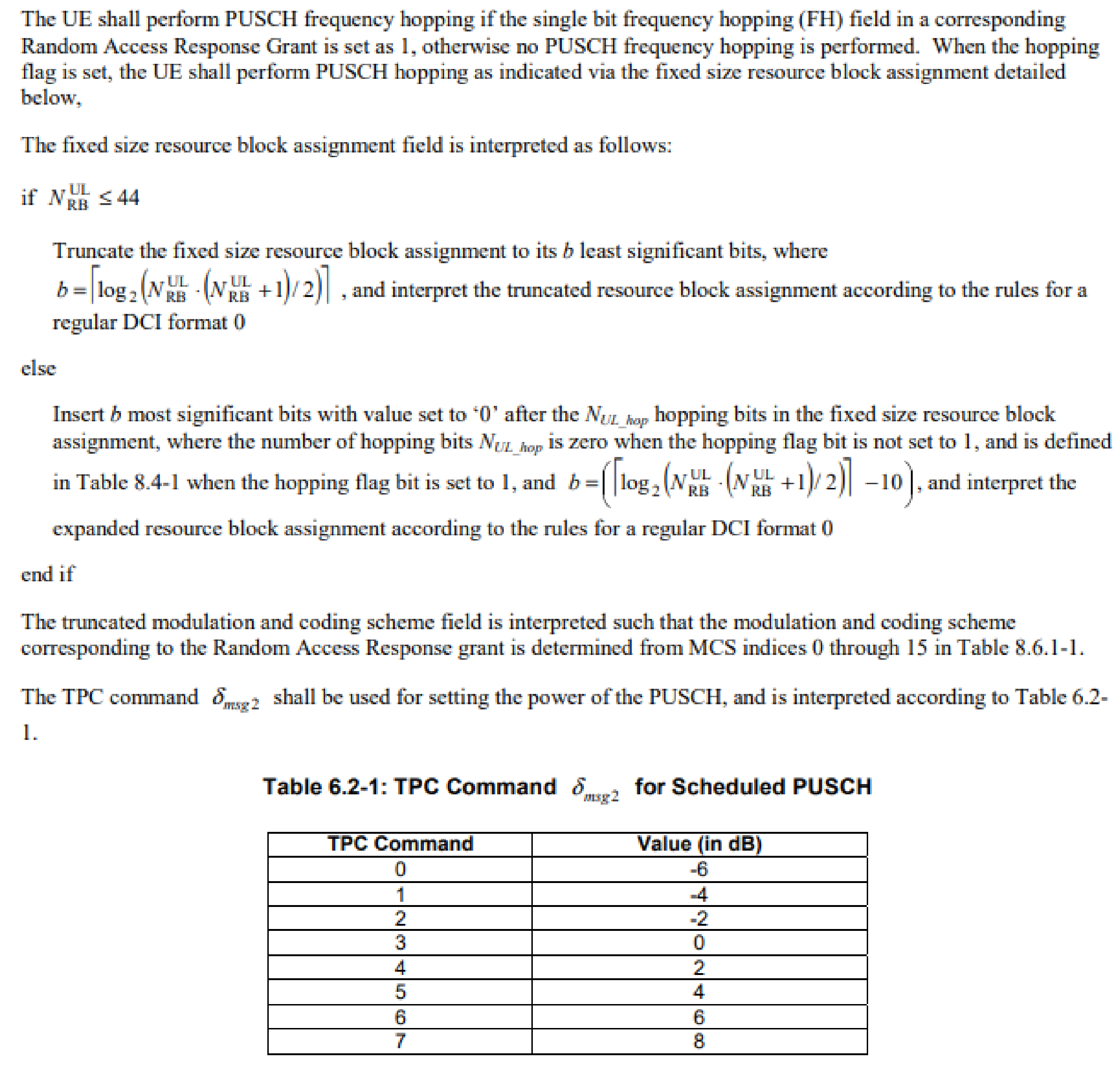
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the second uplink signal is transmitted according to the power adjustment information.	Tesla's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

<table>
<tr><td>14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.</td><td>

The portion of the frequency band used for transmission of the random access signal by Tesla's Accused Instrumentalities does not include control channels. *E.g.,*

See Claim 11.

The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.

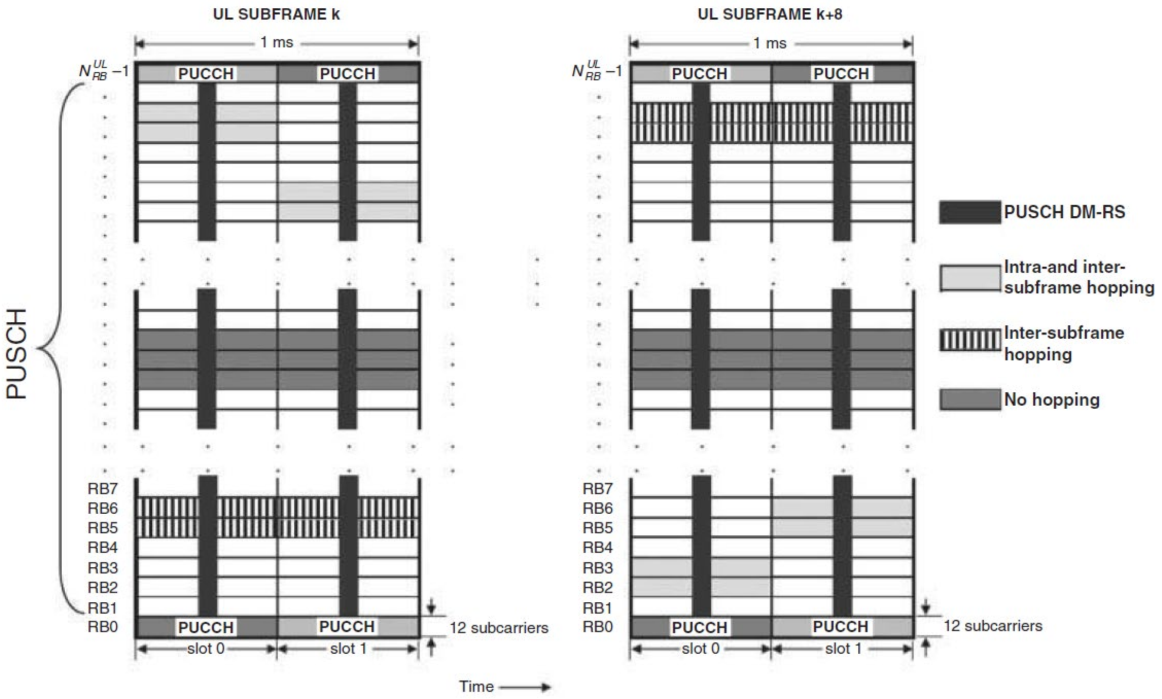


Figure 16.3: Uplink physical data channel processing.

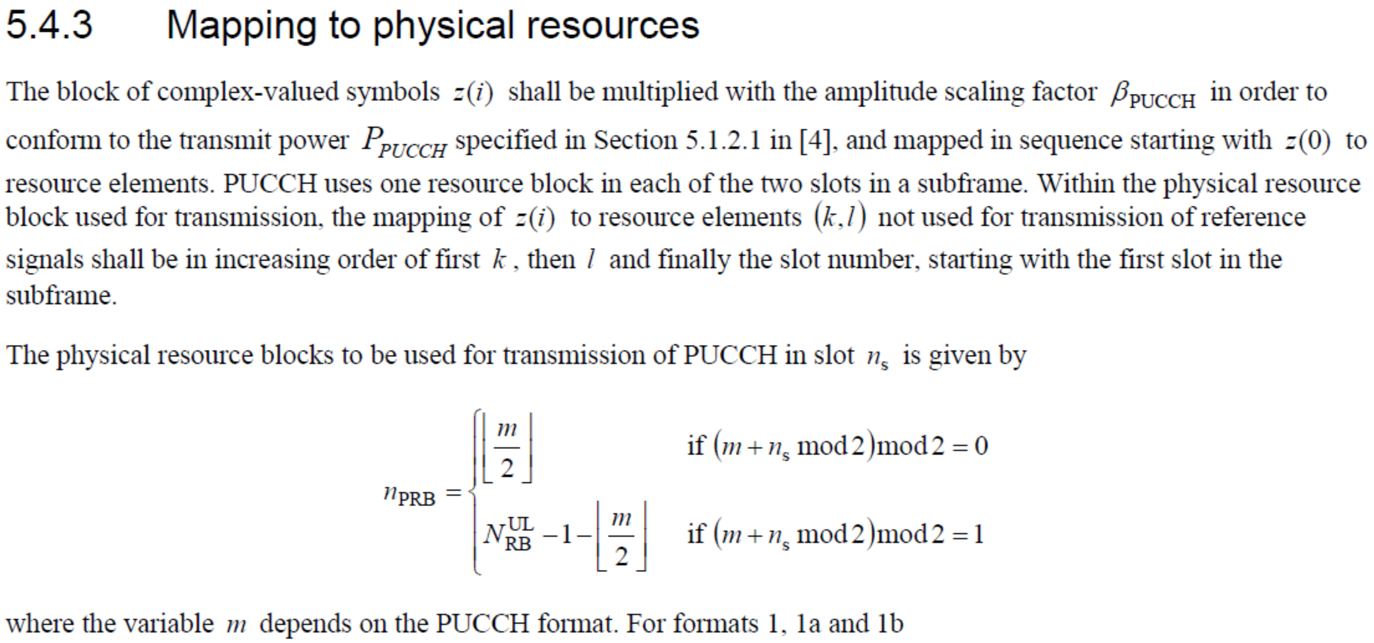
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

</td></tr>
</table>

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

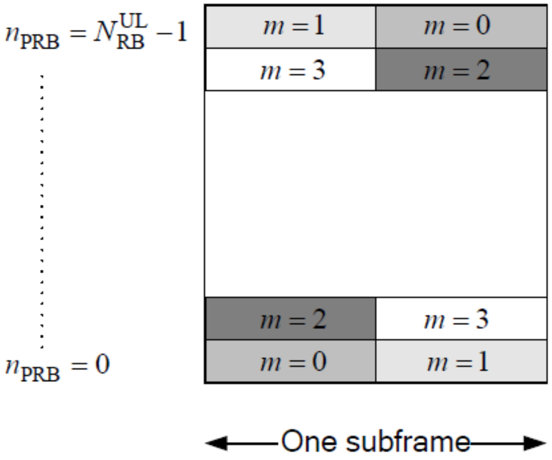


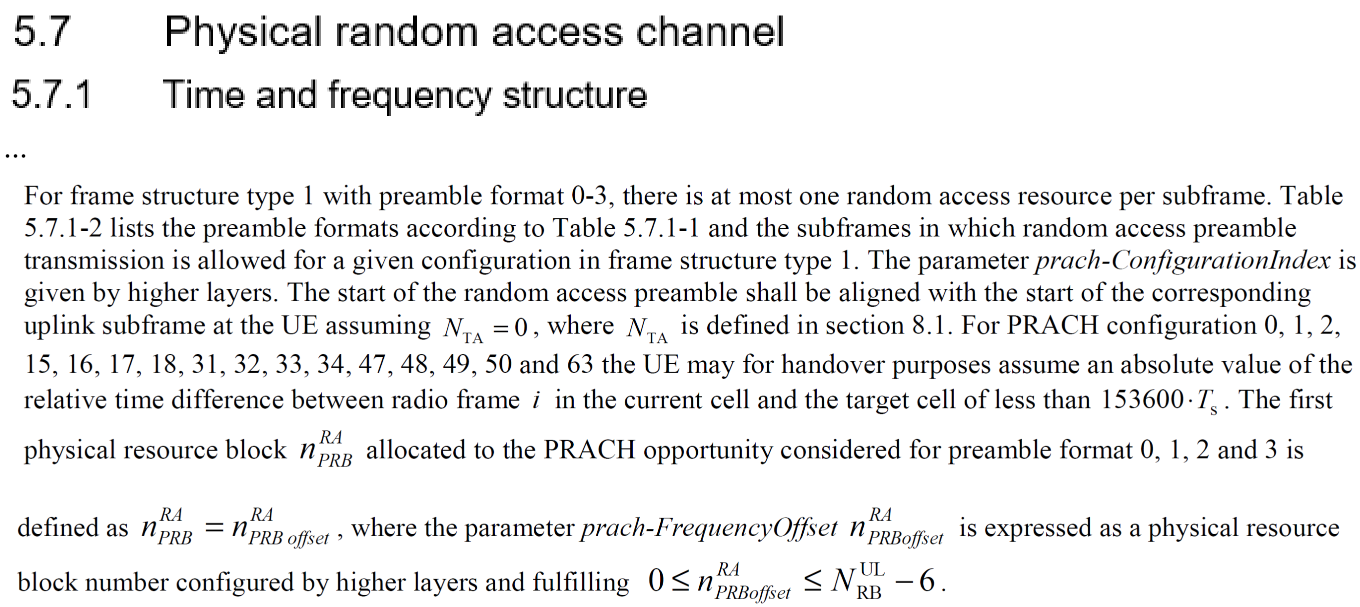
Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\mathrm{RA}}_{\mathrm{PRBoffset}}$. For FDD, the parameter directly determines

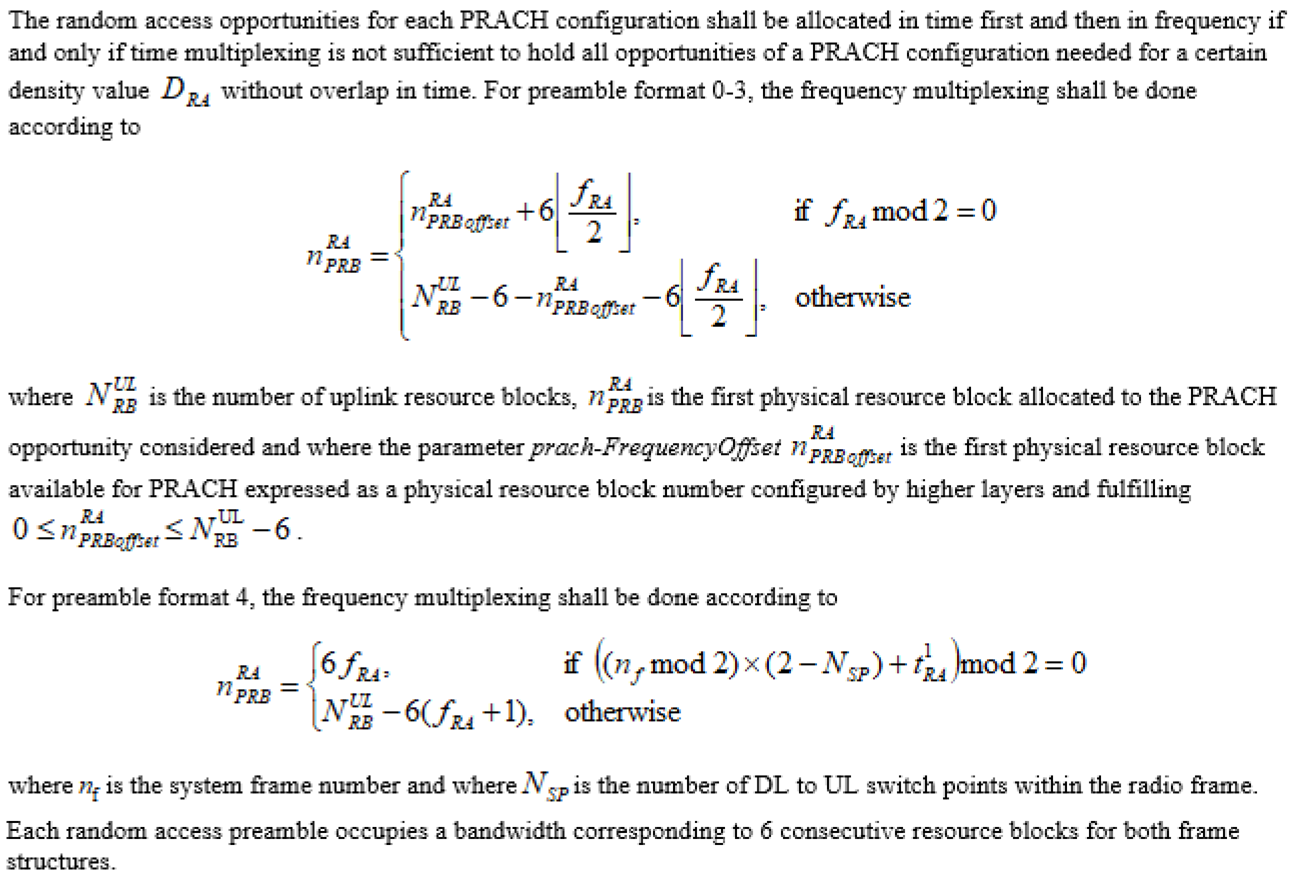
US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\text{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\text{RB}}^{\text{UL}} - 6$. …

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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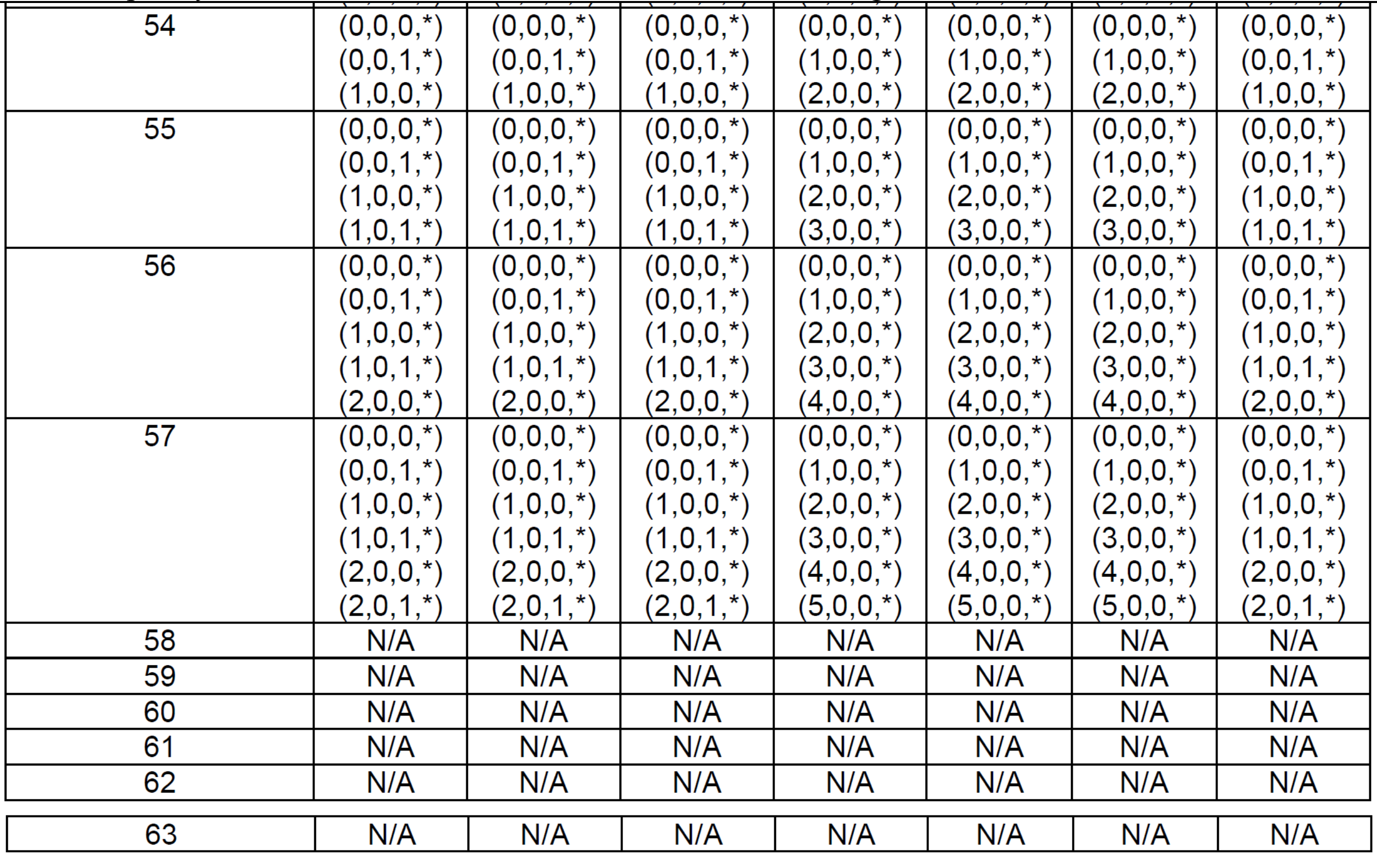
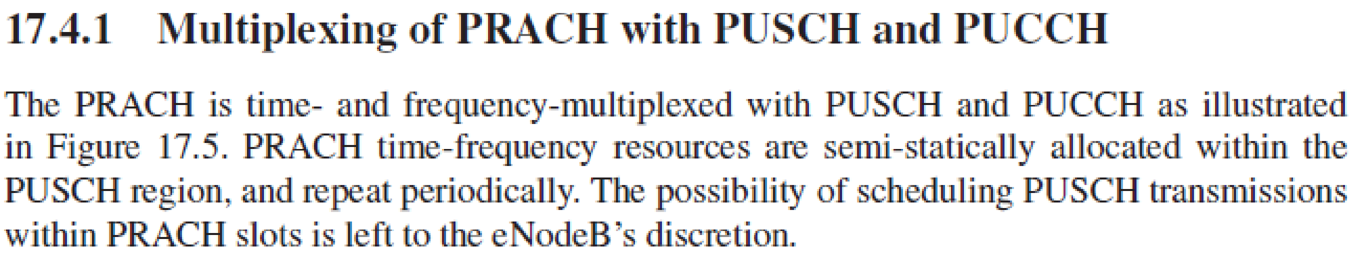


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

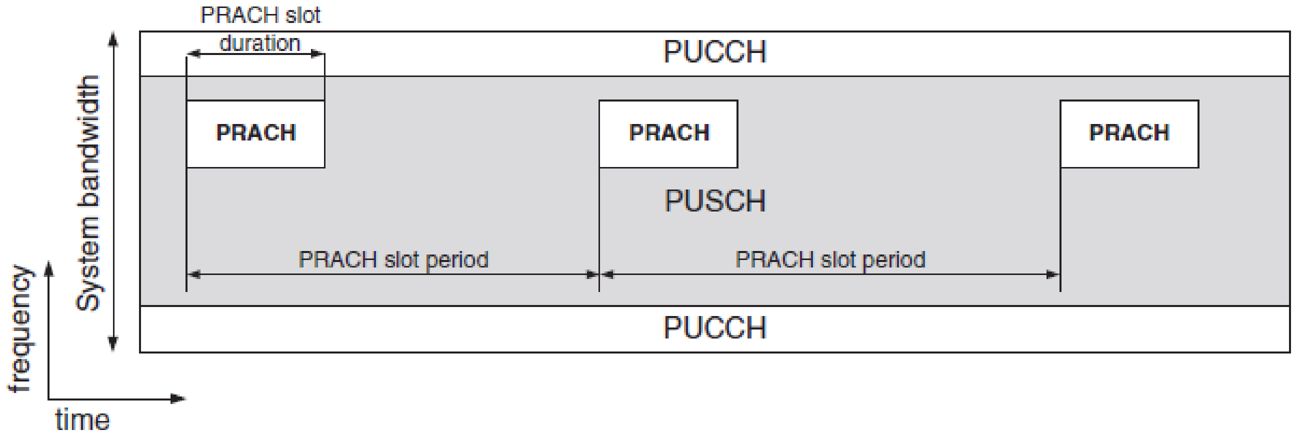


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

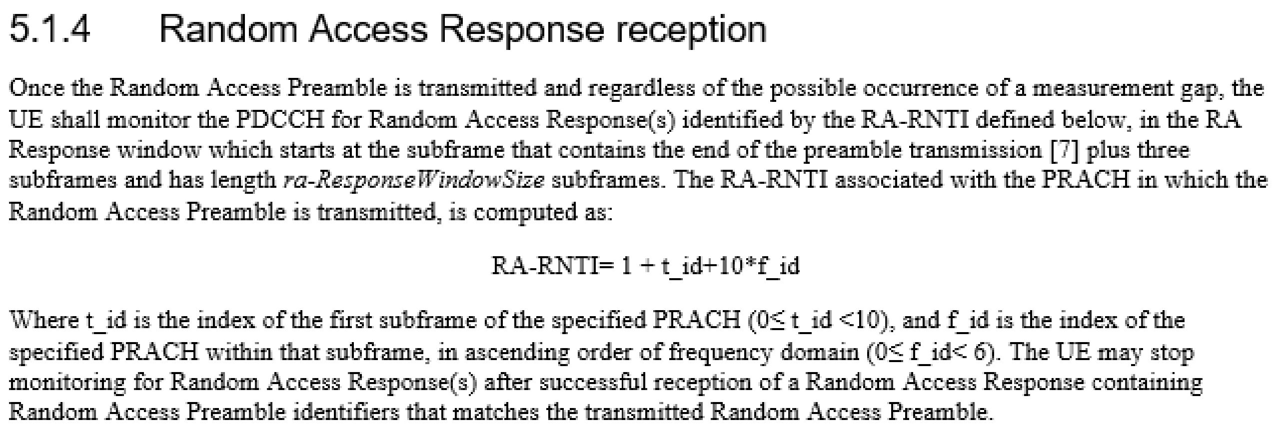
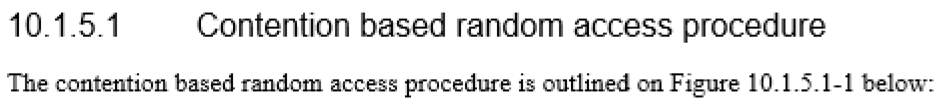
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 15
"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Tesla's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

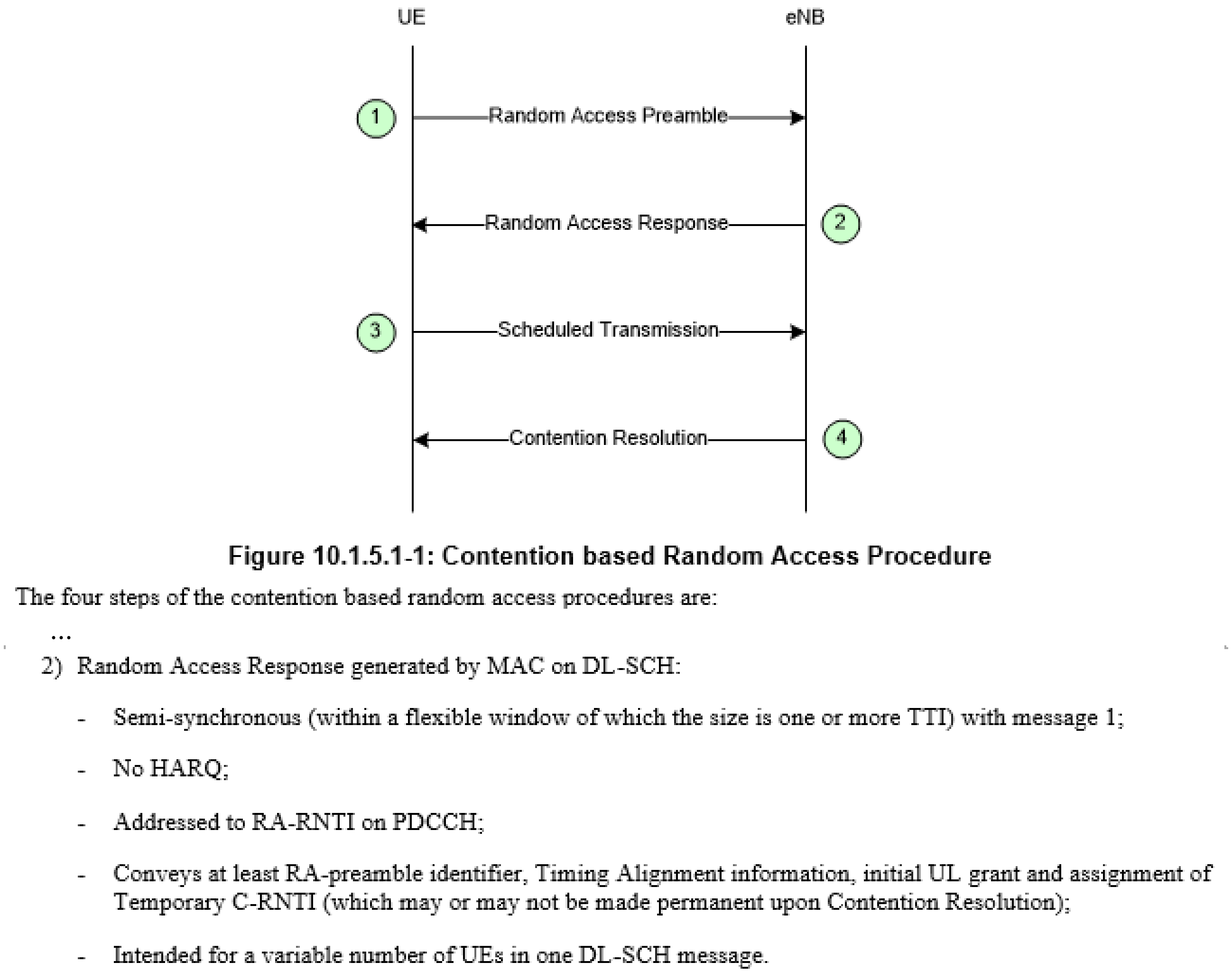


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

...

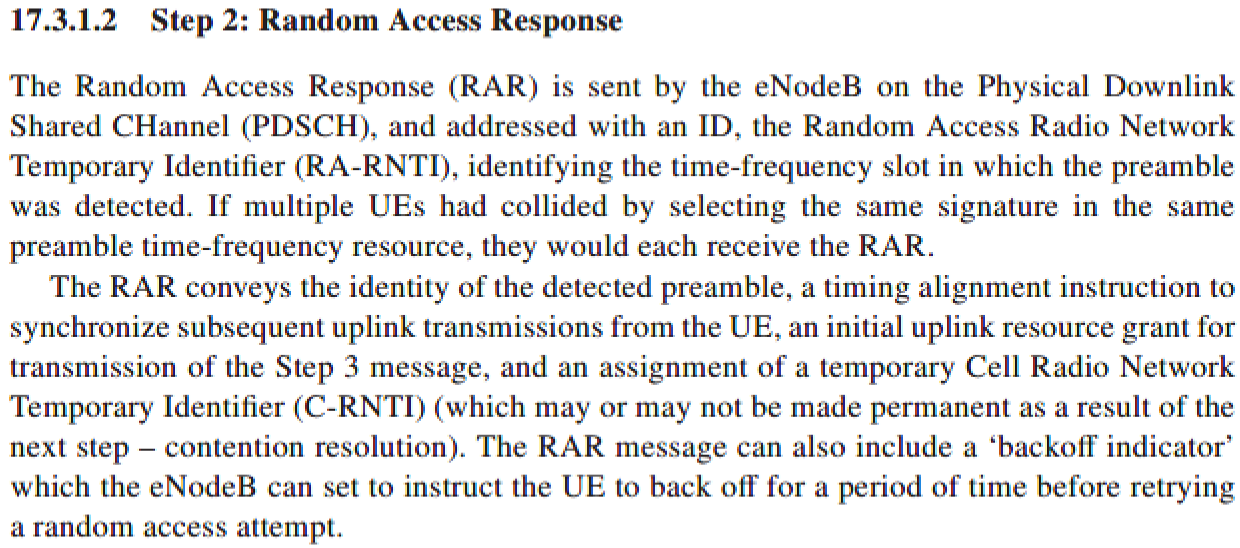
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15

“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

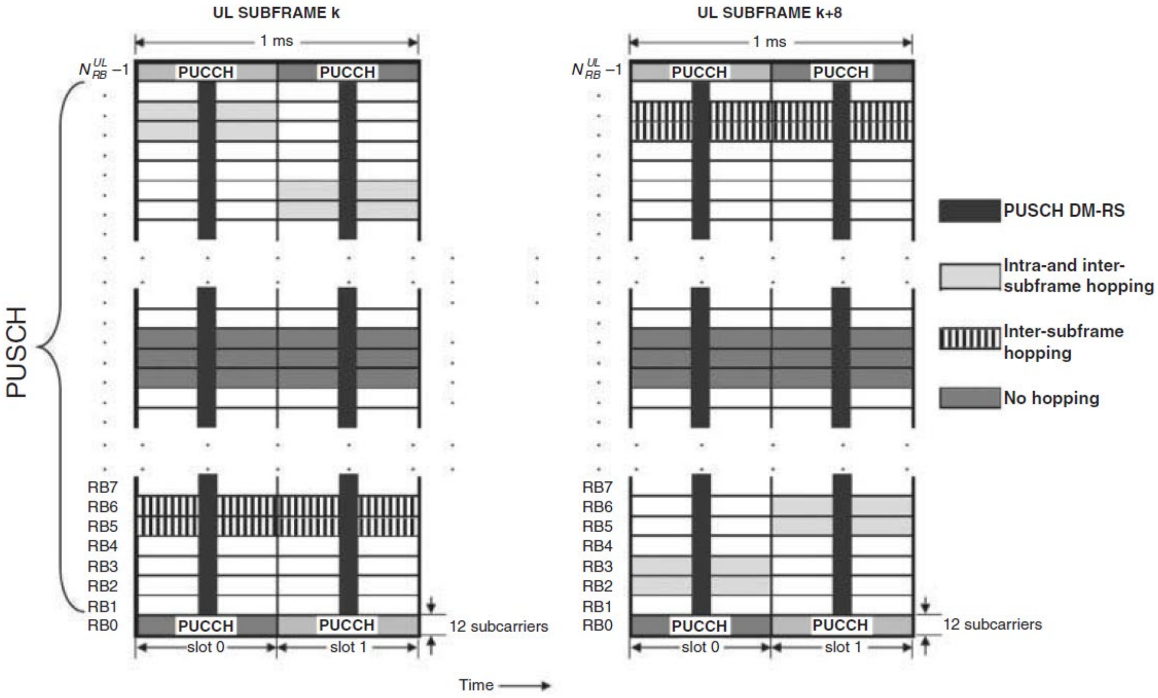
US Patent No. 10,833,908: Claim 16

"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

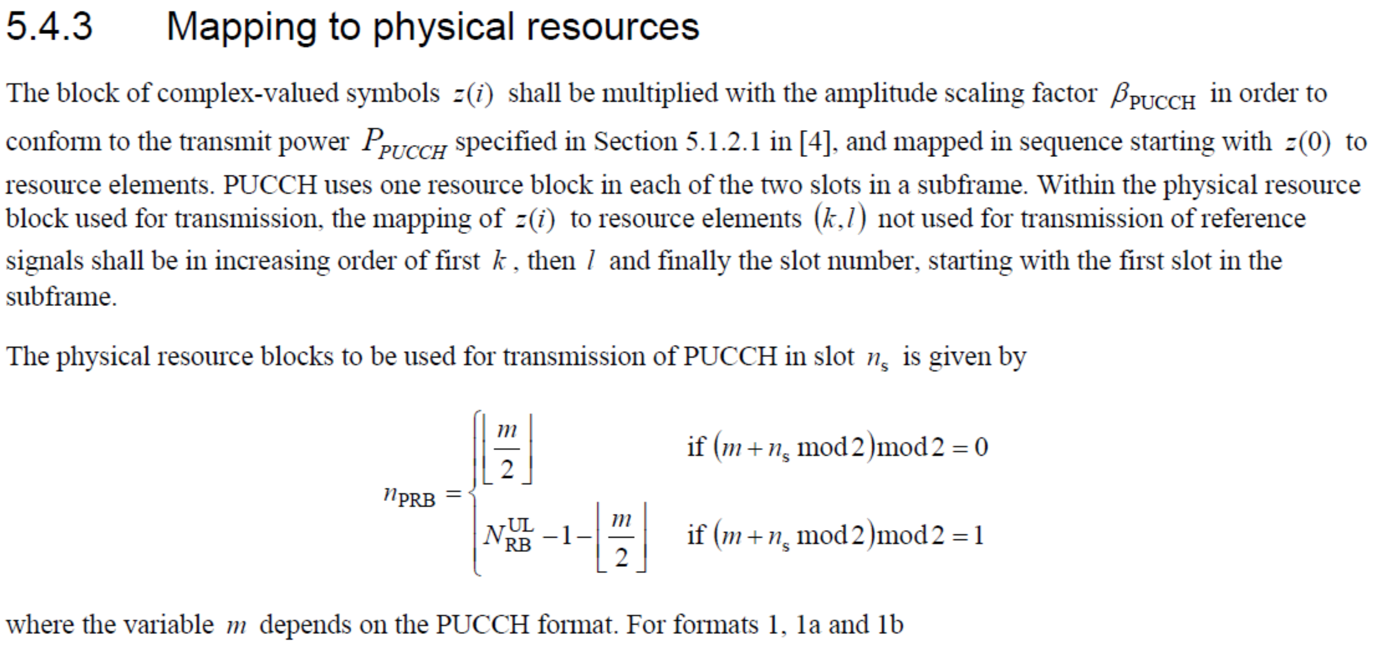
16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Tesla's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Tesla's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 17
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

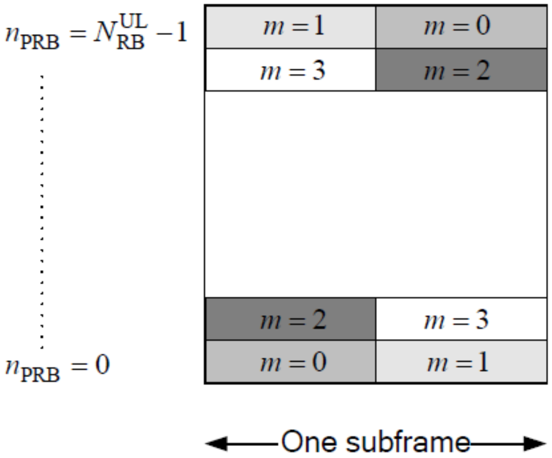


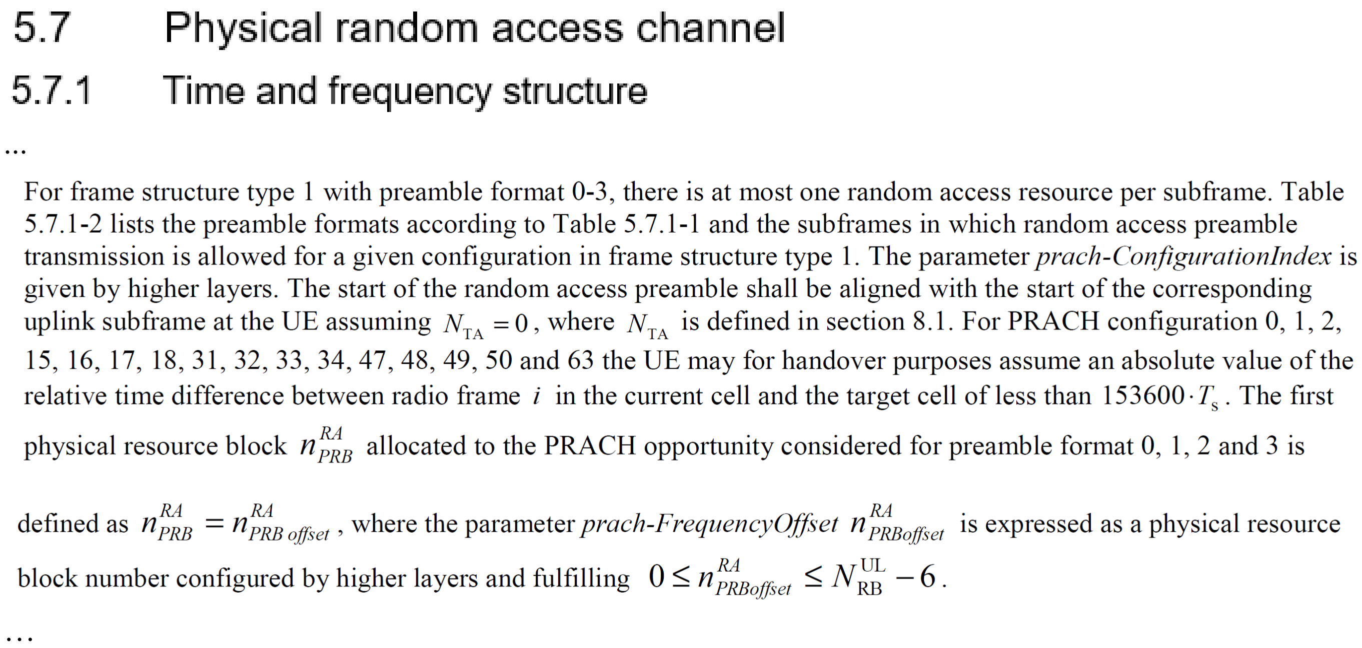
Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

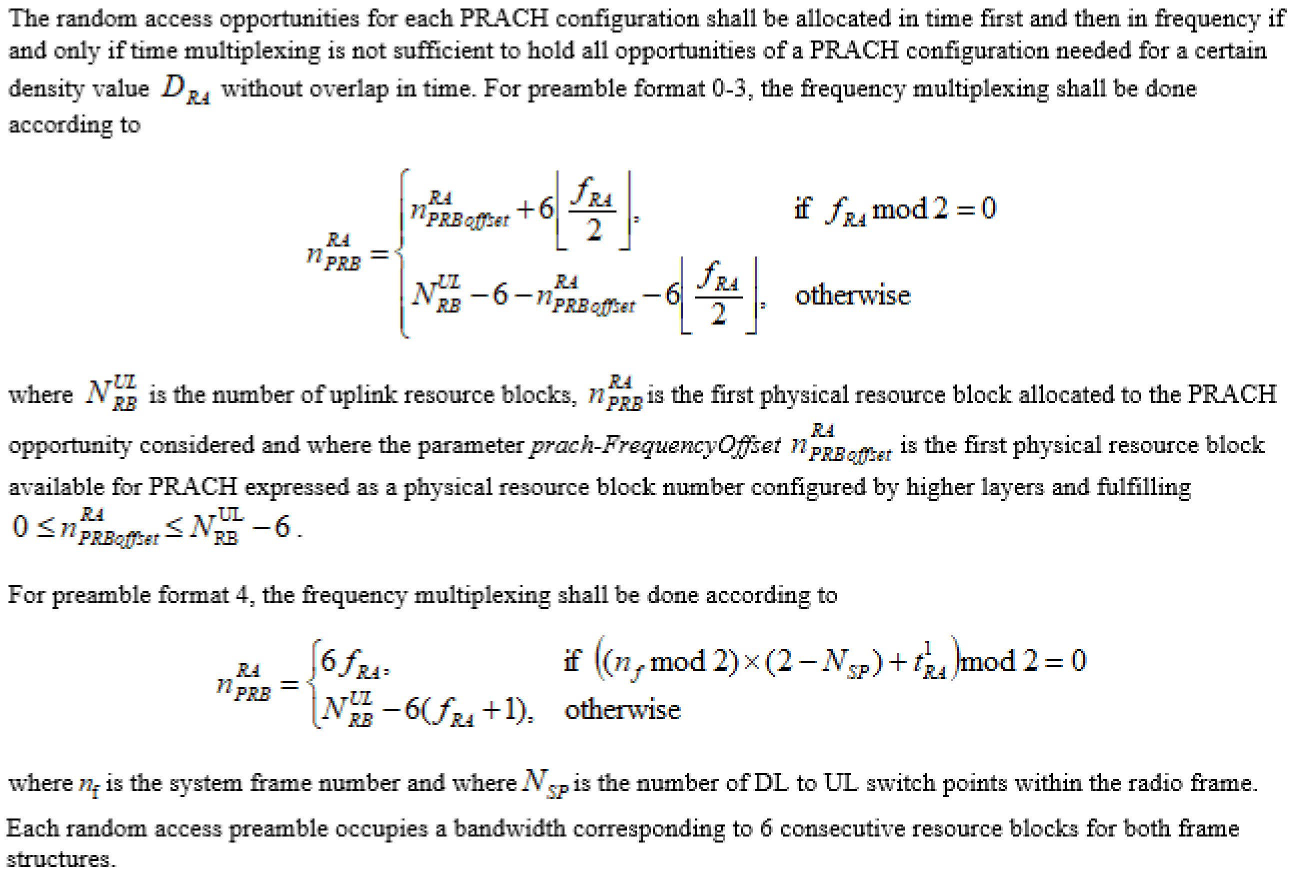
US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure ... For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. ...

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \leq n^{RA}_{PRBoffset} \leq N^{UL}_{RB} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

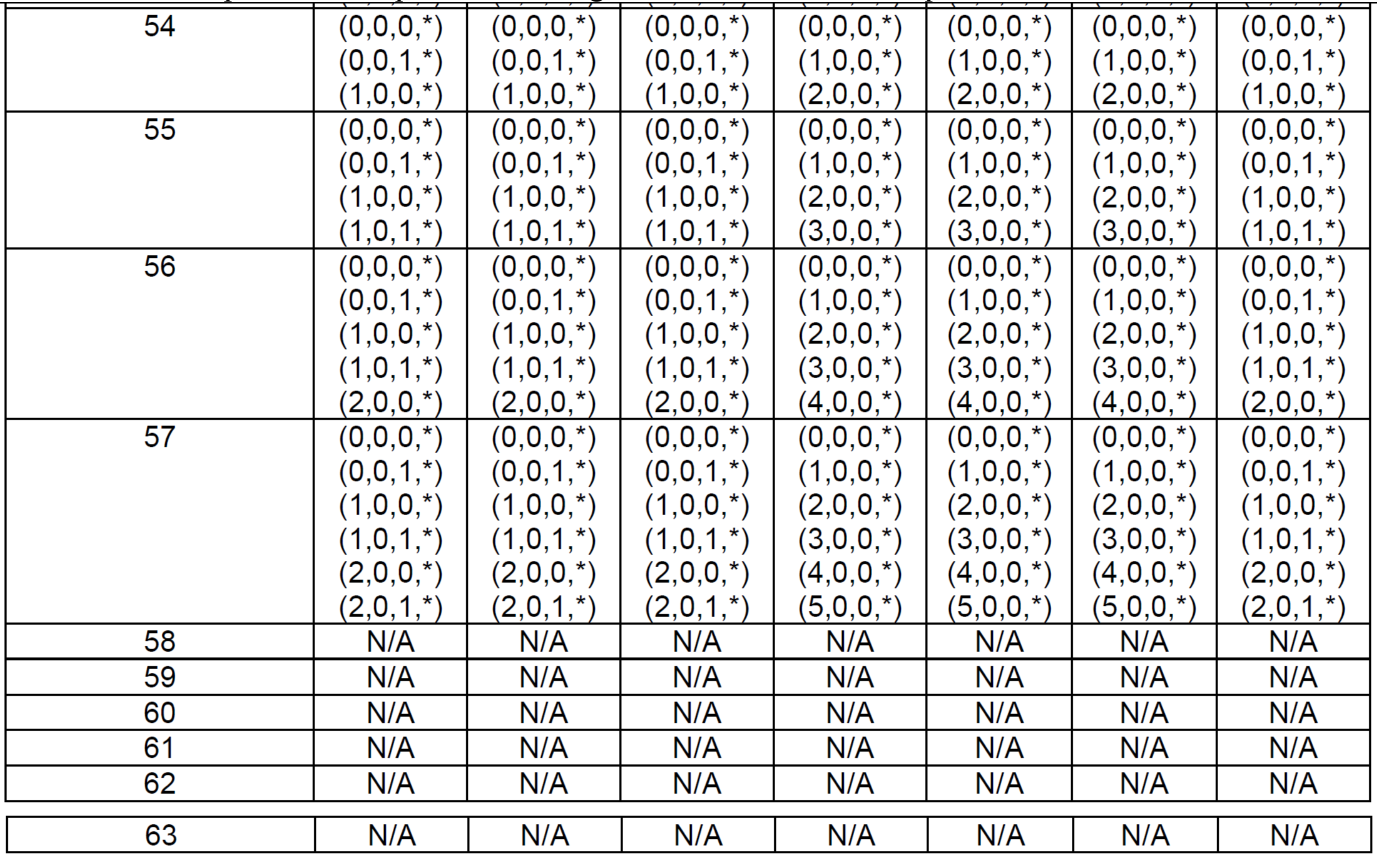
Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.

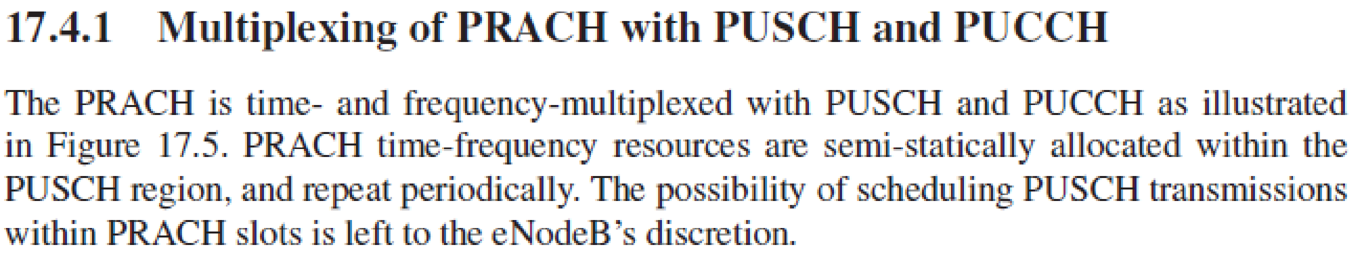
.

.



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

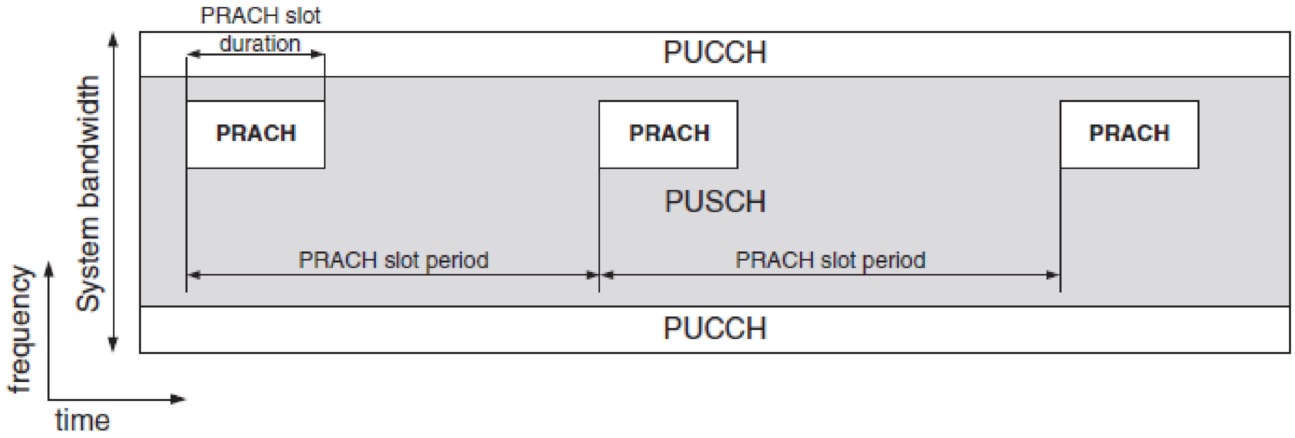


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

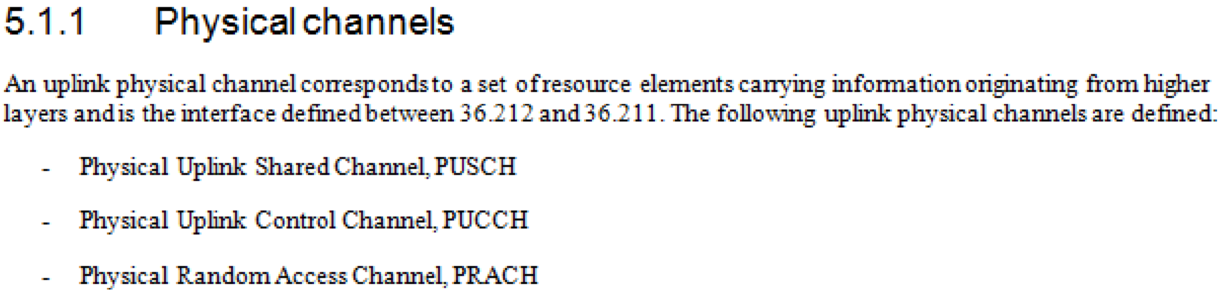
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 17

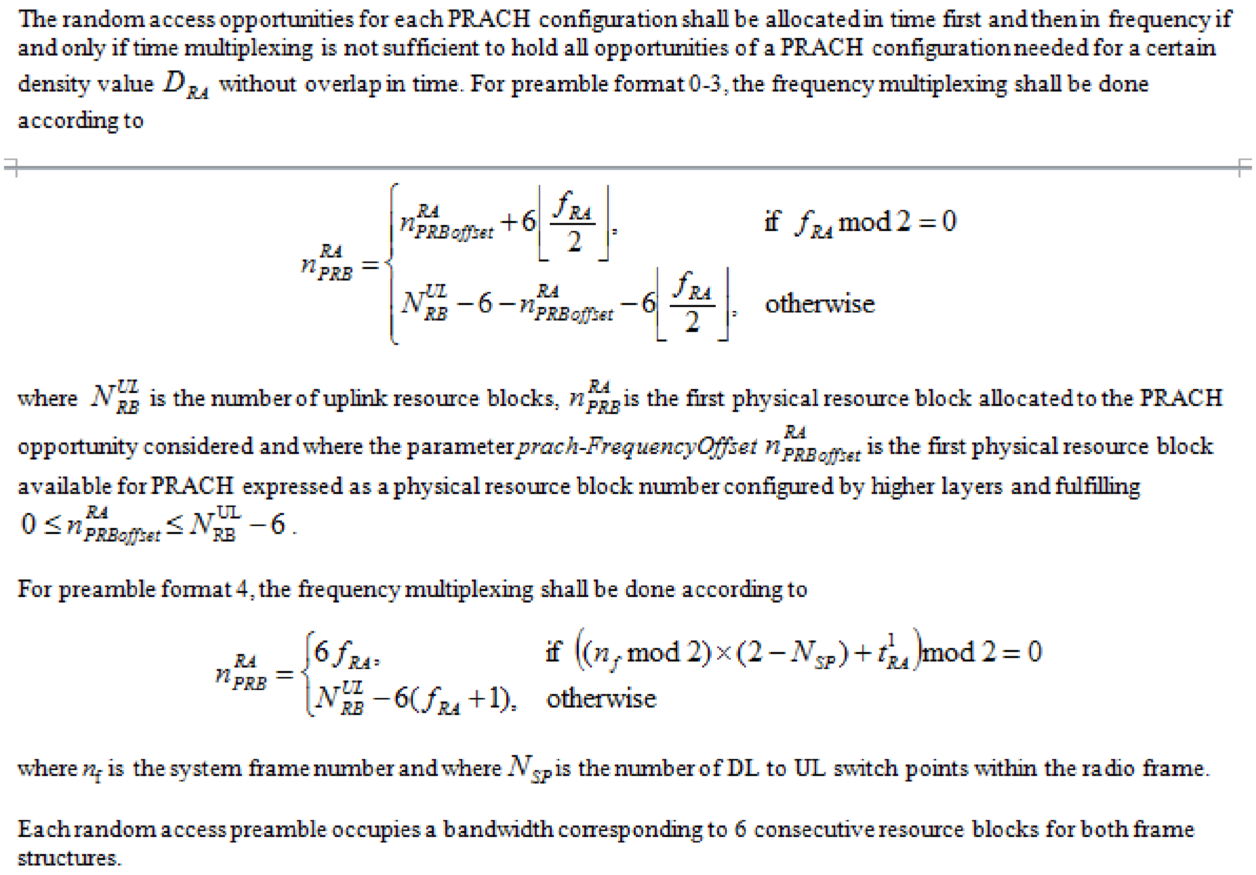
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

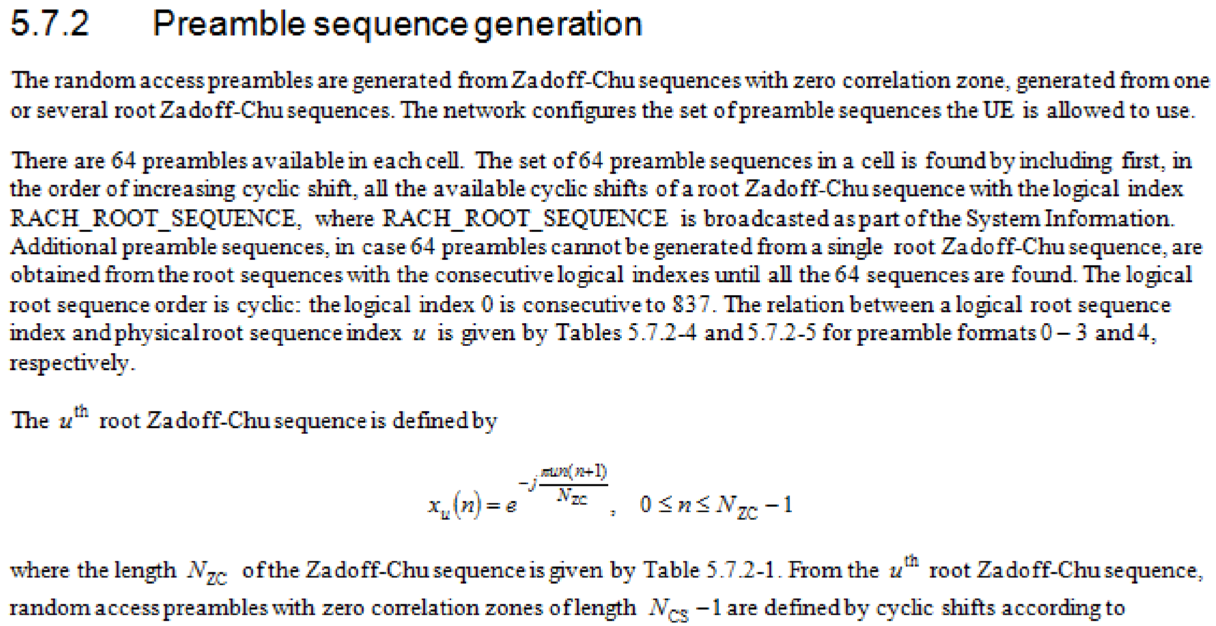
US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Tesla's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB. 5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

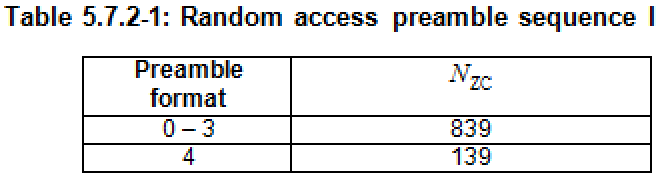
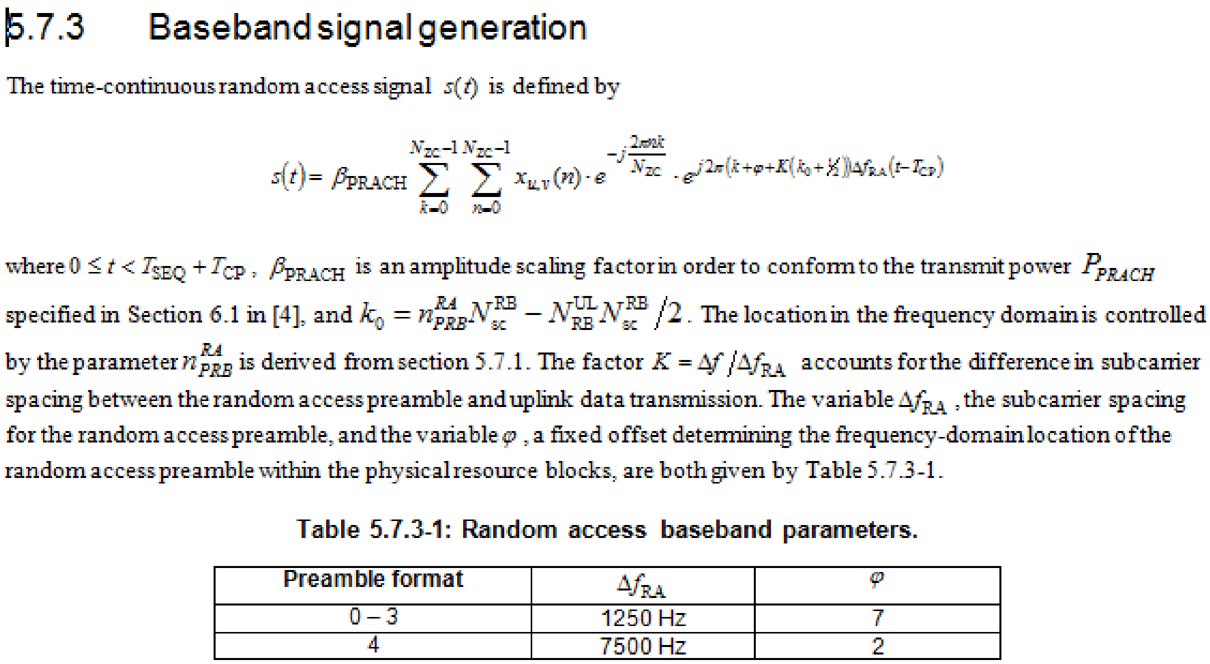


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

where $0 \le t < T_{\mathrm{SEQ}} + T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\mathrm{sc}}^{\mathrm{RB}} - N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

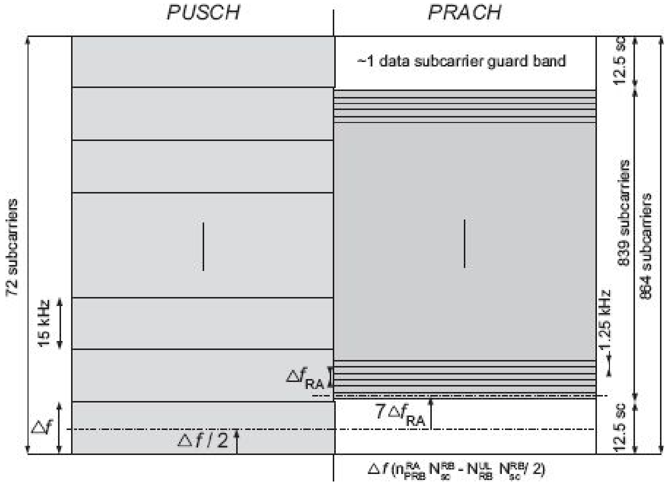
Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

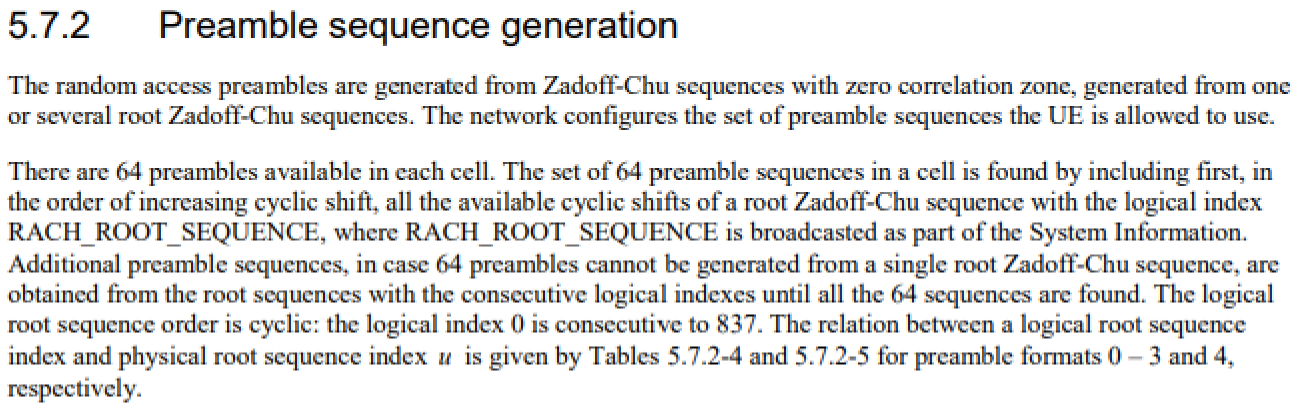
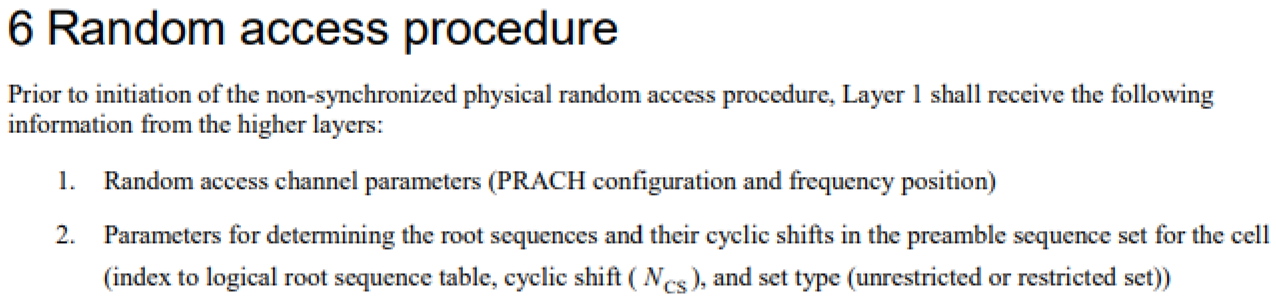
Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.



See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 19
"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Tesla's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19
“The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

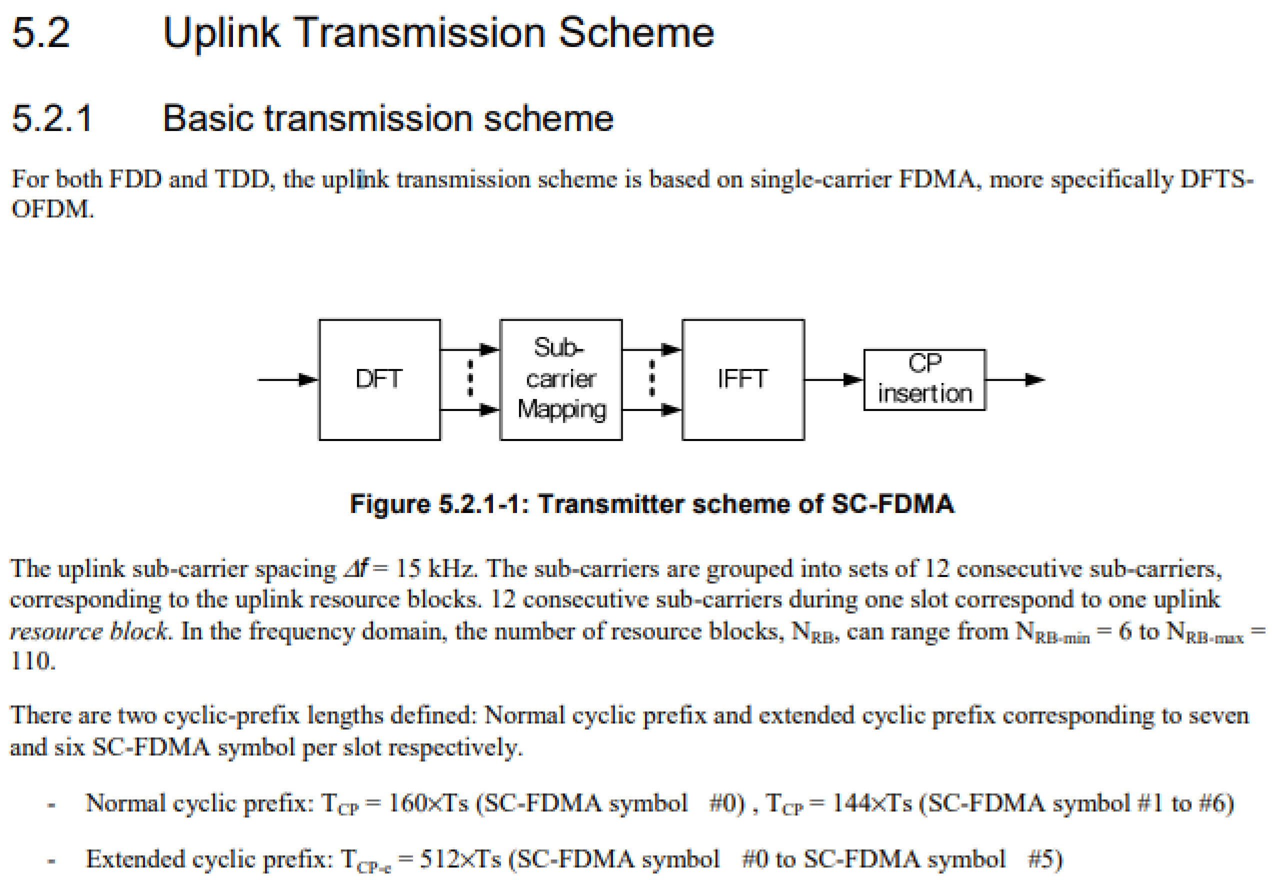
"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

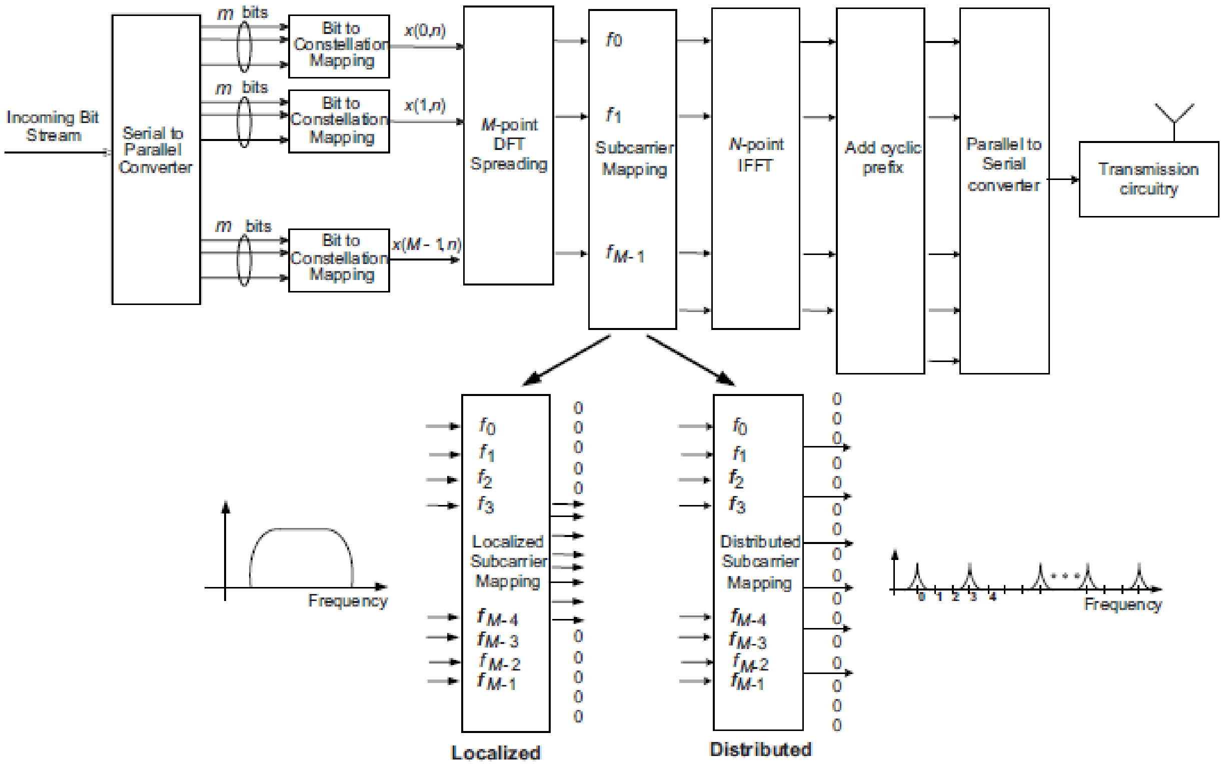
See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

US Patent No. 10,833,908: Claim 20
“The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.”

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. Tesla’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,* Tesla’s Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5)

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

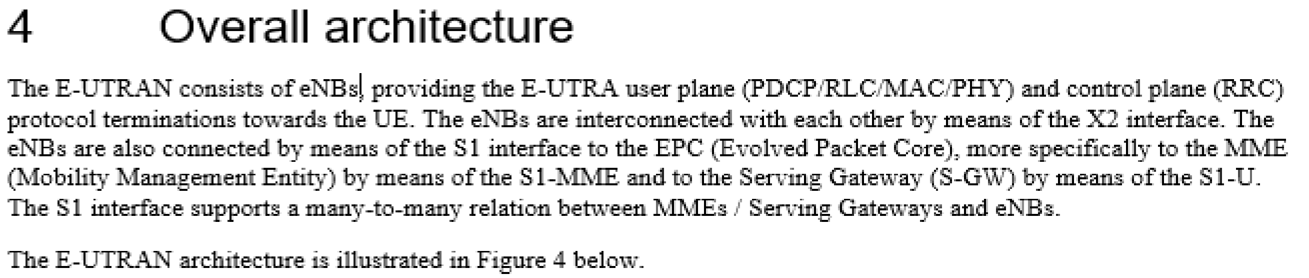
	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28. **14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)** Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.  Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20

"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:”

21. A mobile station comprising:	To the extent the preamble is considered a limitation, Tesla’s Accused Instrumentalities meet the preamble of claim 21 of the ’908 patent. *E.g.,* Tesla’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Tesla offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff’s Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

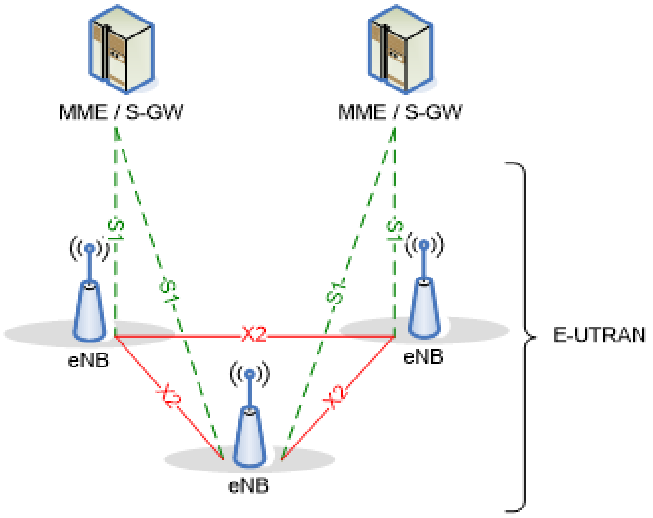
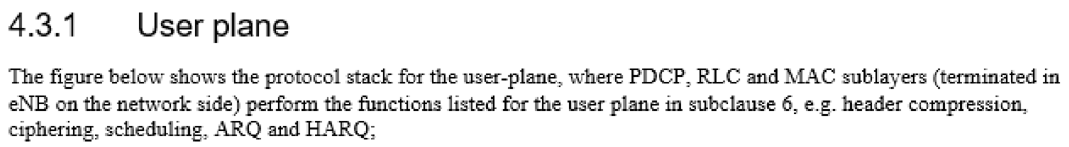


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

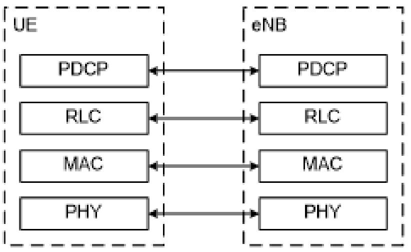


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	Tesla's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The Tesla Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

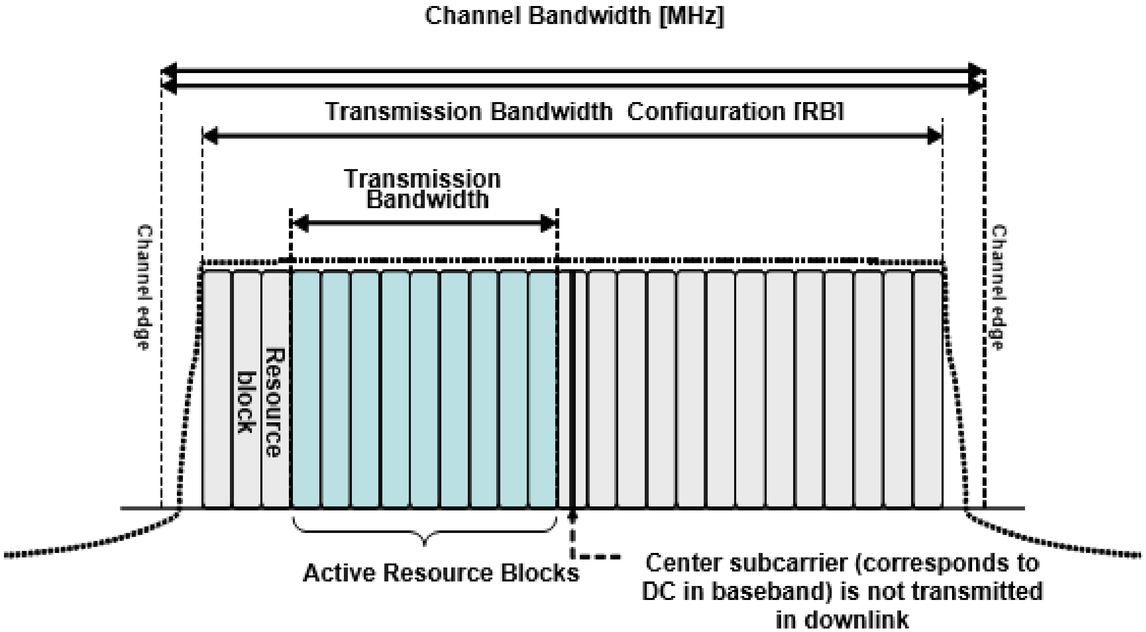
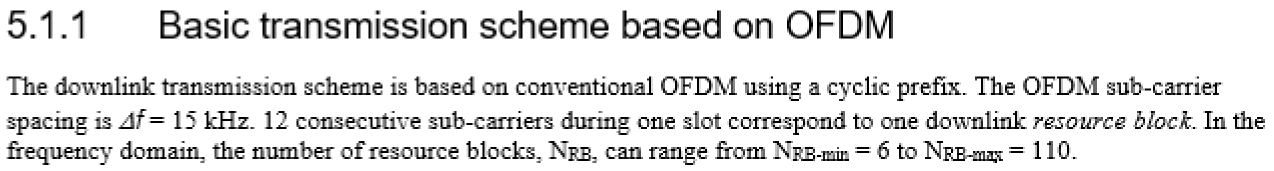


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

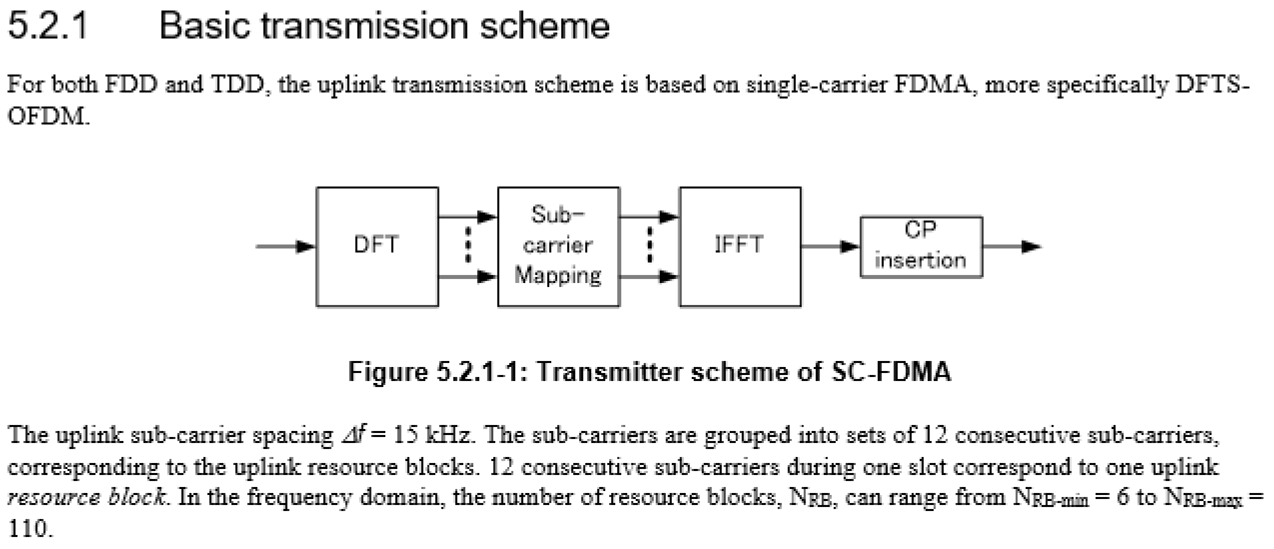
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

5.3 Physical uplink shared channel

The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.

4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\ \text{ms}$ long and consists of 20 slots of length $T_{\text{slot}} = 15360 \cdot T_s = 0.5\ \text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

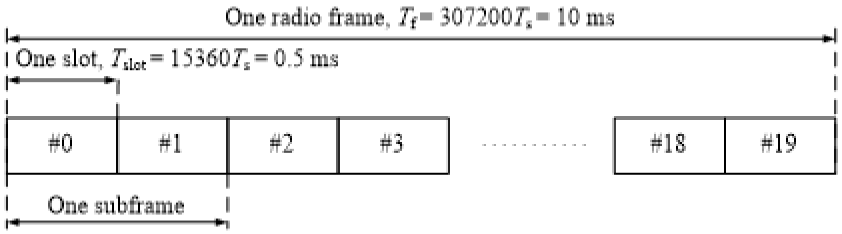
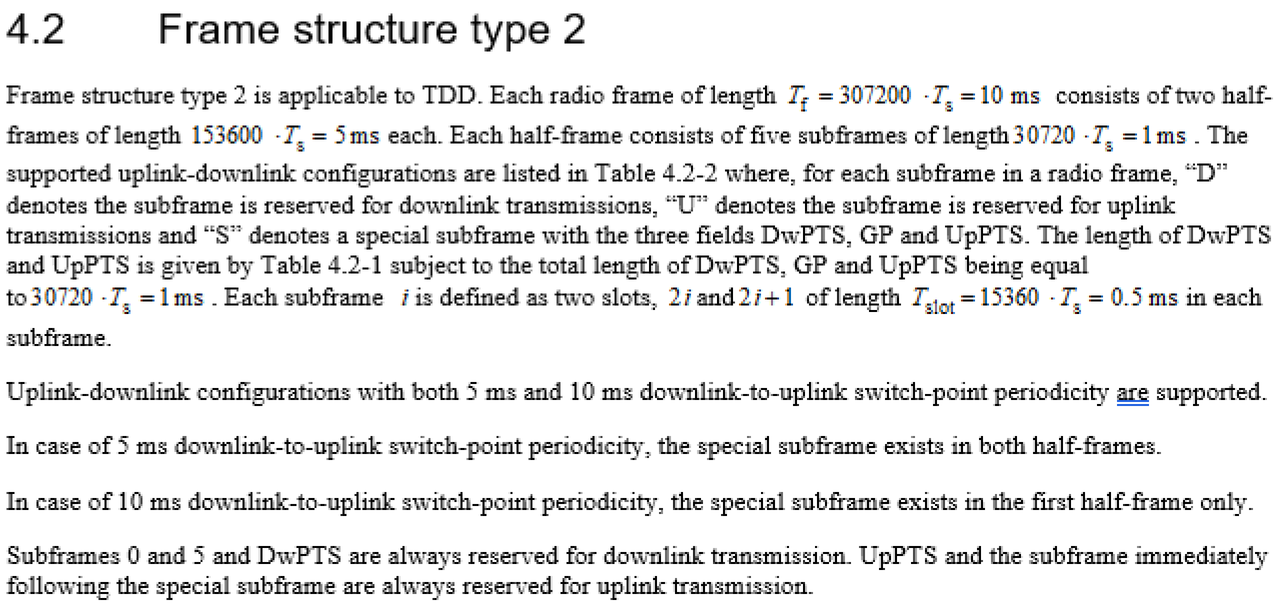


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, “D” denotes the subframe is reserved for downlink transmissions, “U” denotes the subframe is reserved for uplink transmissions and “S” denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

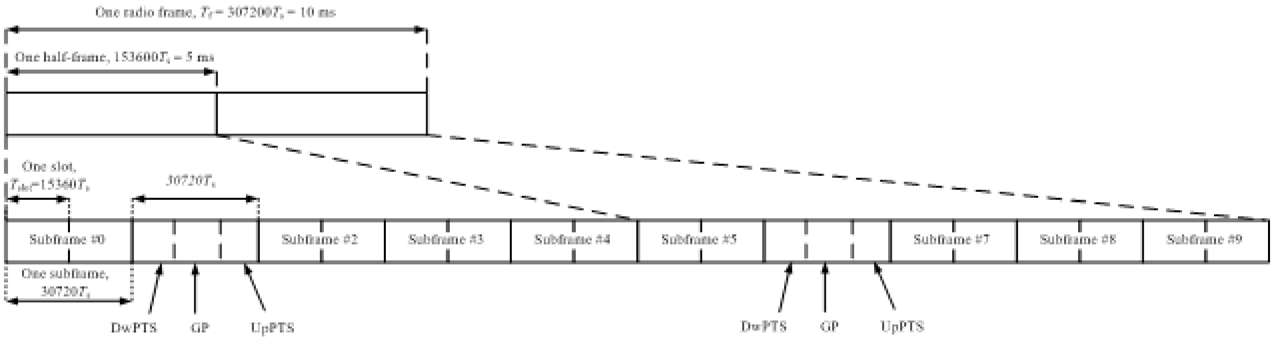


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).

5.2 Slot structure and physical resources

5.2.1 Resource grid

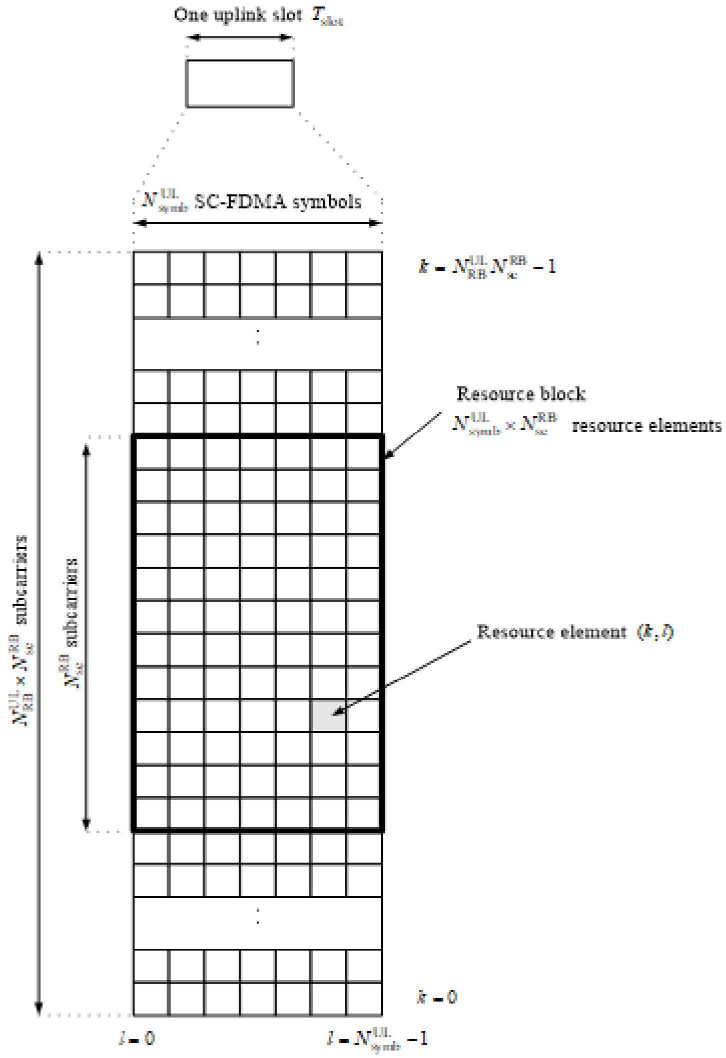
The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

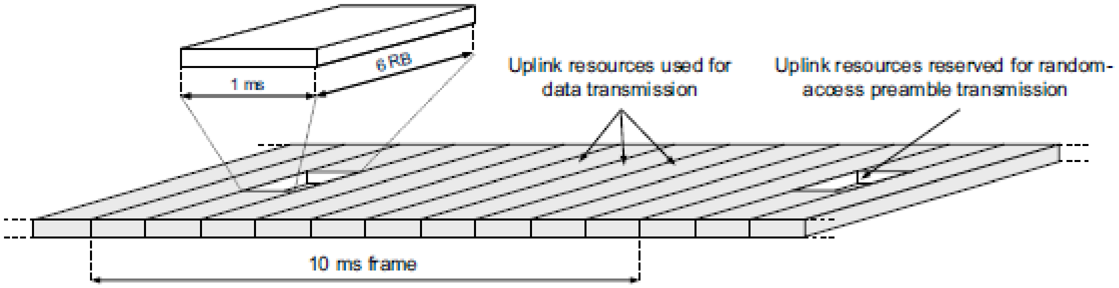
The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

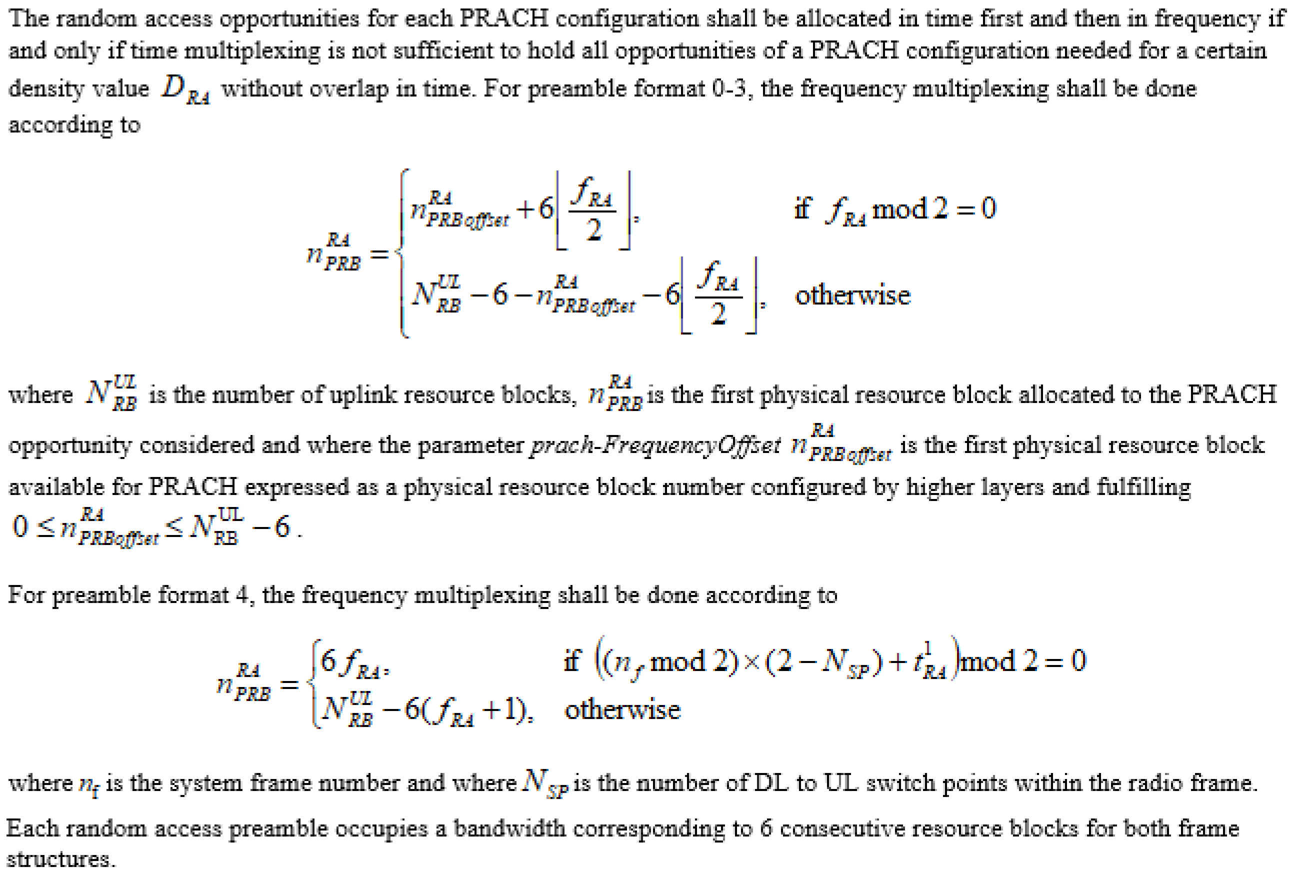
	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 21(c)

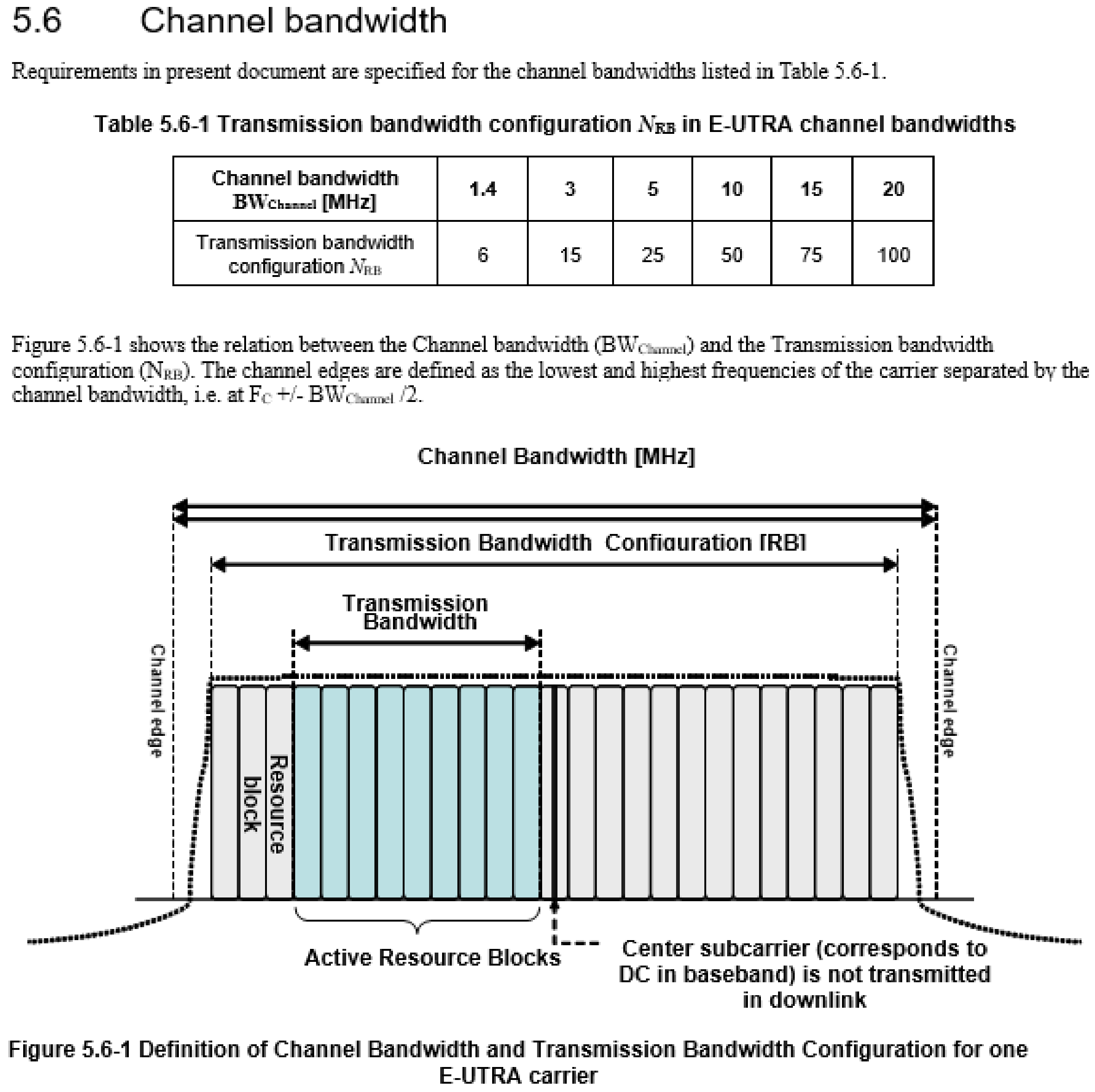
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	Tesla’s Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

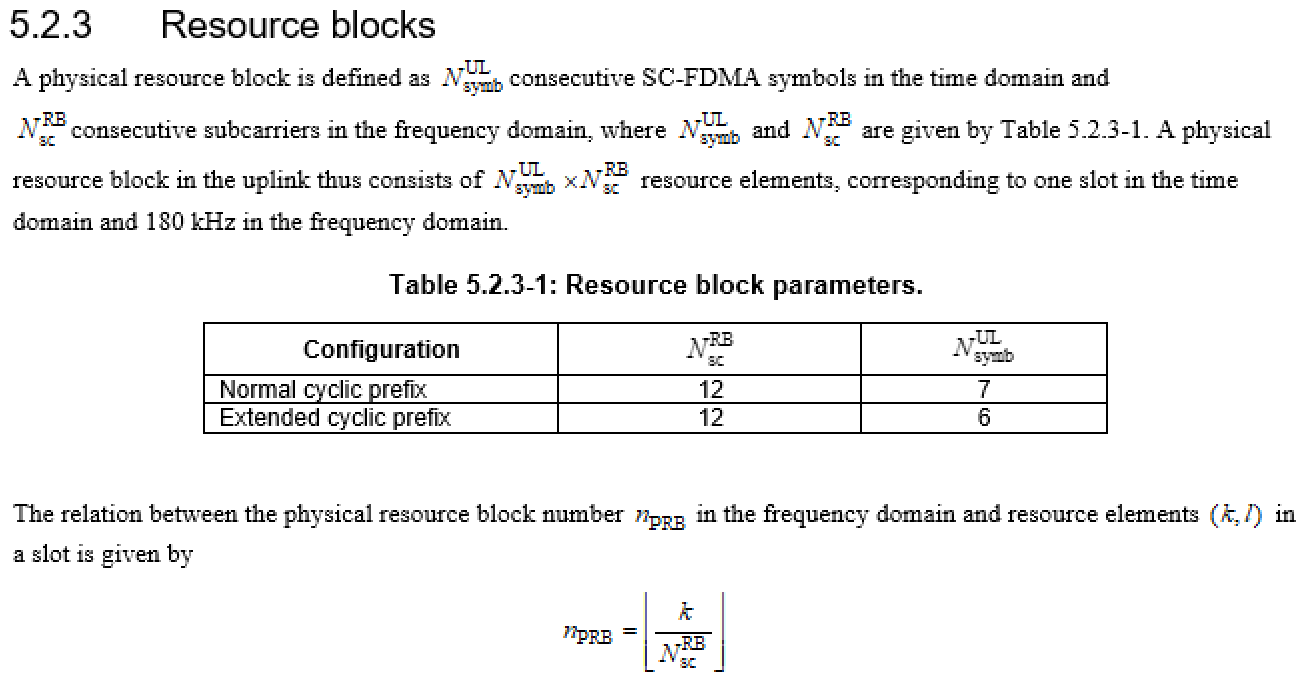
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

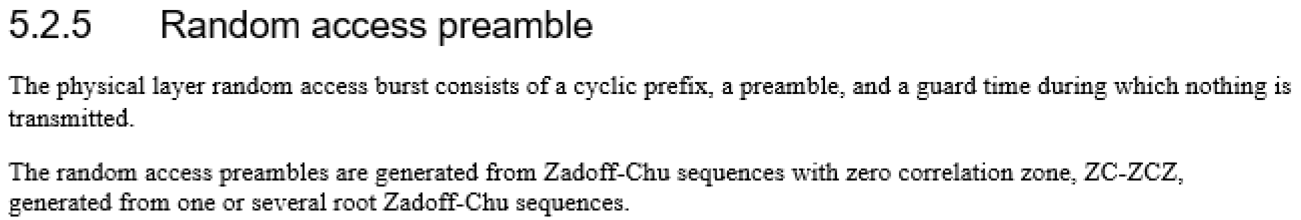
Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\mathrm{PRB}} = \left\lfloor \frac{k}{N_{\mathrm{sc}}^{\mathrm{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

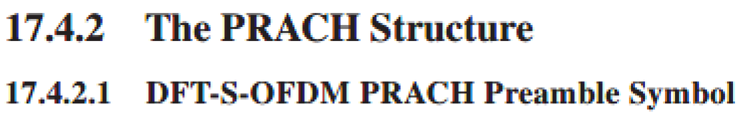


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

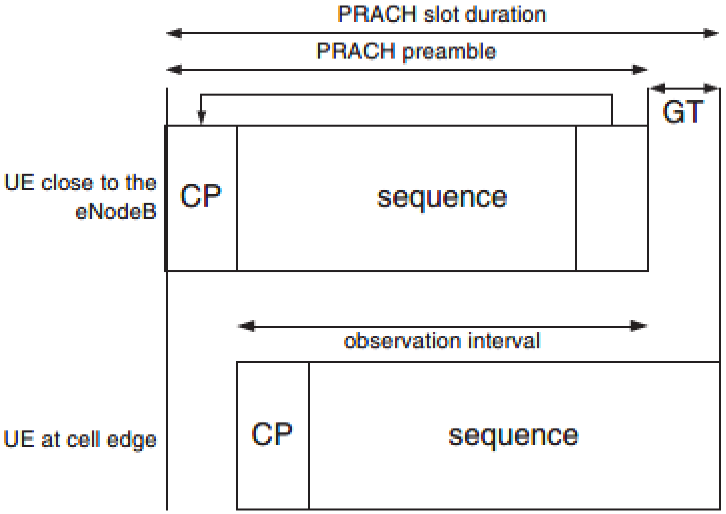


17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

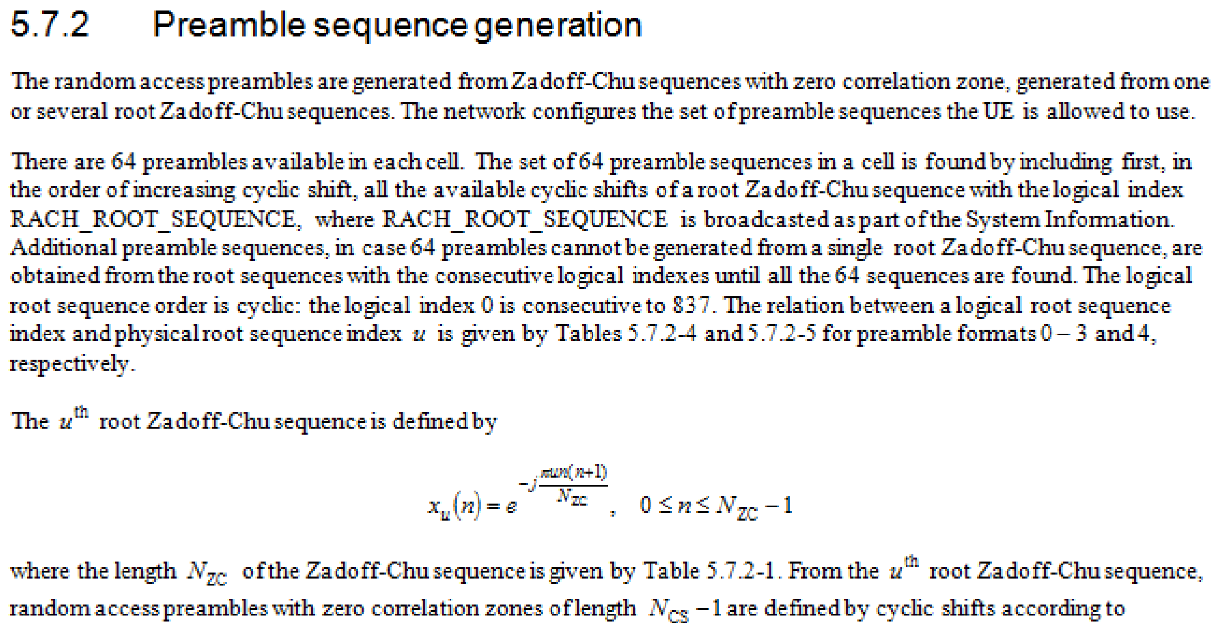
…

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional  Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

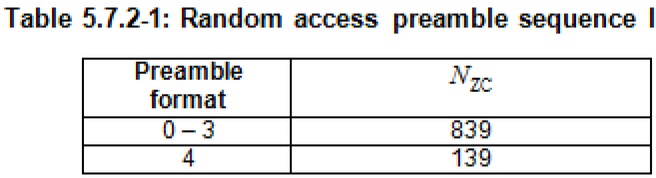


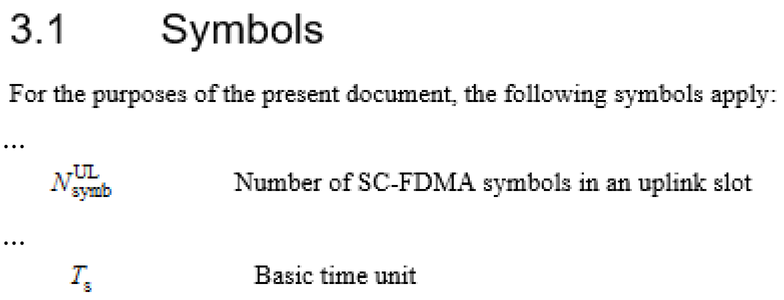
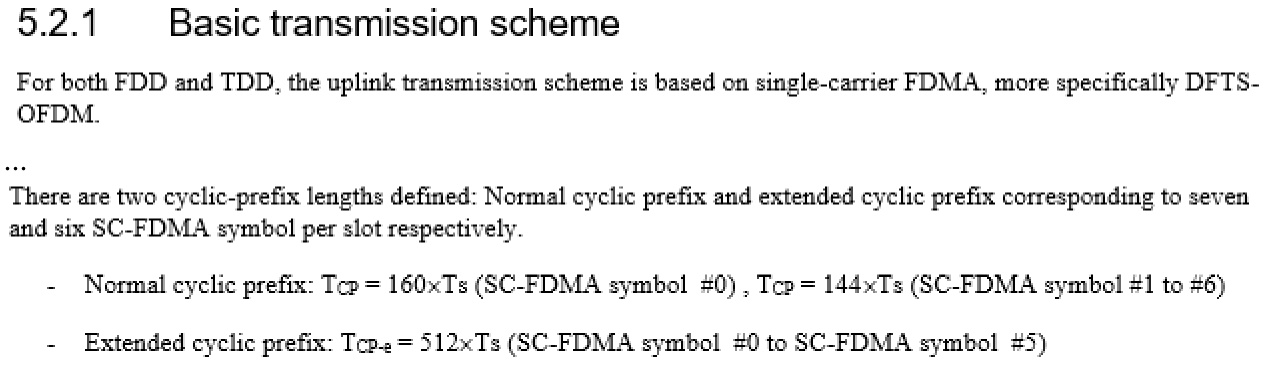
Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)

“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Tesla’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

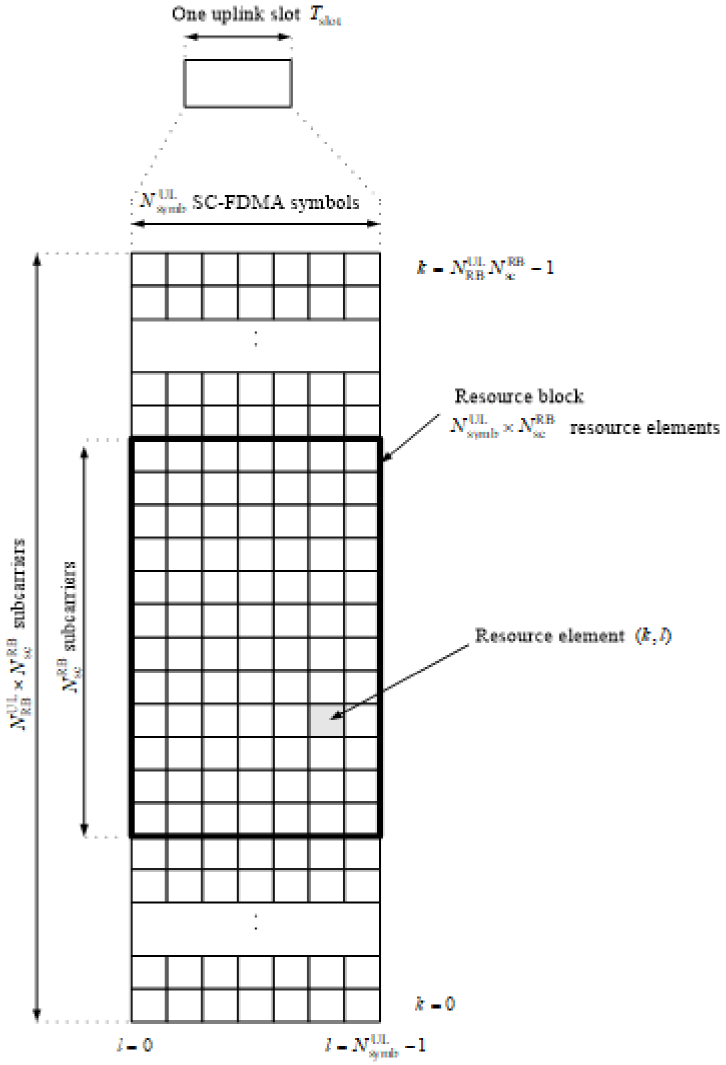
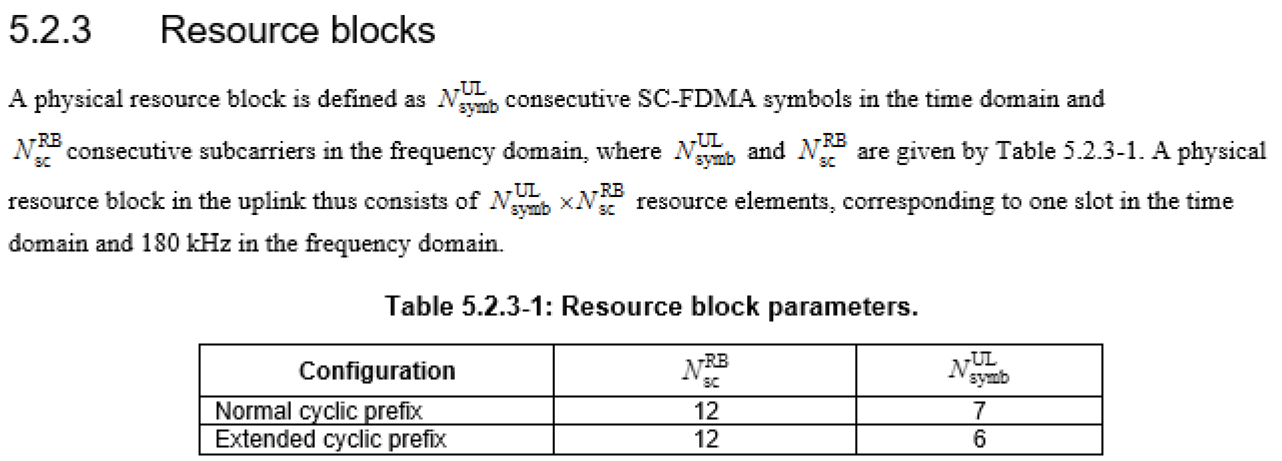


Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

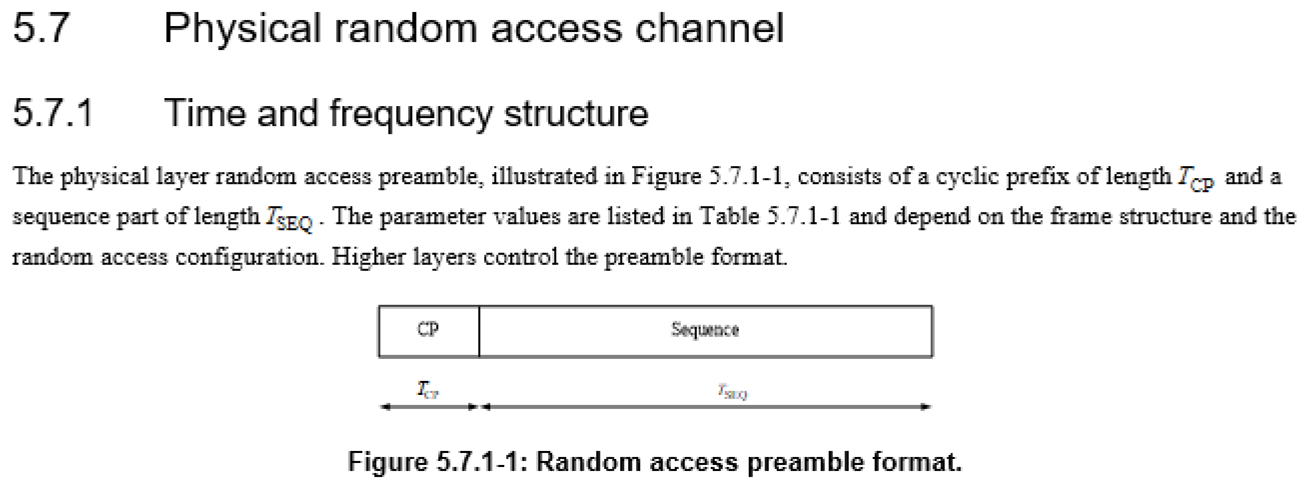
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

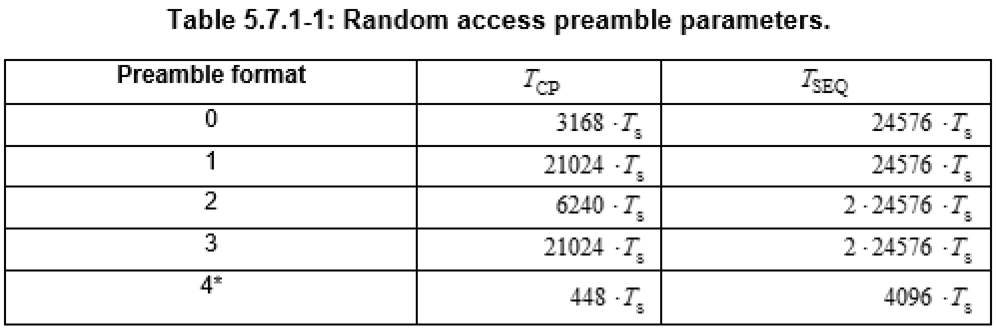


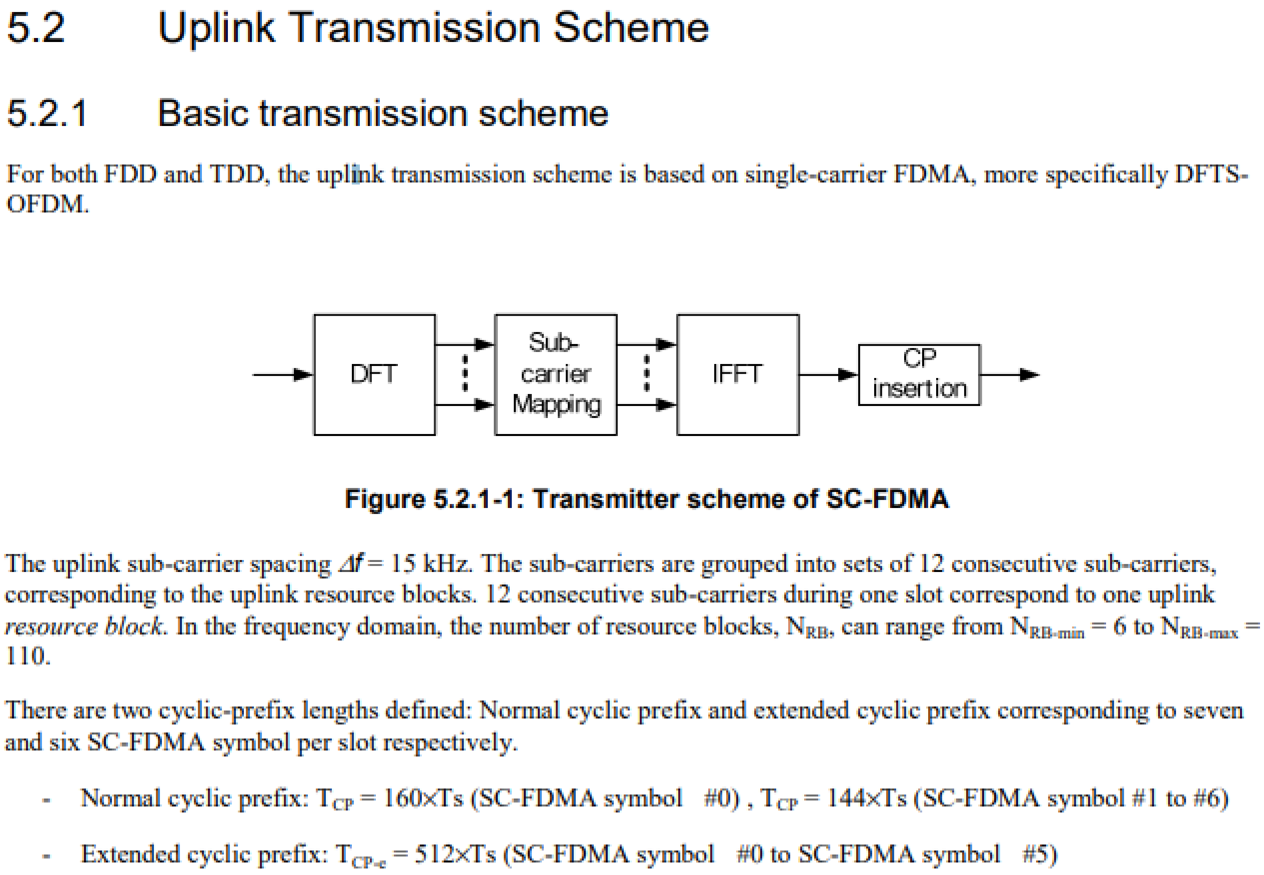
Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

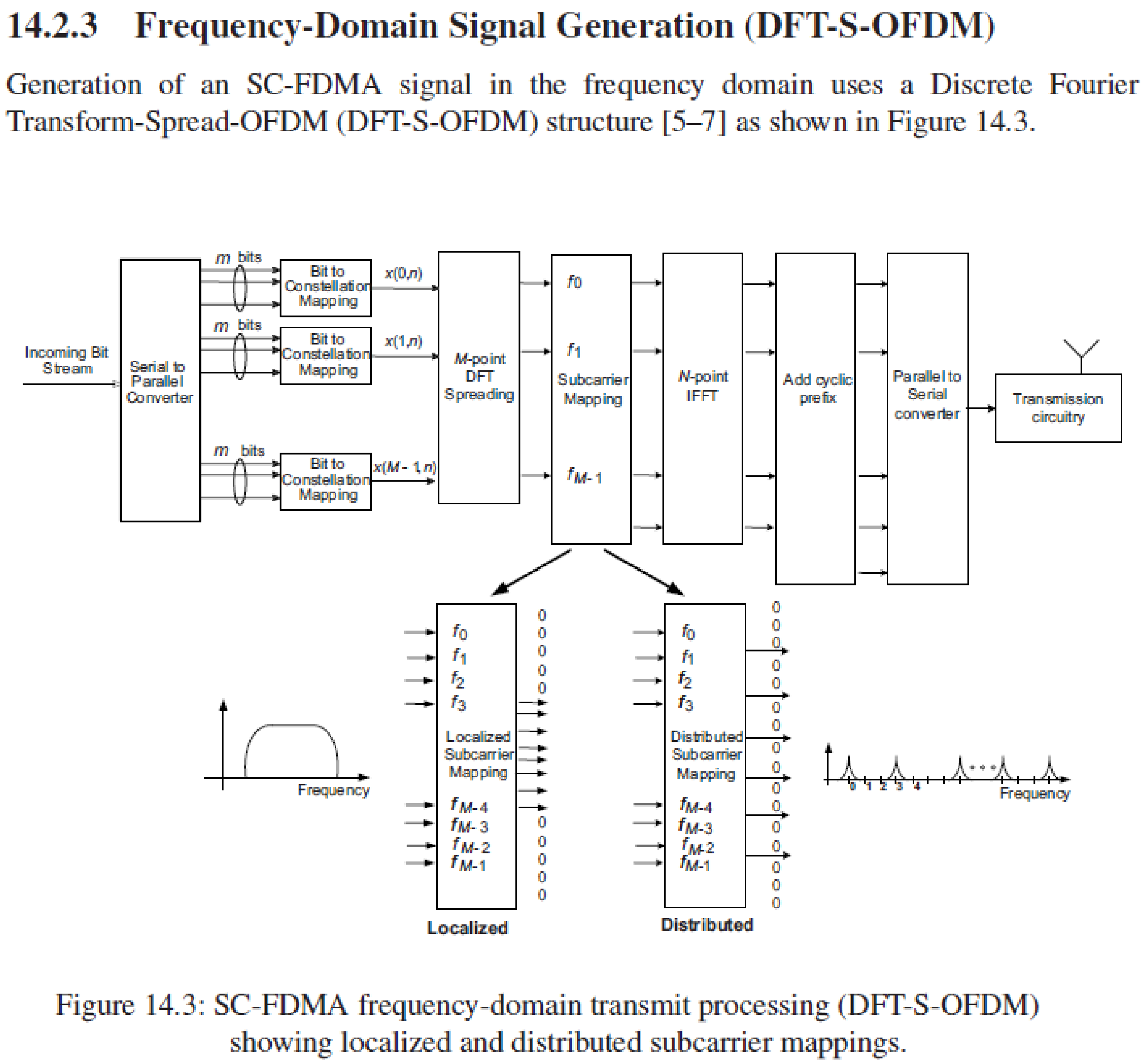
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)

"a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;"

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	Tesla's Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, Tesla's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

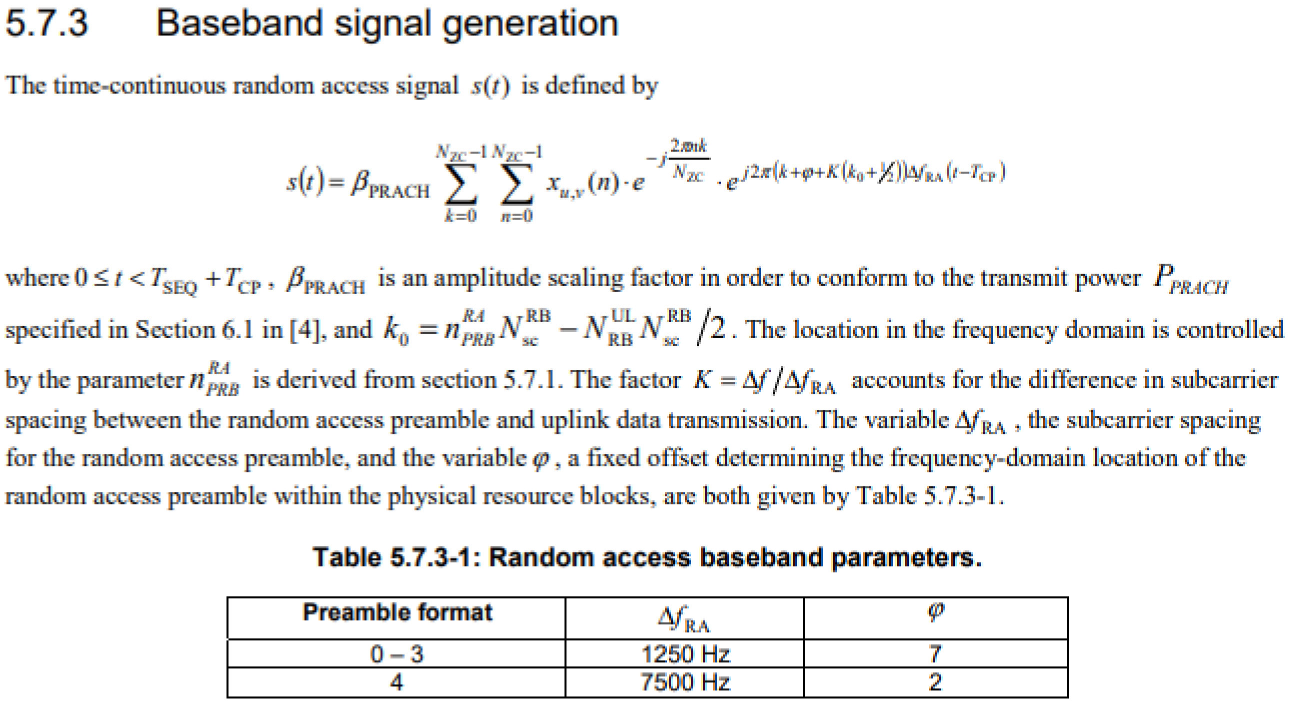
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

US Patent No. 10,833,908: Claim 21(f)
"wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band"

wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;

Tesla's Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

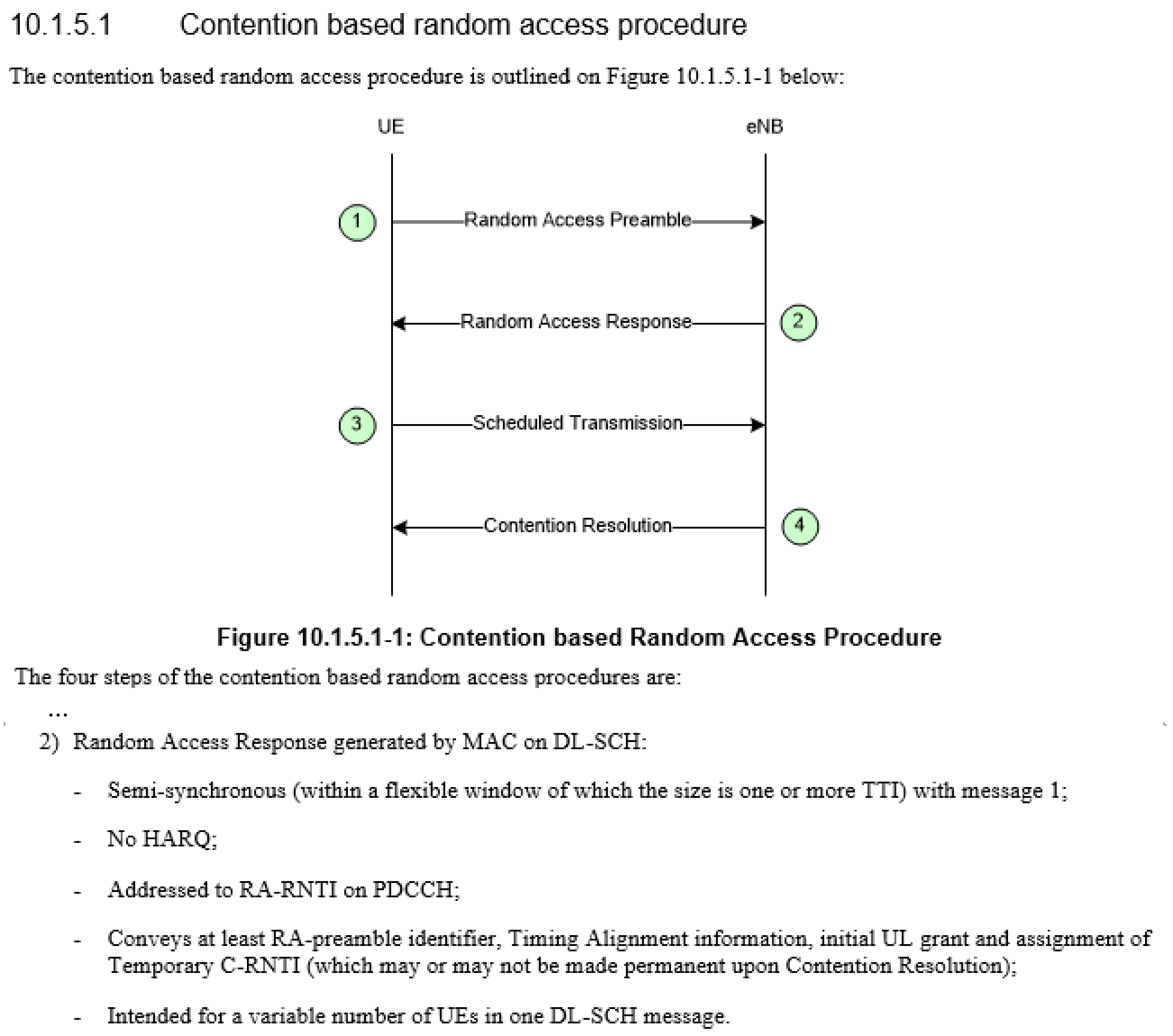
where $0\le t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

wherein the mobile station is further configured to receive, from the base station, a second analog signal	Tesla’s Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

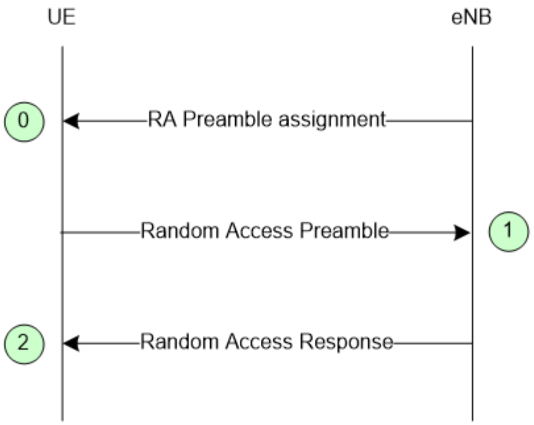
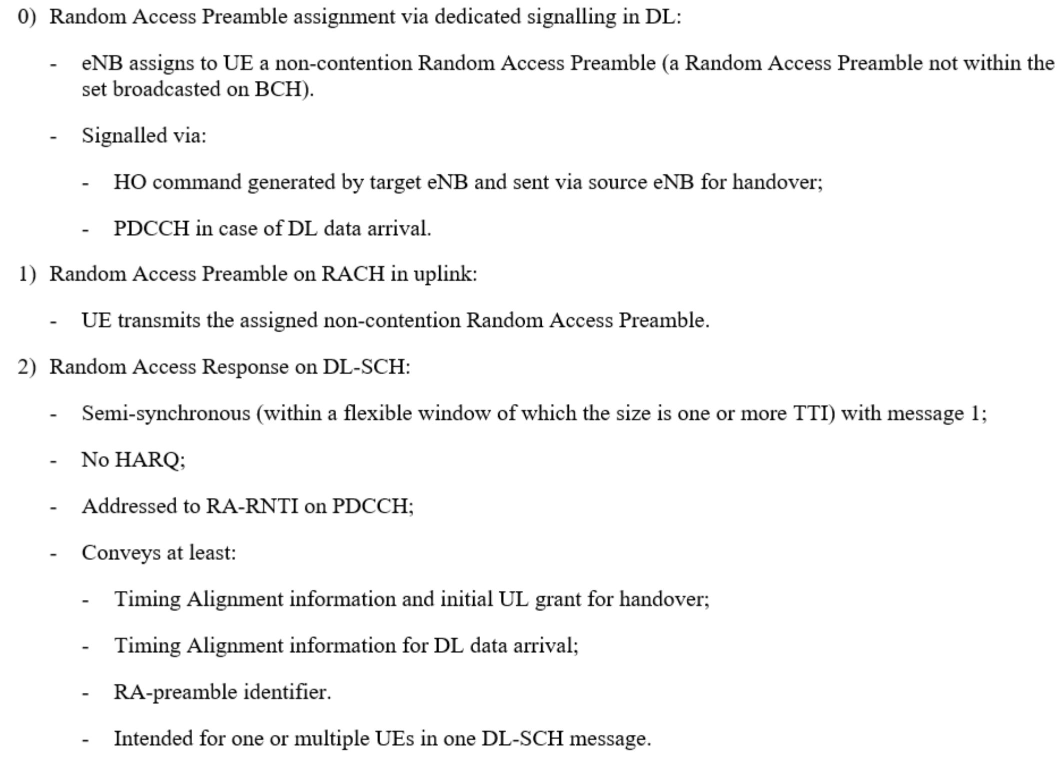


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

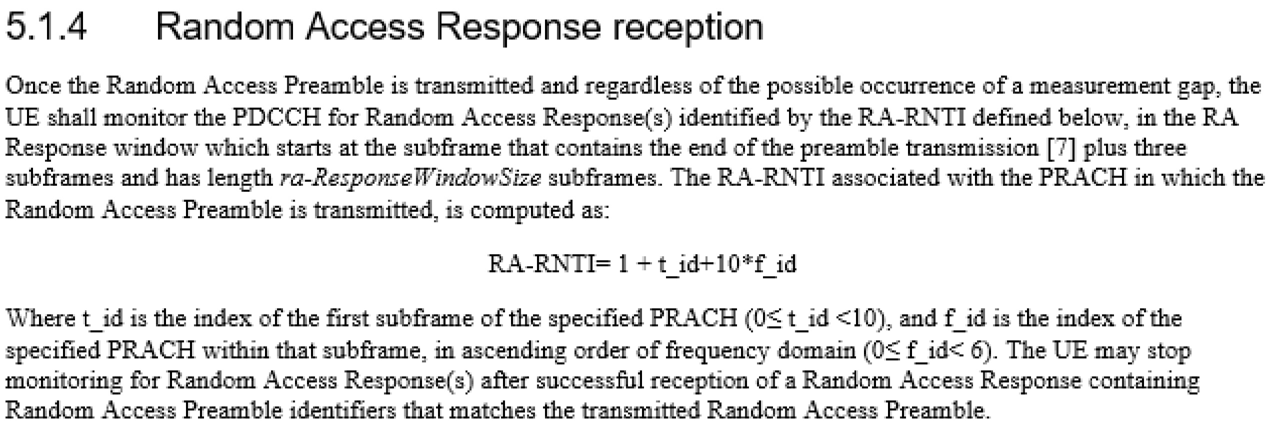


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

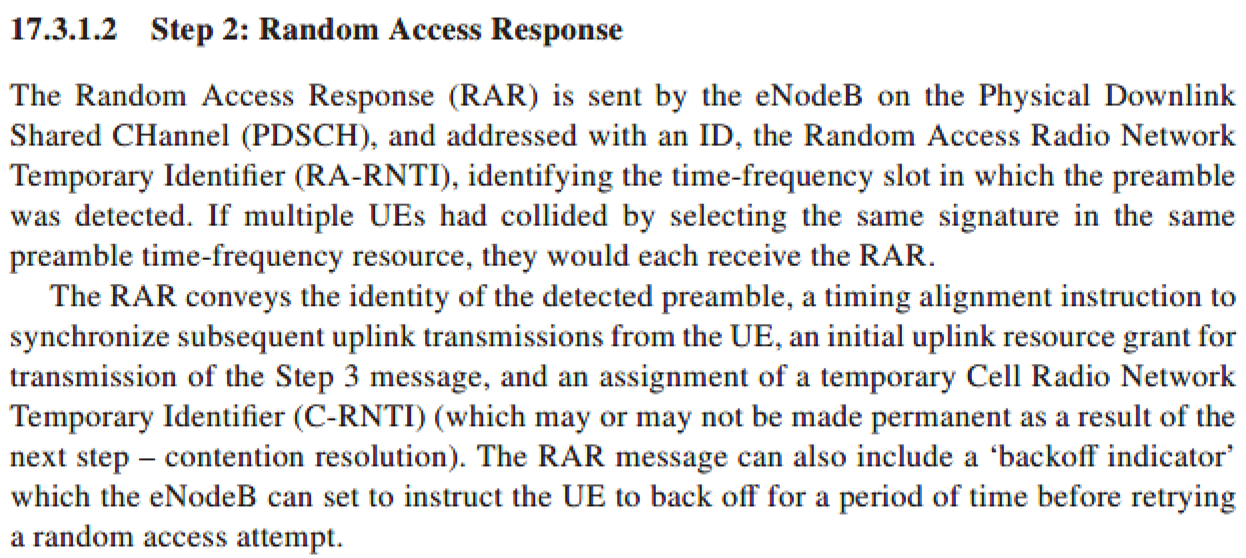
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

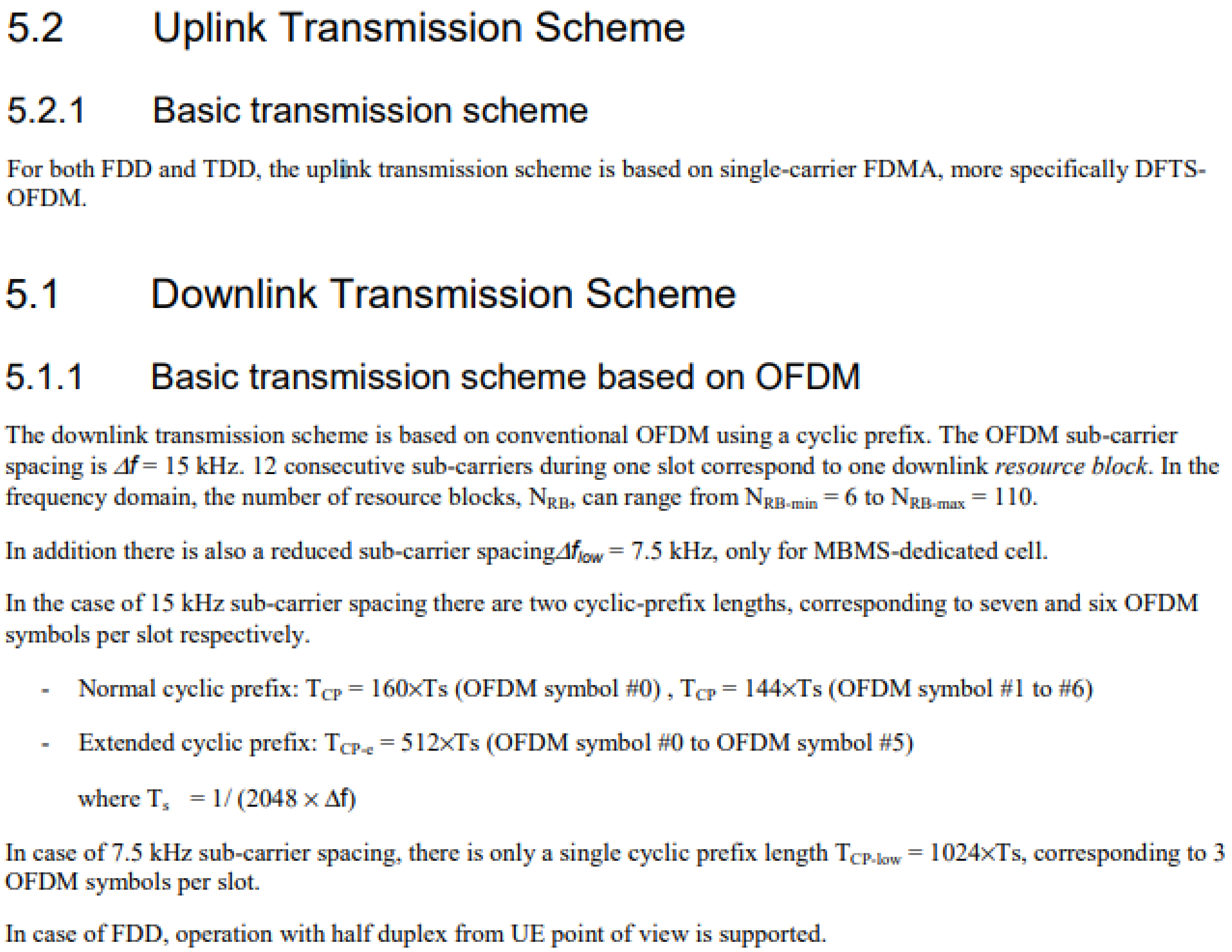
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	Tesla's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, Tesla's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. 5.1 Downlink Transmission Scheme 5.1.1 Basic transmission scheme based on OFDM The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

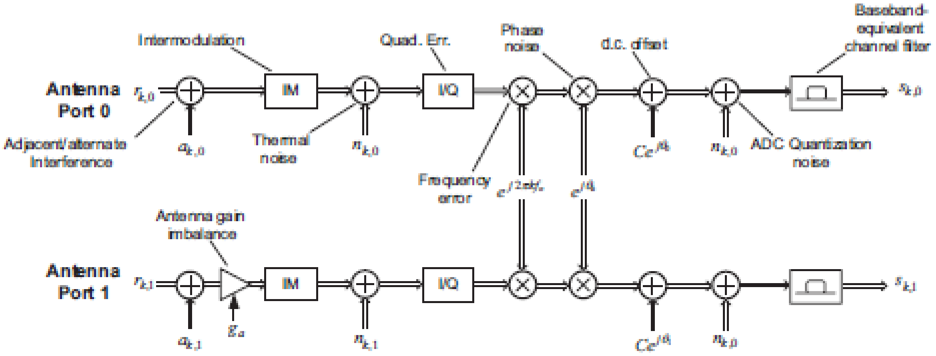


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.

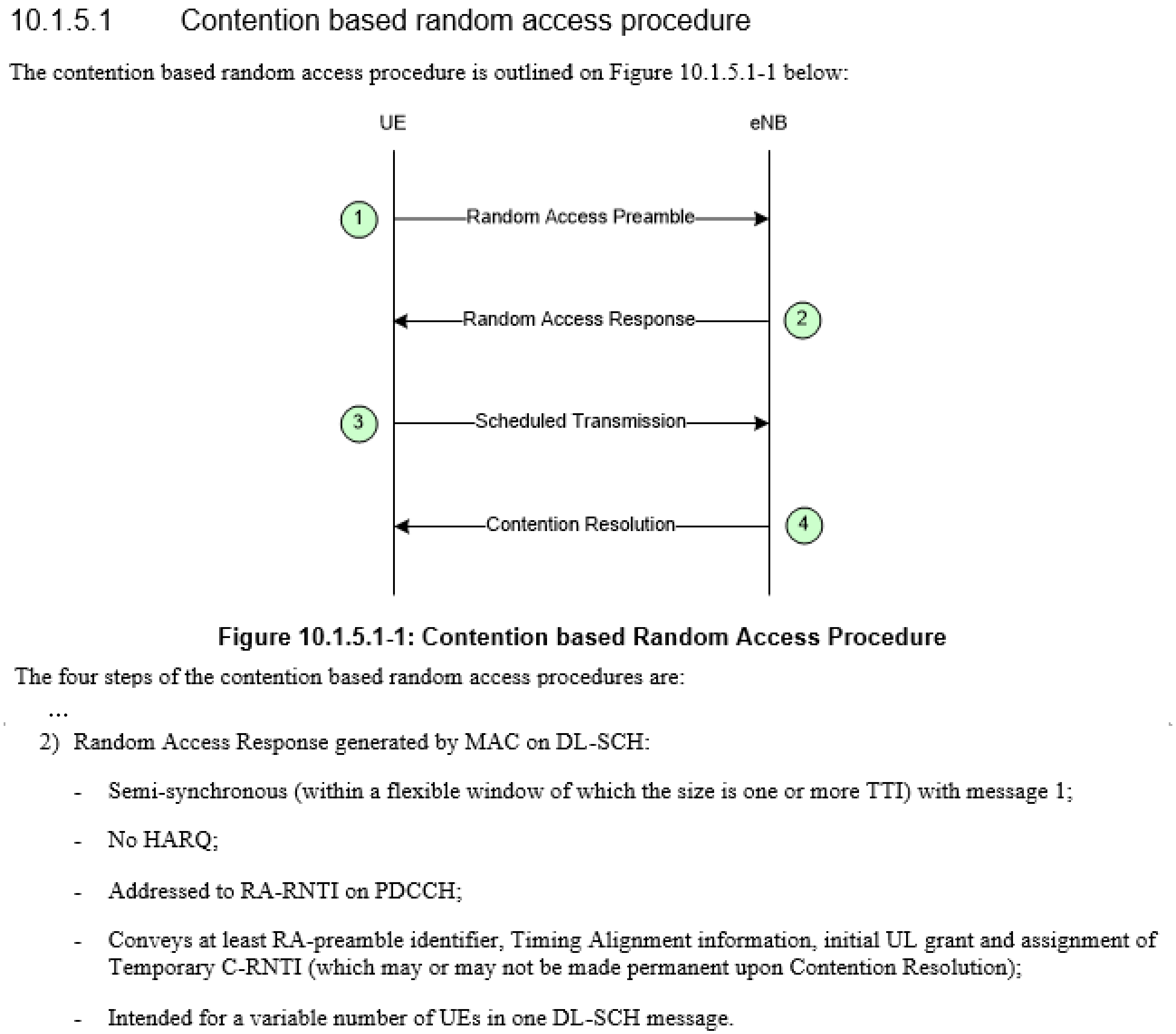
- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

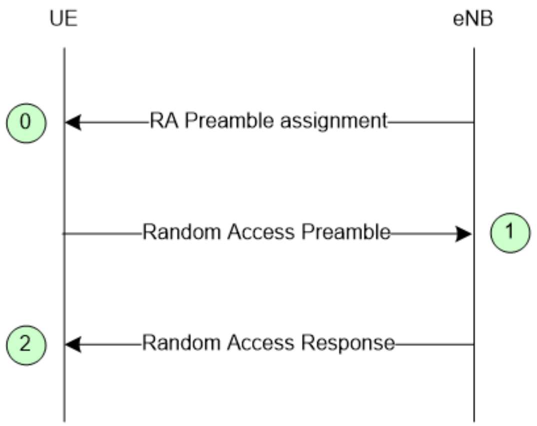
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

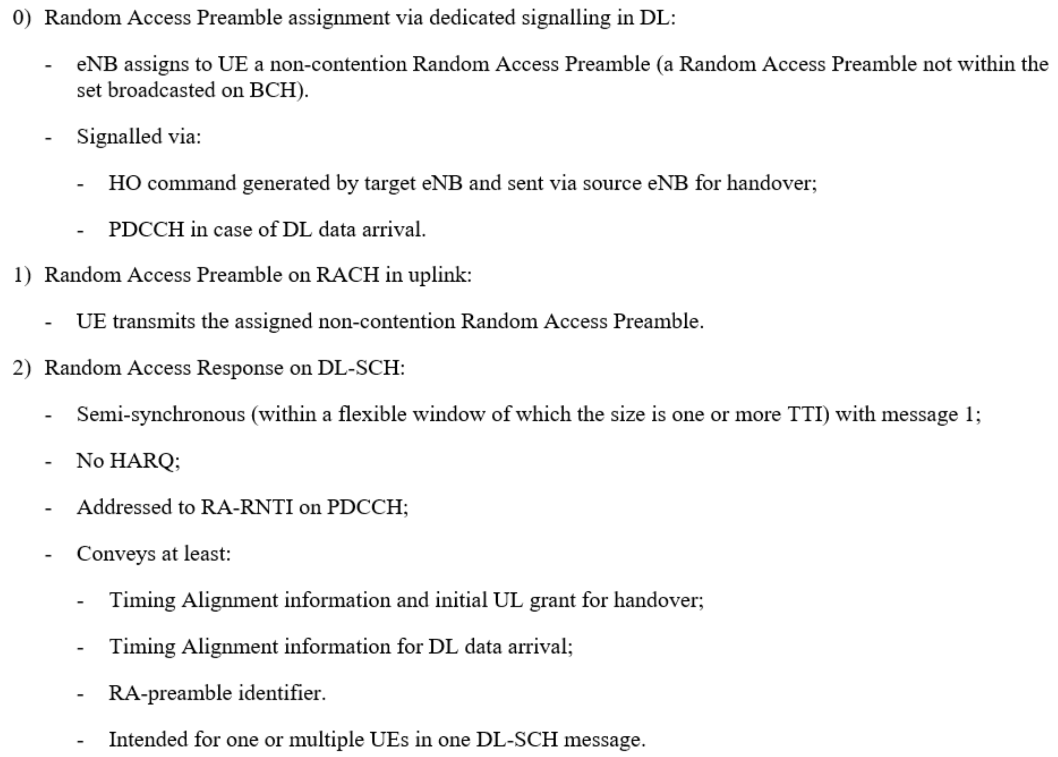
See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 21(h)
“wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message..”

	10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

“wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message..”

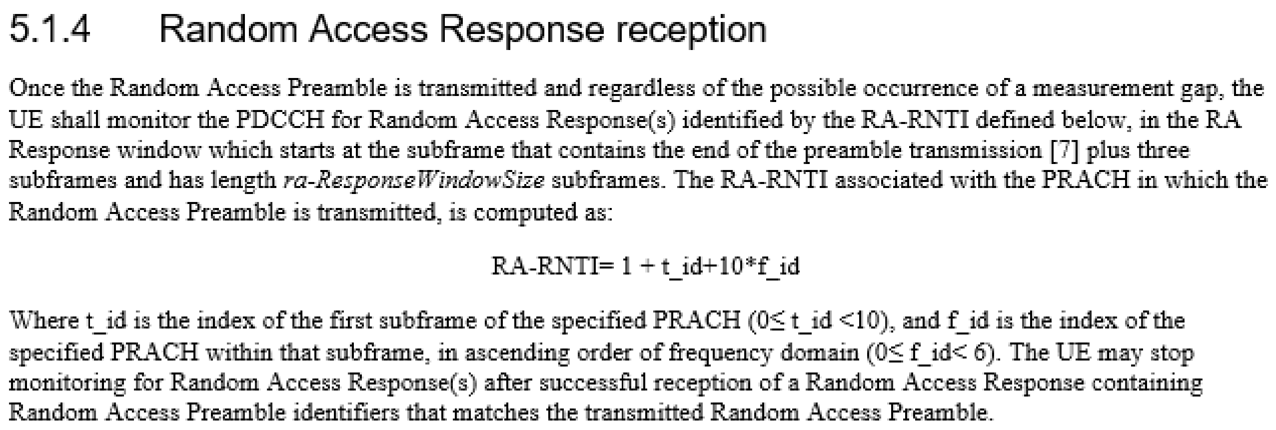


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

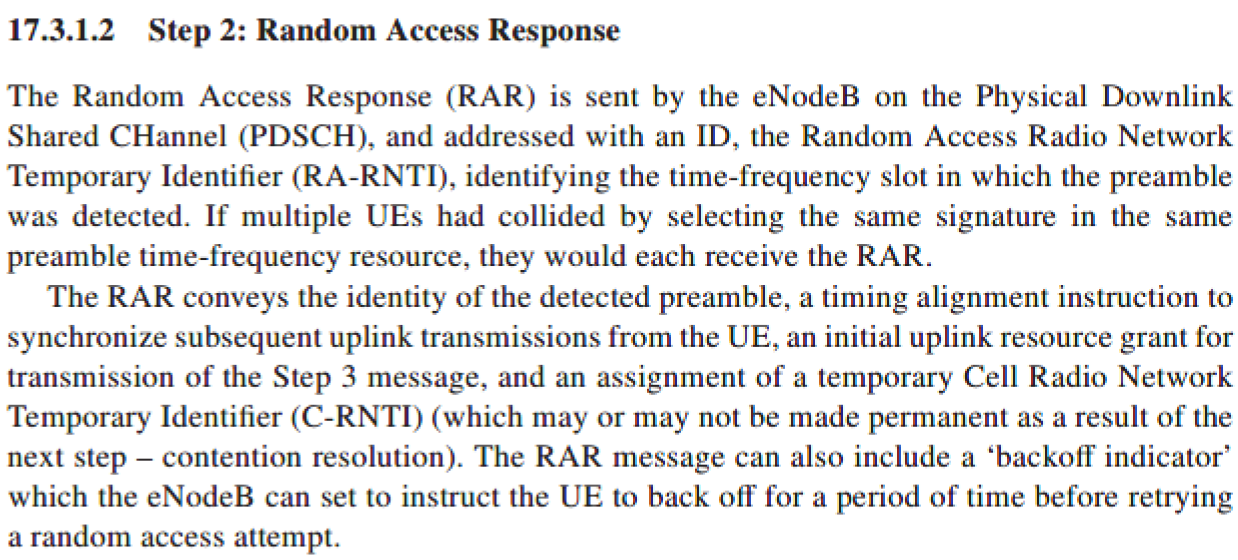
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

US Patent No. 10,833,908: Claim 21(h)

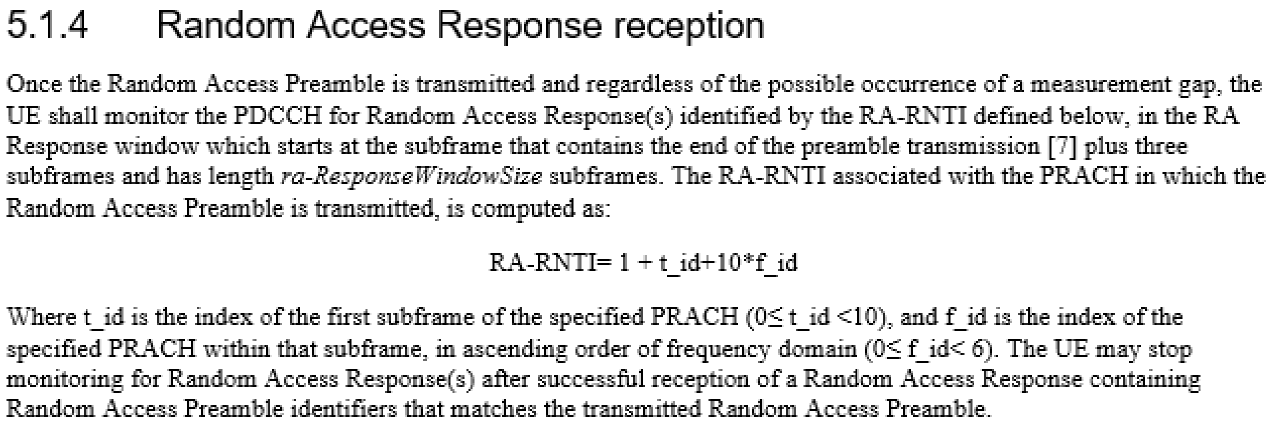
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

	See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

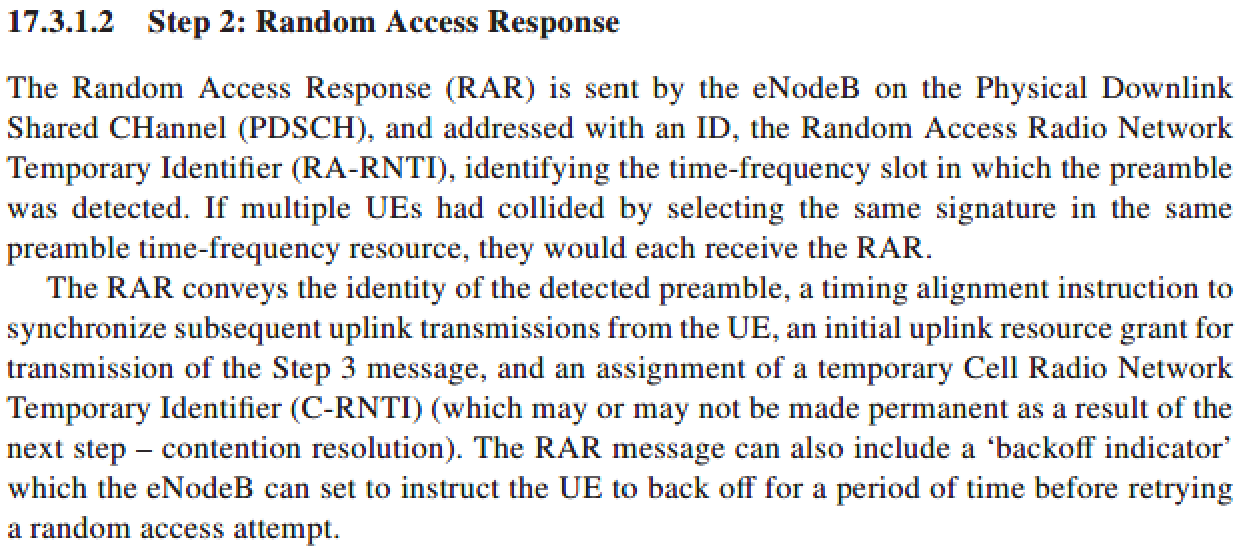
US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

22. The mobile station of claim 21, wherein:	*See* Claim 21.

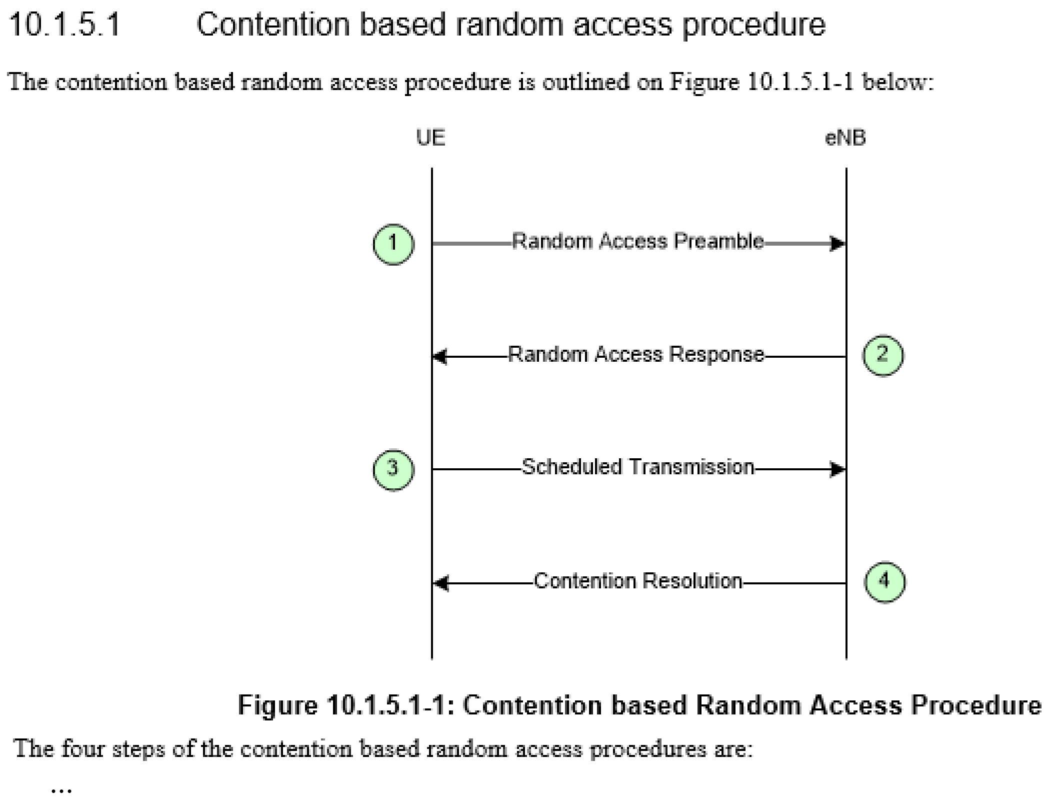
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	Tesla’s Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\le t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\le f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

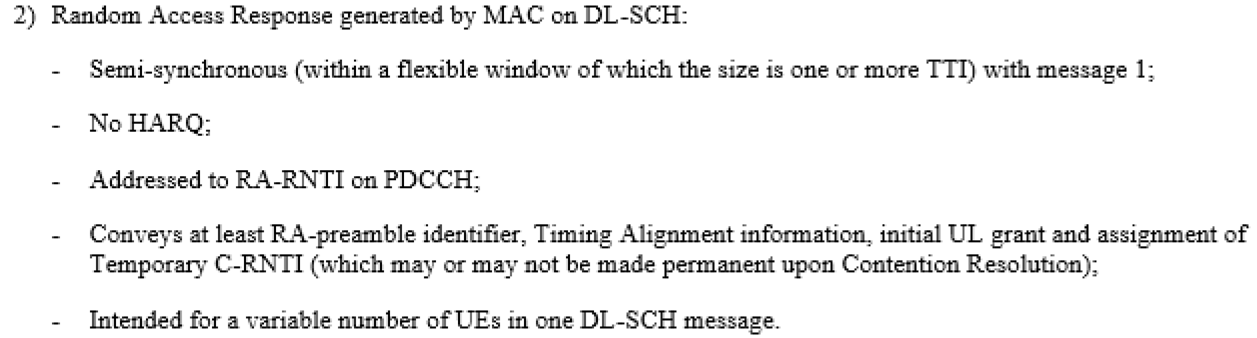
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Tesla's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

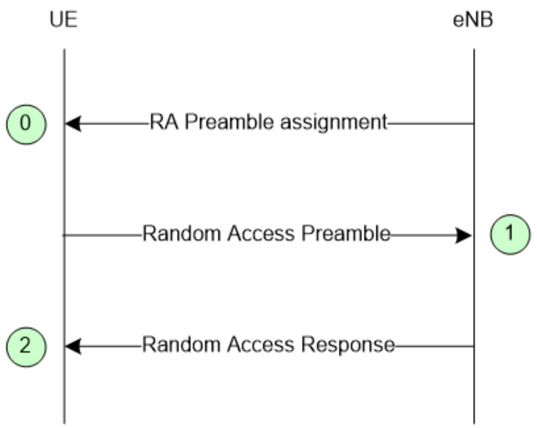
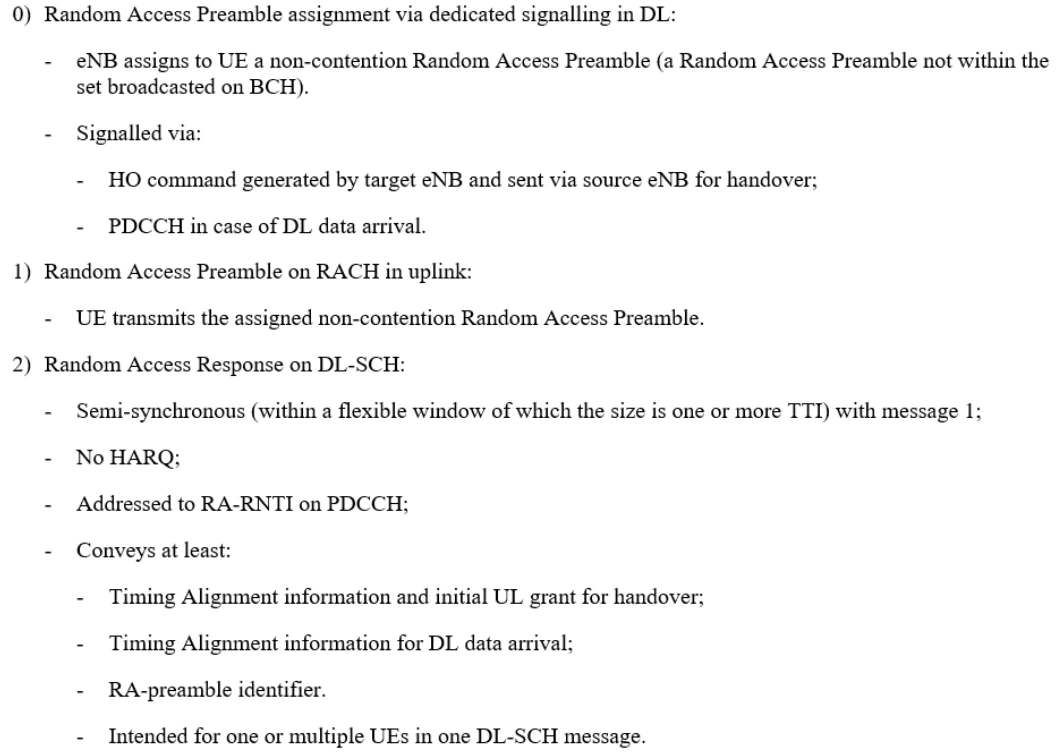


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

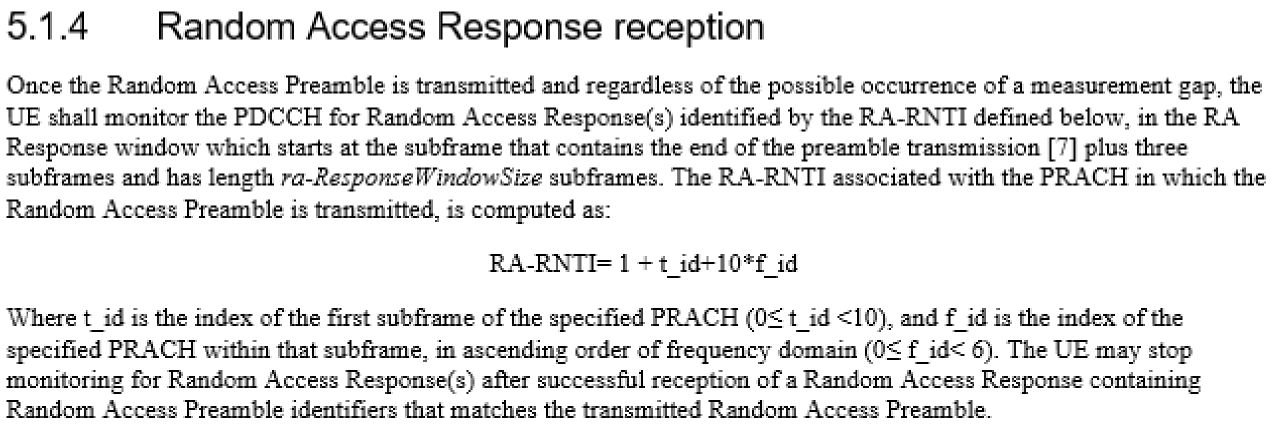
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

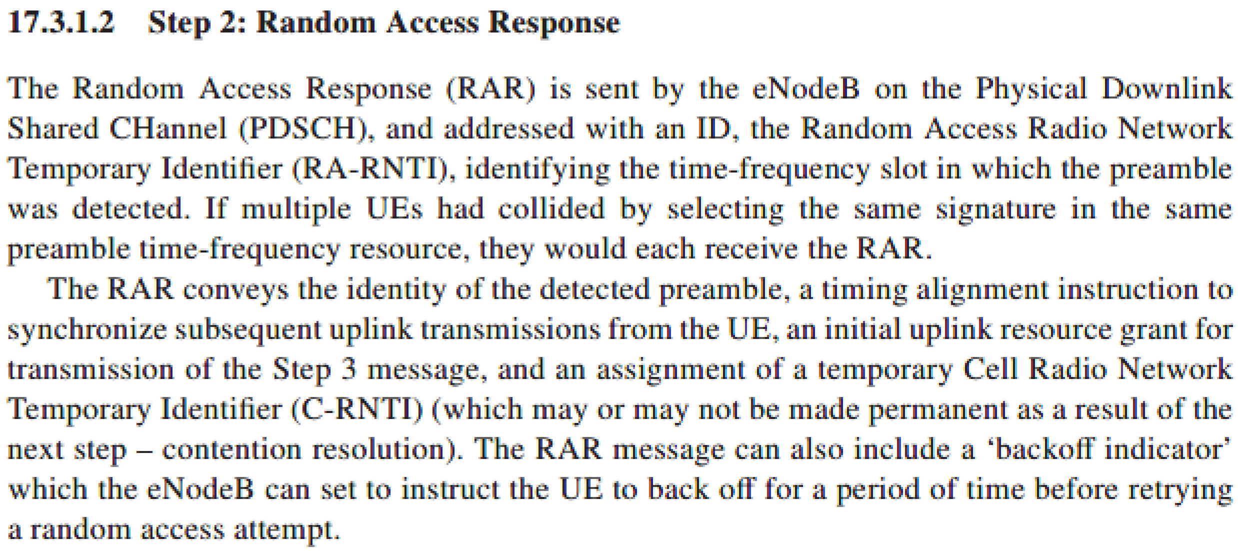
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



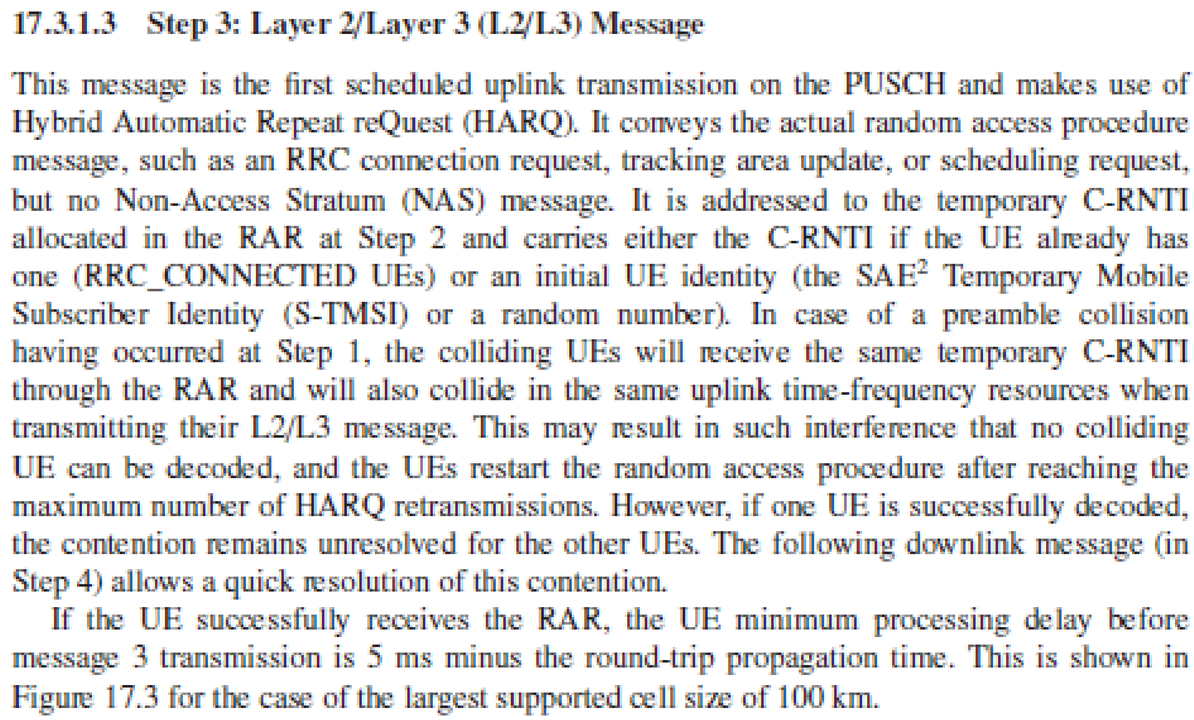
17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

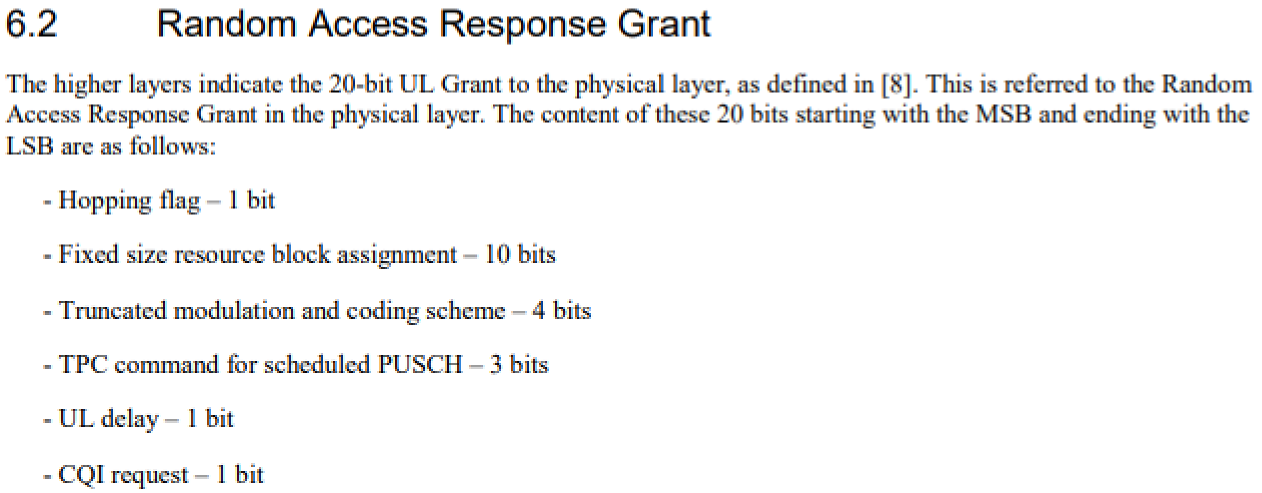
The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

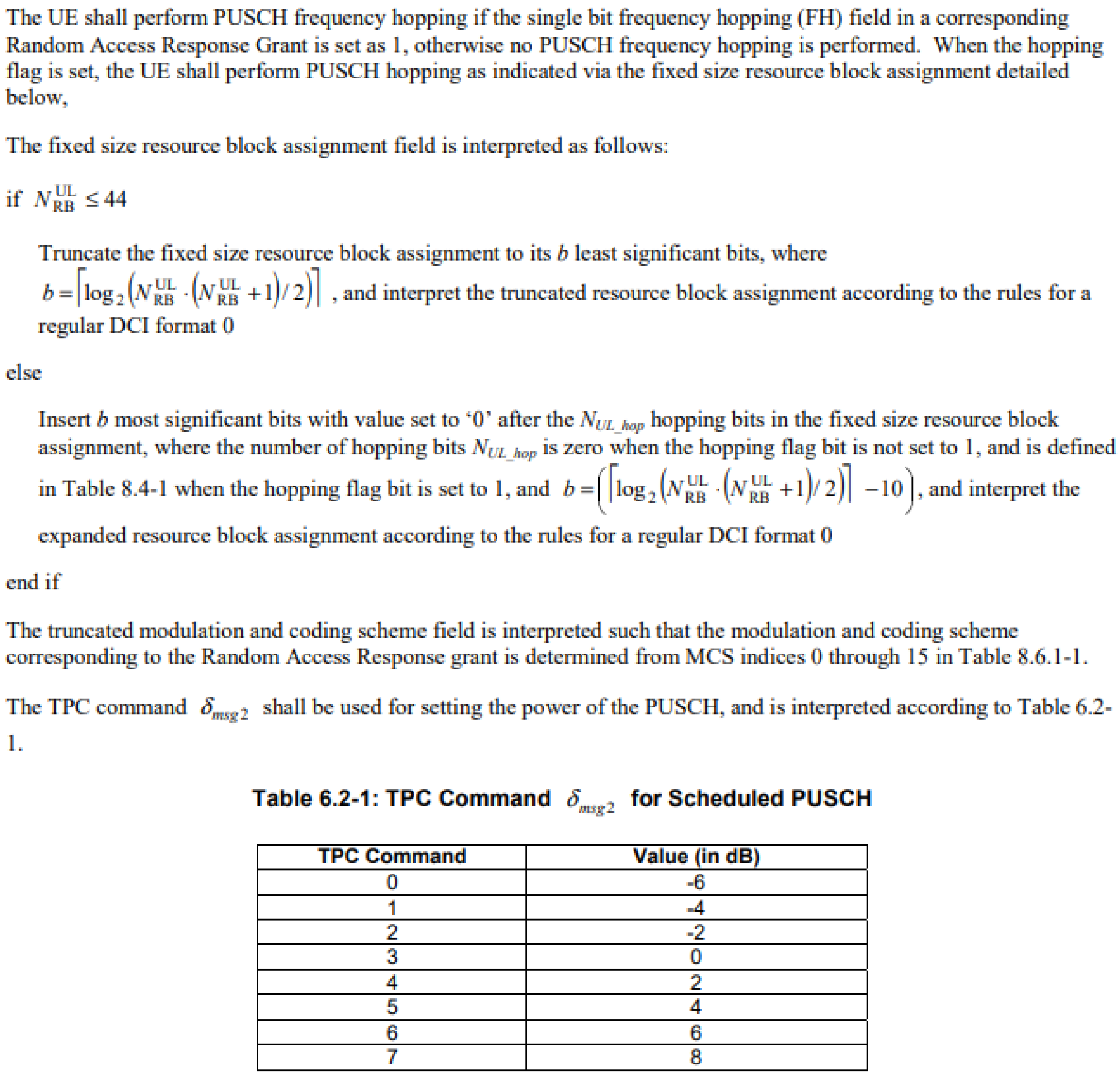
US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by Tesla's Accused Instrumentalities includes power adjustment information. *E.g.,* *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{RB}^{UL} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{RB}^{UL} \cdot \left(N_{RB}^{UL}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{RB}^{UL} \cdot \left(N_{RB}^{UL}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

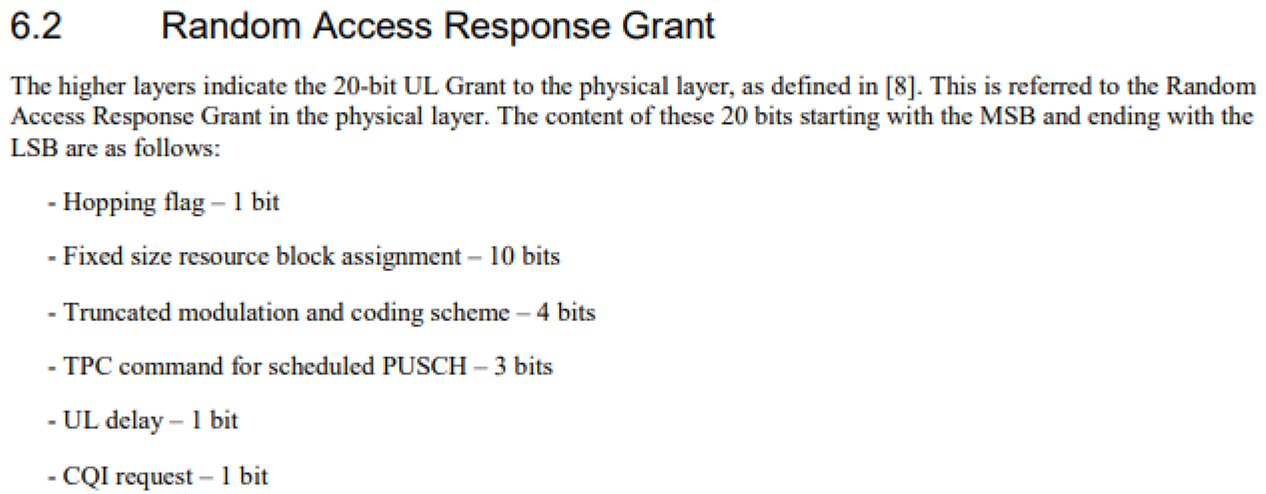
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

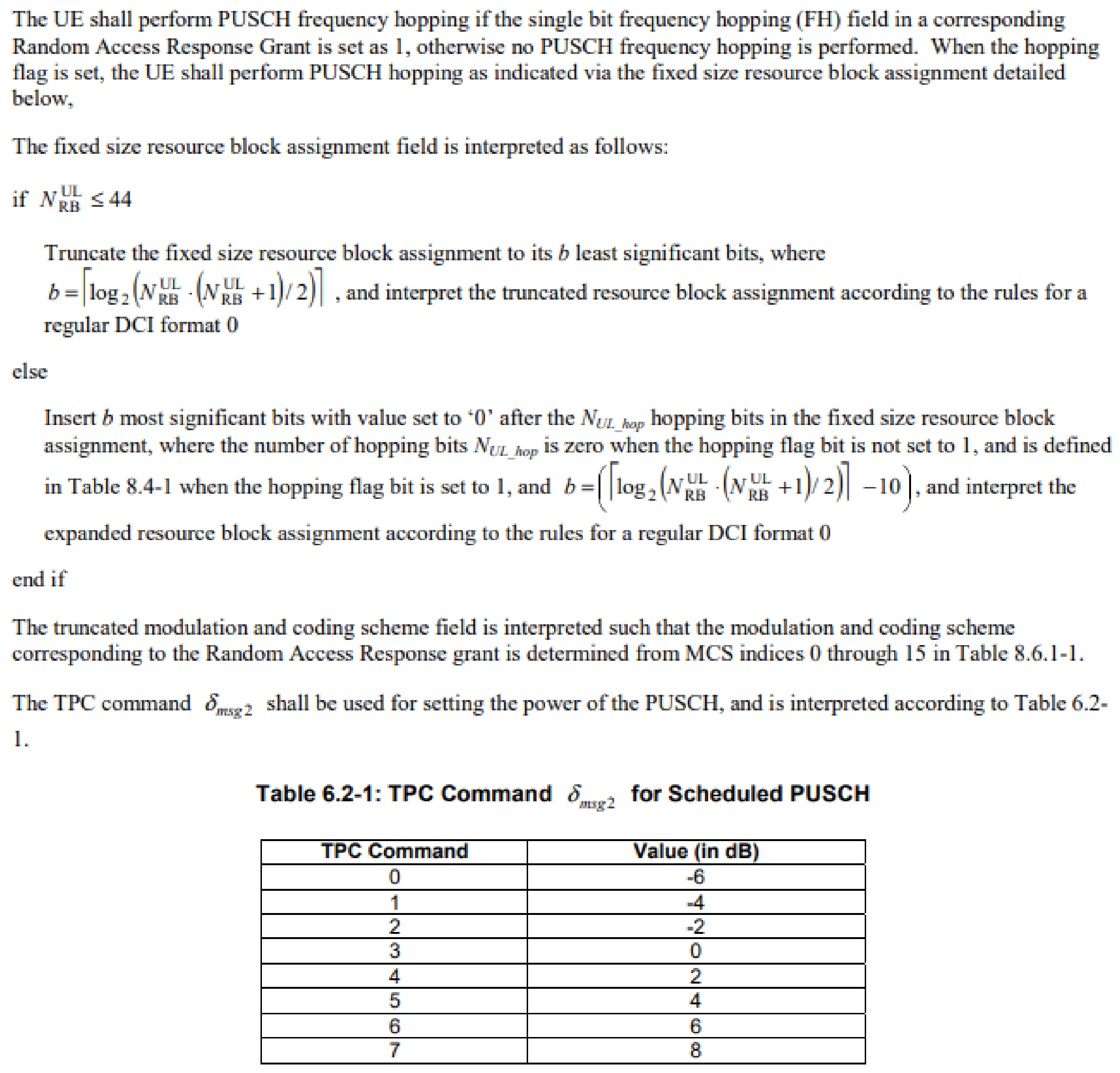
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	Tesla's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b=\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}}\cdot\left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b=\left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}}\cdot\left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil-10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

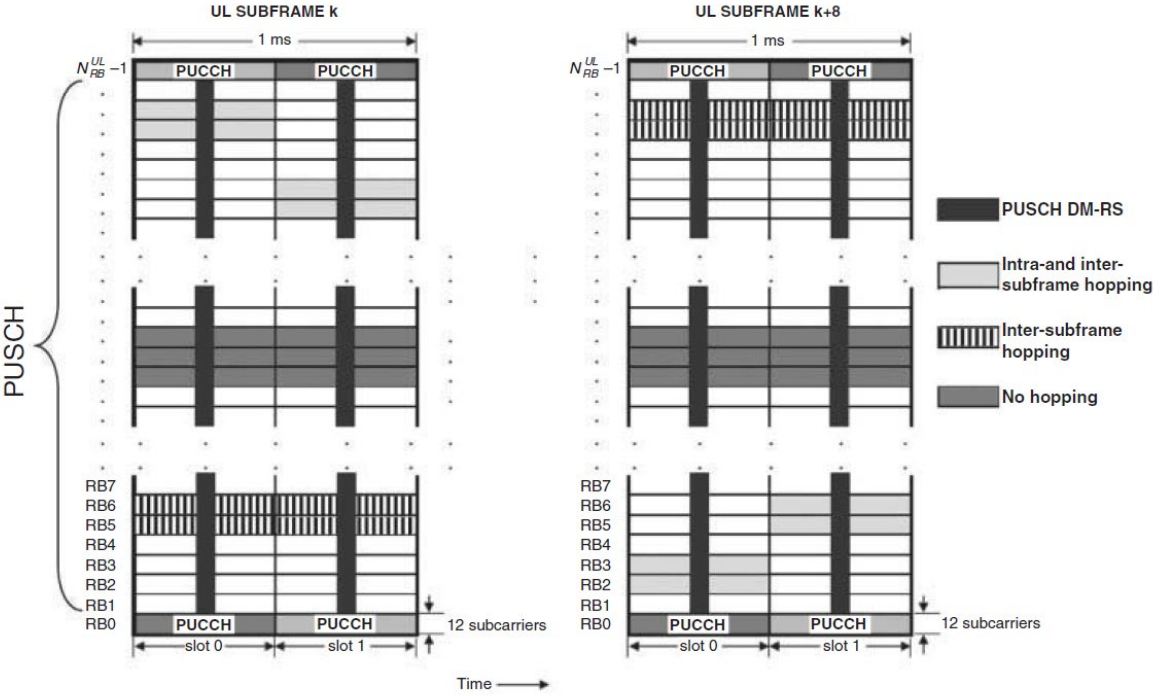
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

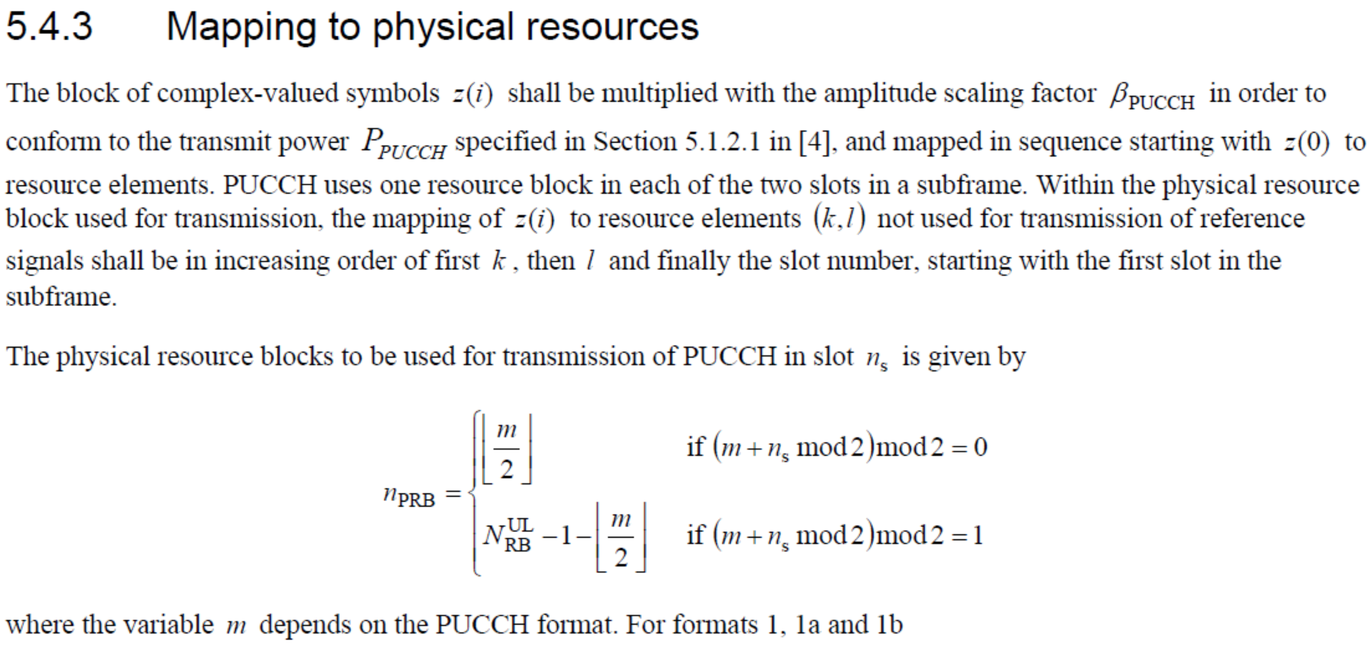
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Tesla’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

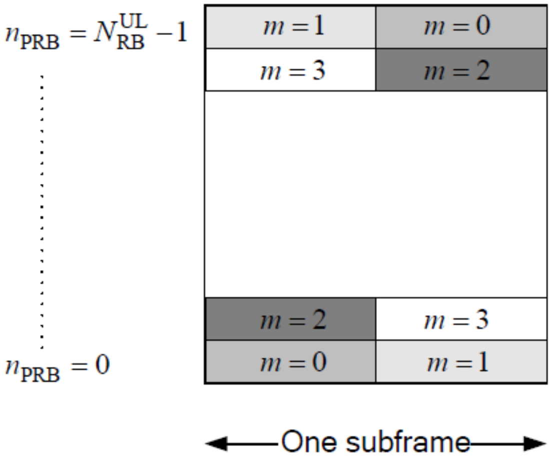


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

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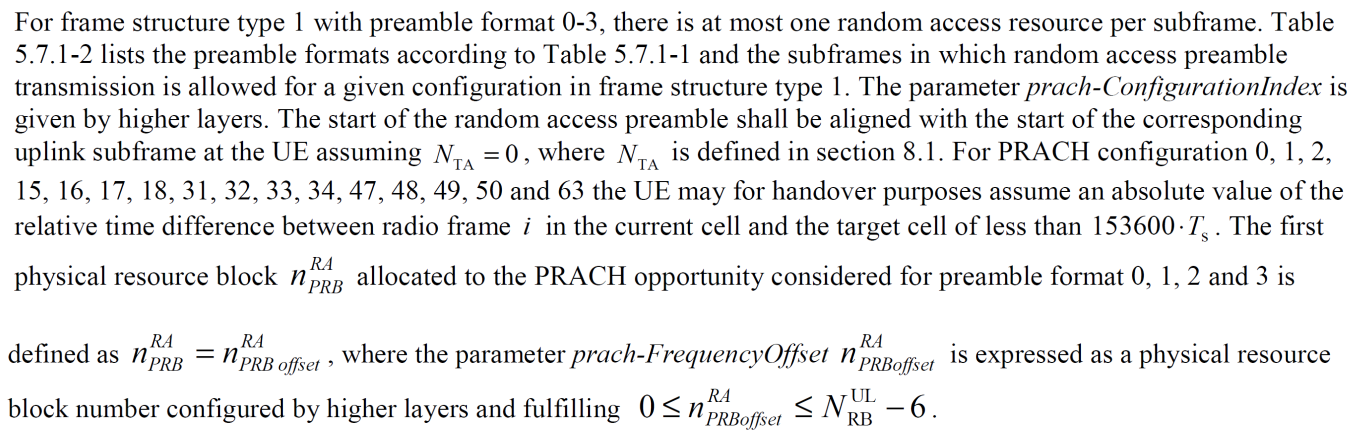
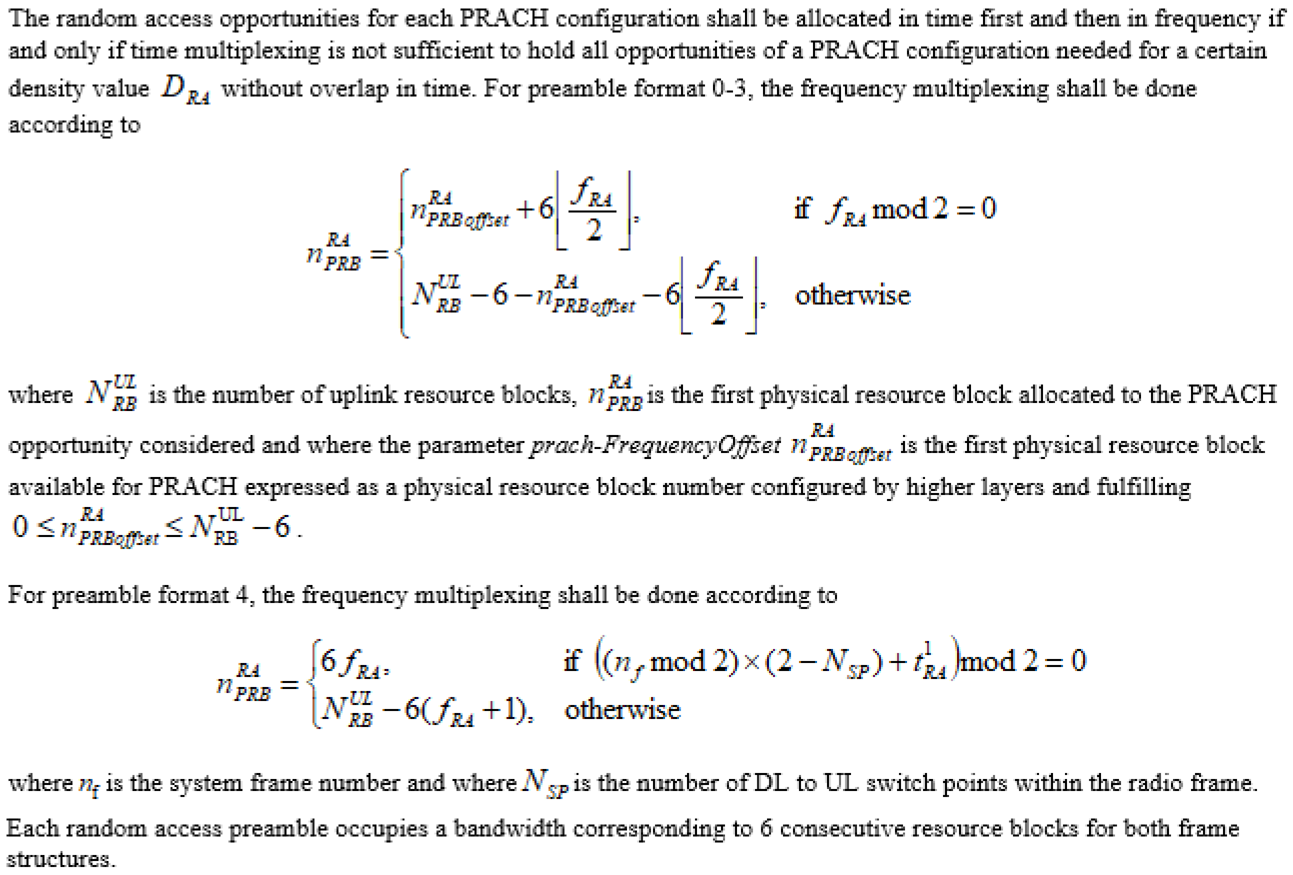


For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 24

" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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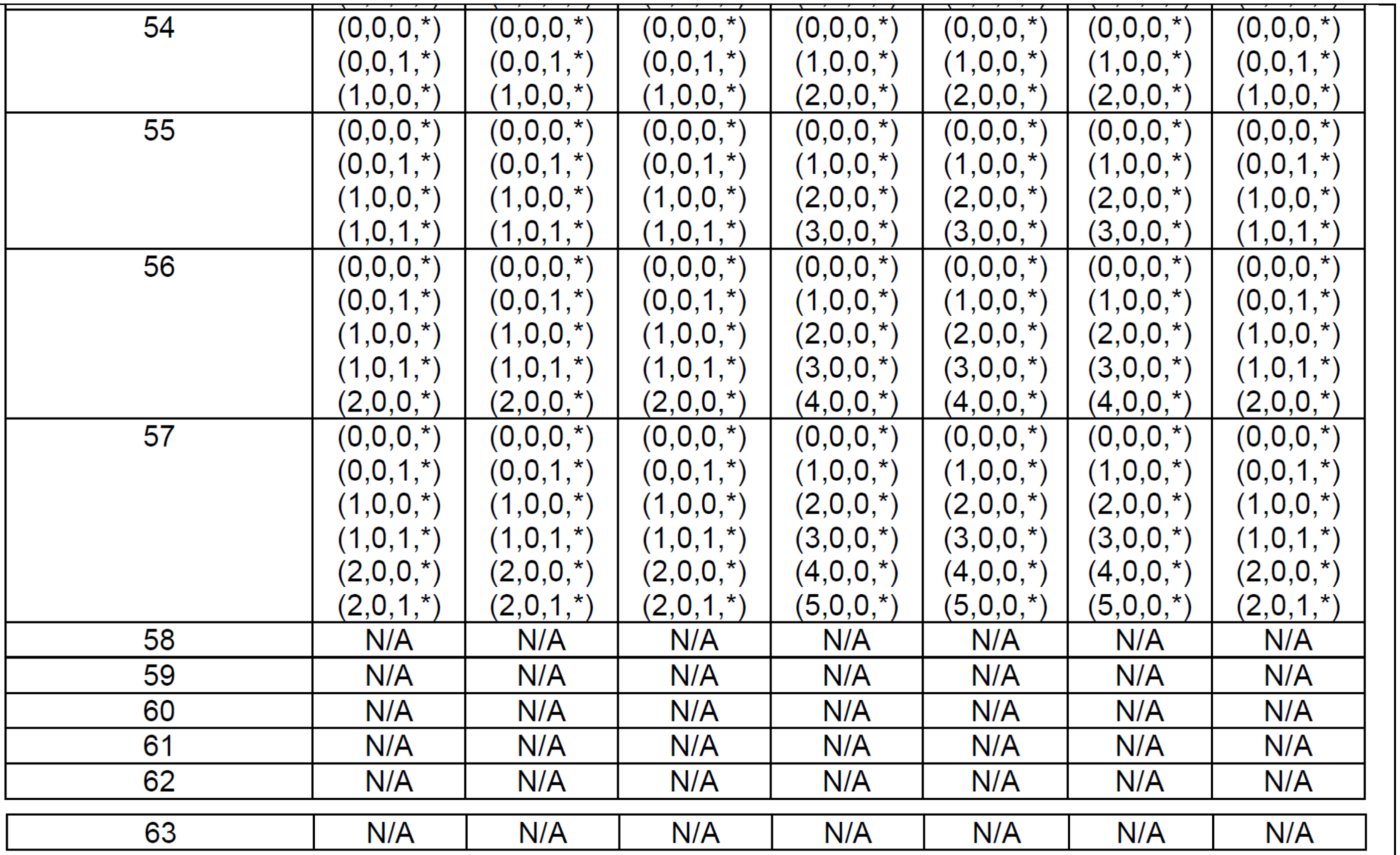
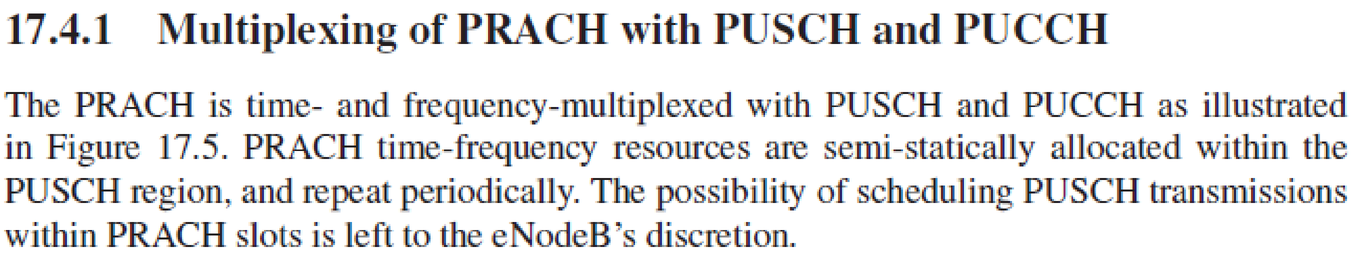
US Patent No. 10,833,908: Claim 24

" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

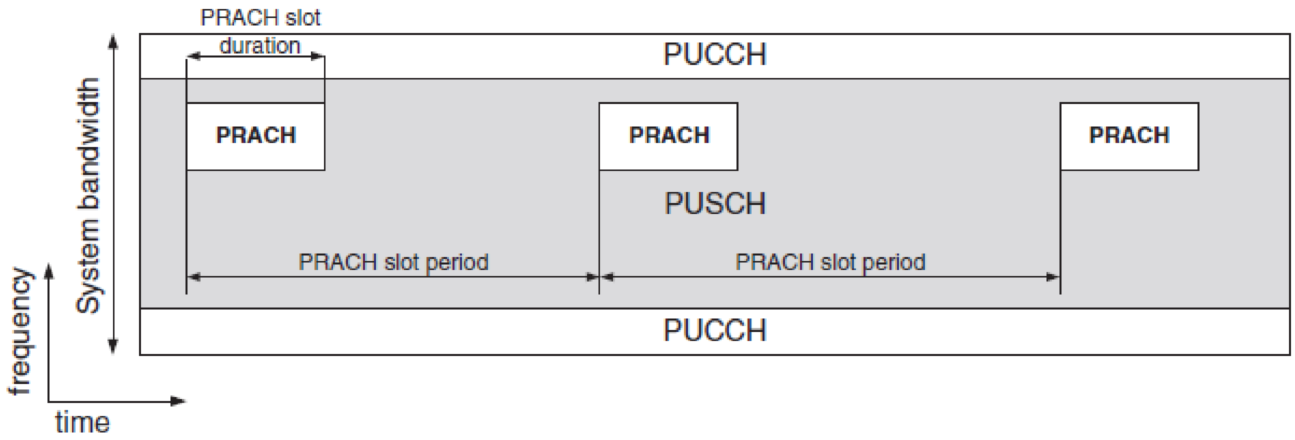
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



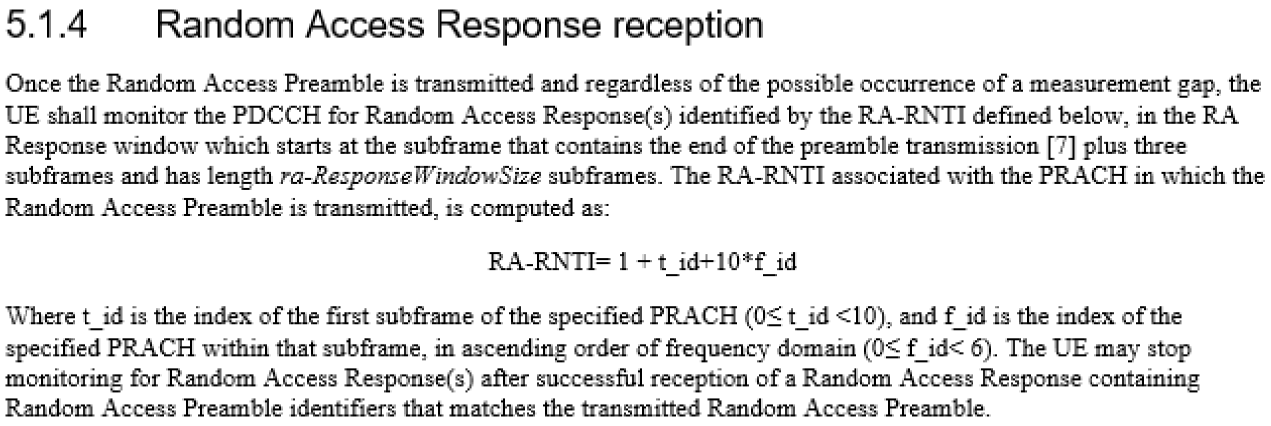
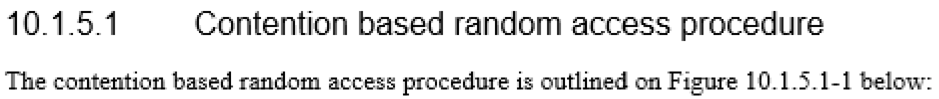
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Tesla's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $RA\text{-}RNTI= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

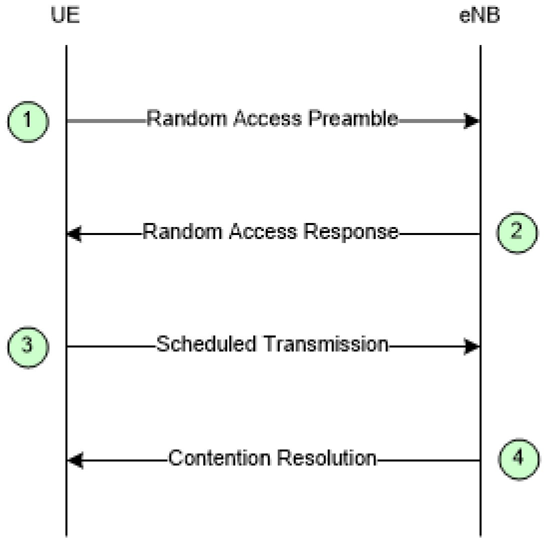


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

...

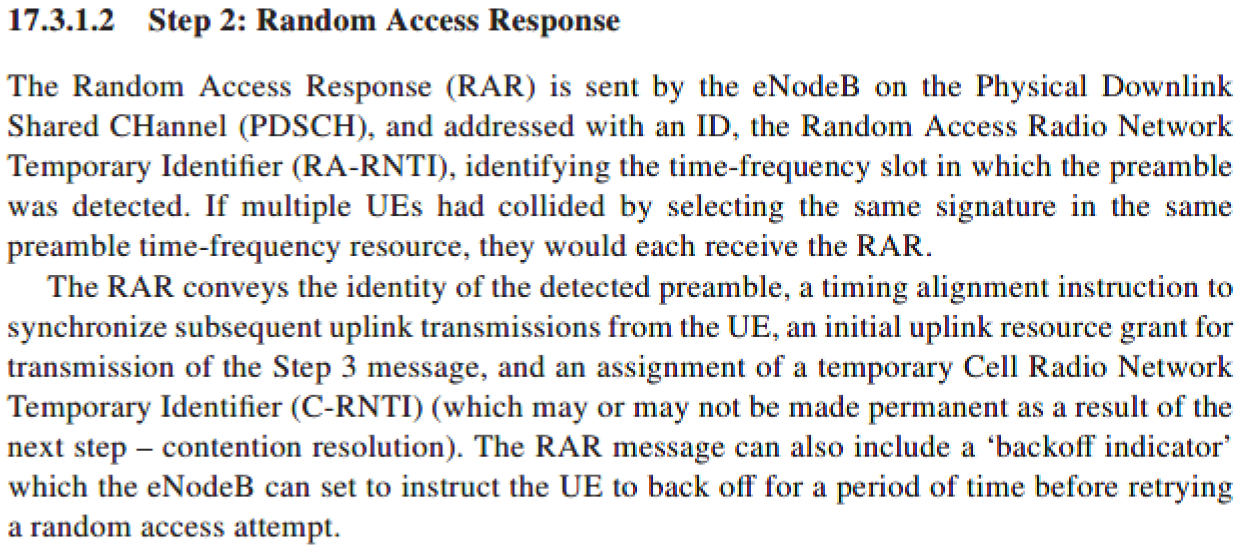
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25

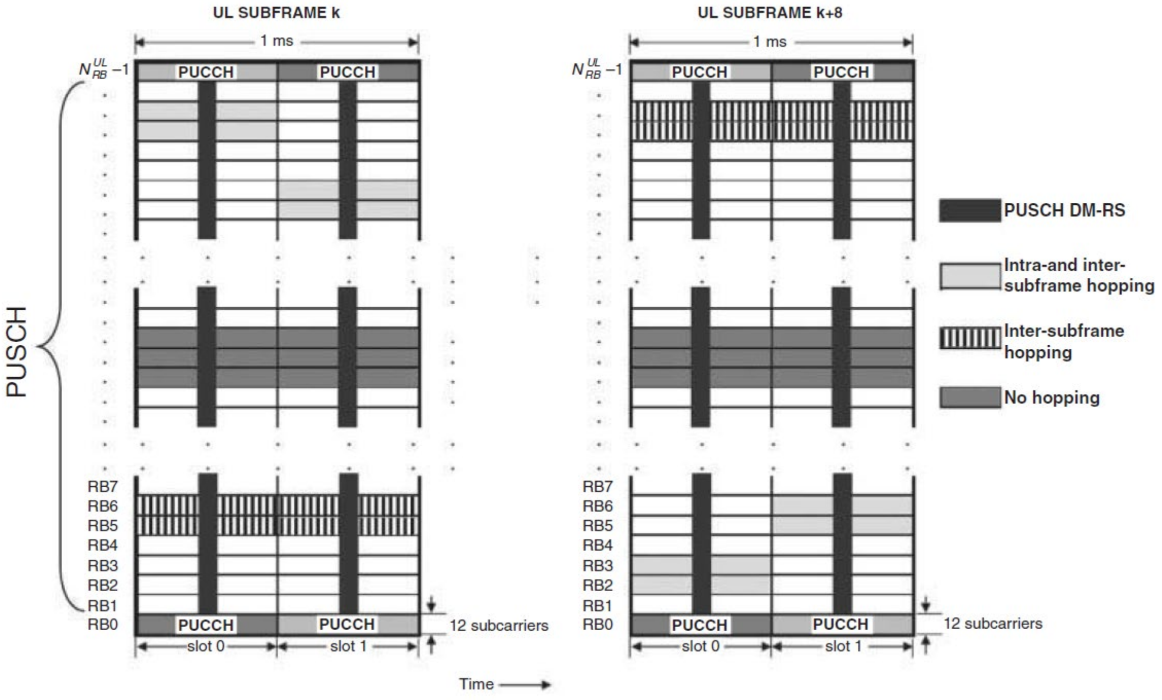
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Tesla's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

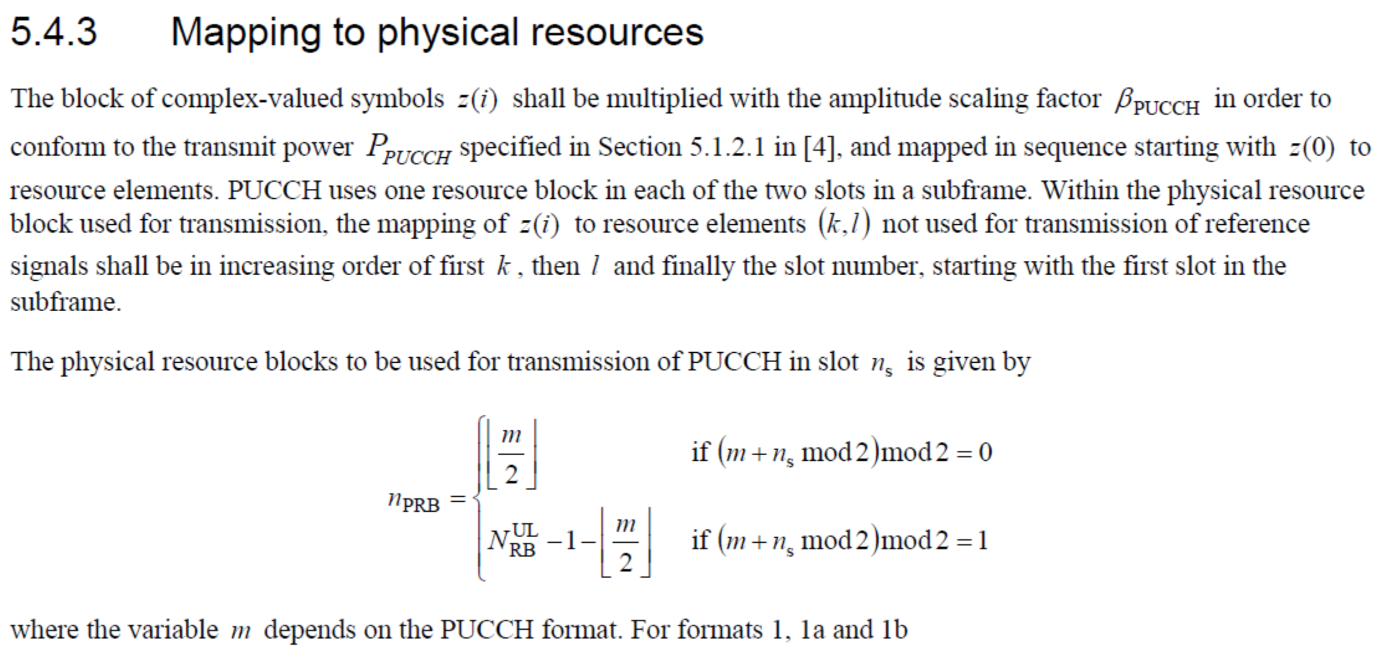
US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Tesla's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing.

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

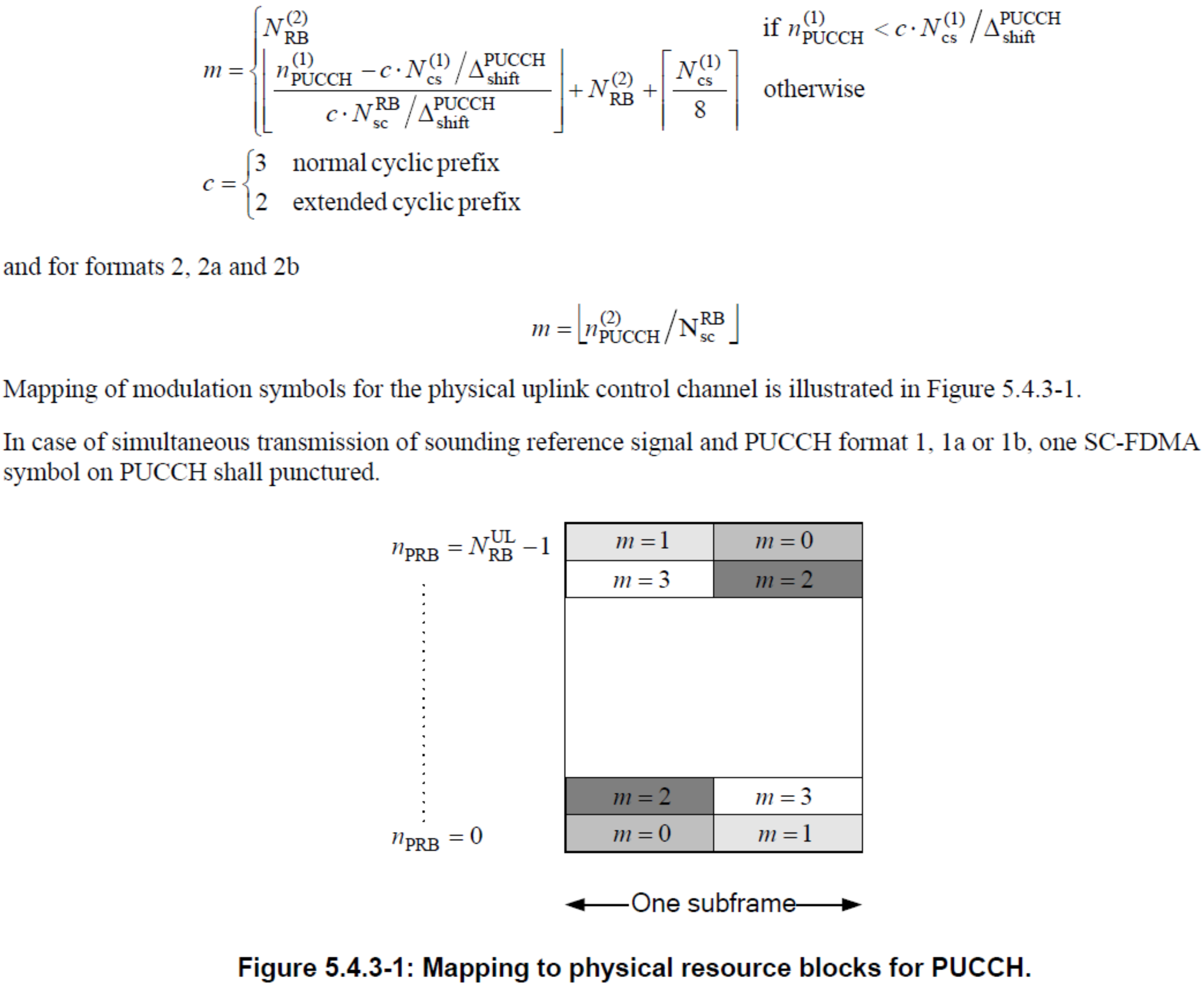
The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c\cdot N_{\mathrm{cs}}^{(1)}/\Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \frac{n^{(1)}_{\mathrm{PUCCH}} - c\cdot N^{(1)}_{\mathrm{cs}}/\Delta^{\mathrm{PUCCH}}_{\mathrm{shift}}}{c\cdot N^{\mathrm{RB}}_{\mathrm{sc}}/\Delta^{\mathrm{PUCCH}}_{\mathrm{shift}}} \right\rfloor + N^{(2)}_{\mathrm{RB}} + \left\lceil \frac{N^{(1)}_{\mathrm{cs}}}{8}\right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n^{(2)}_{\mathrm{PUCCH}} / \mathrm{N}^{\mathrm{RB}}_{\mathrm{sc}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

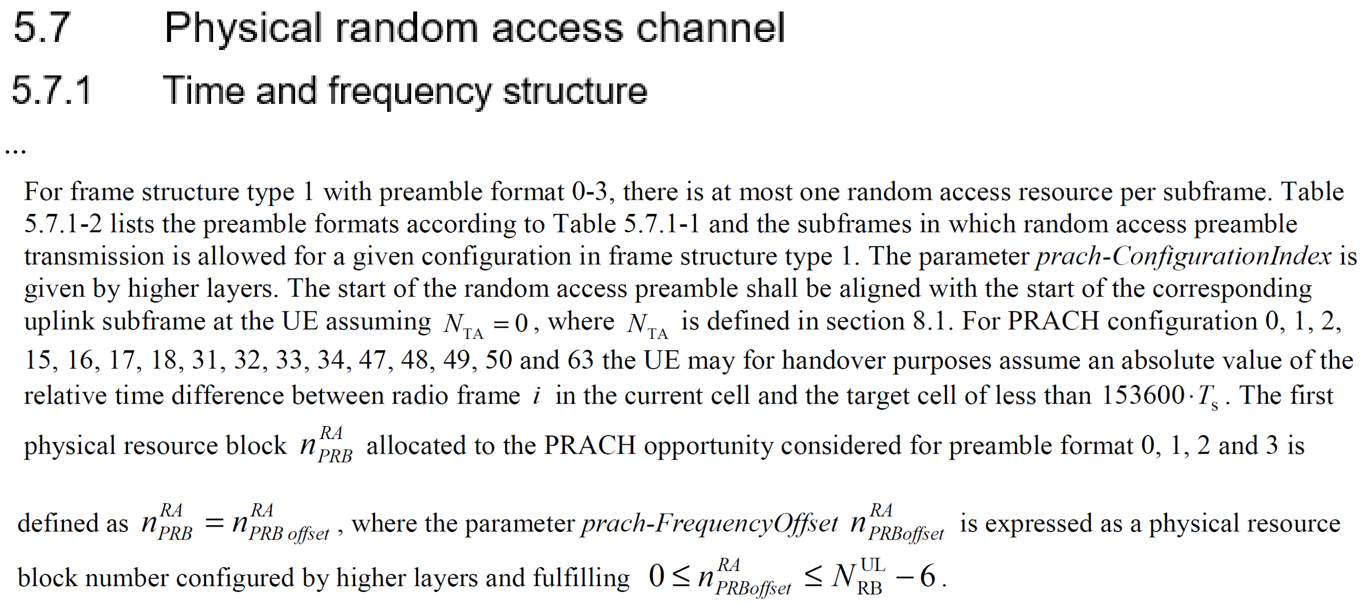
Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

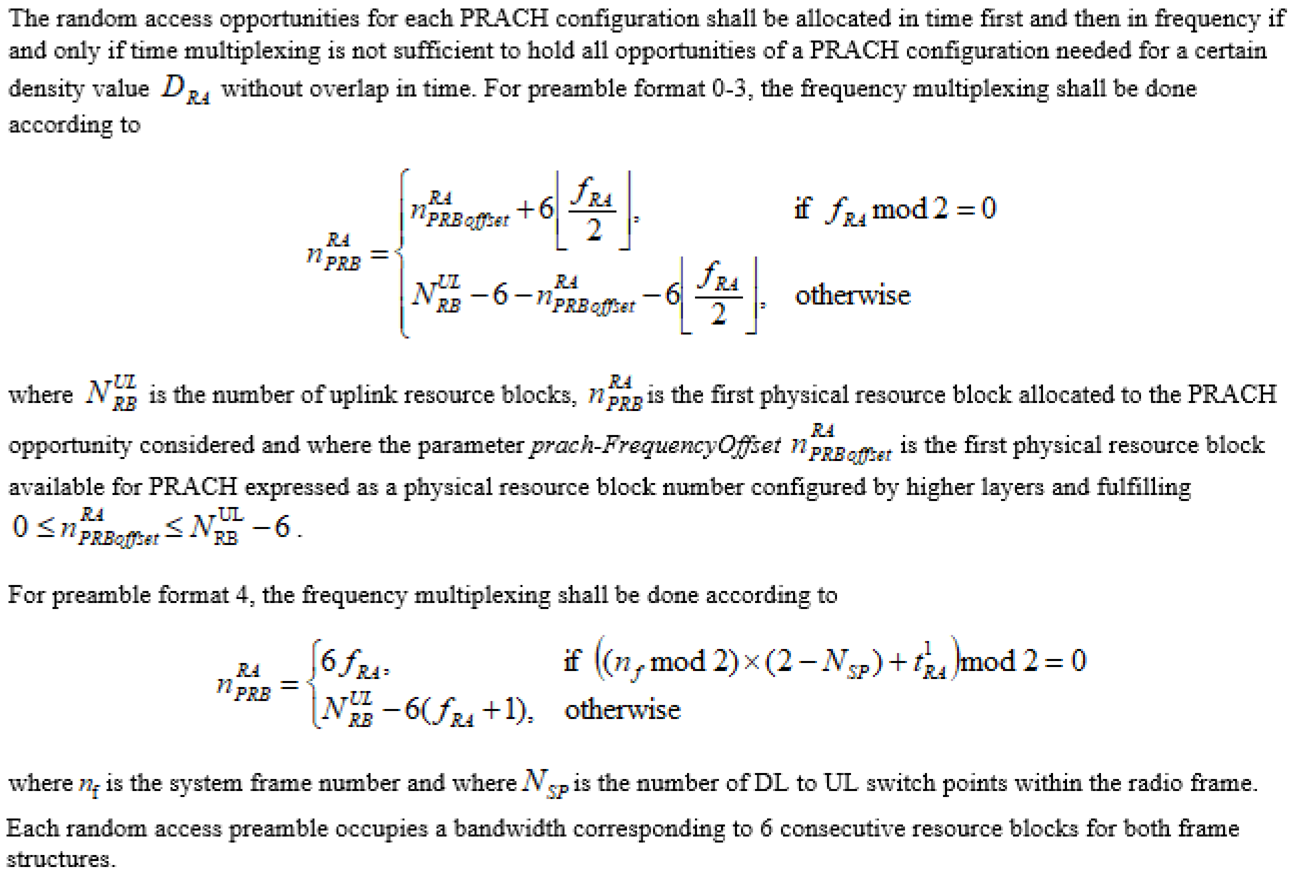
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure ... For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_s$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.
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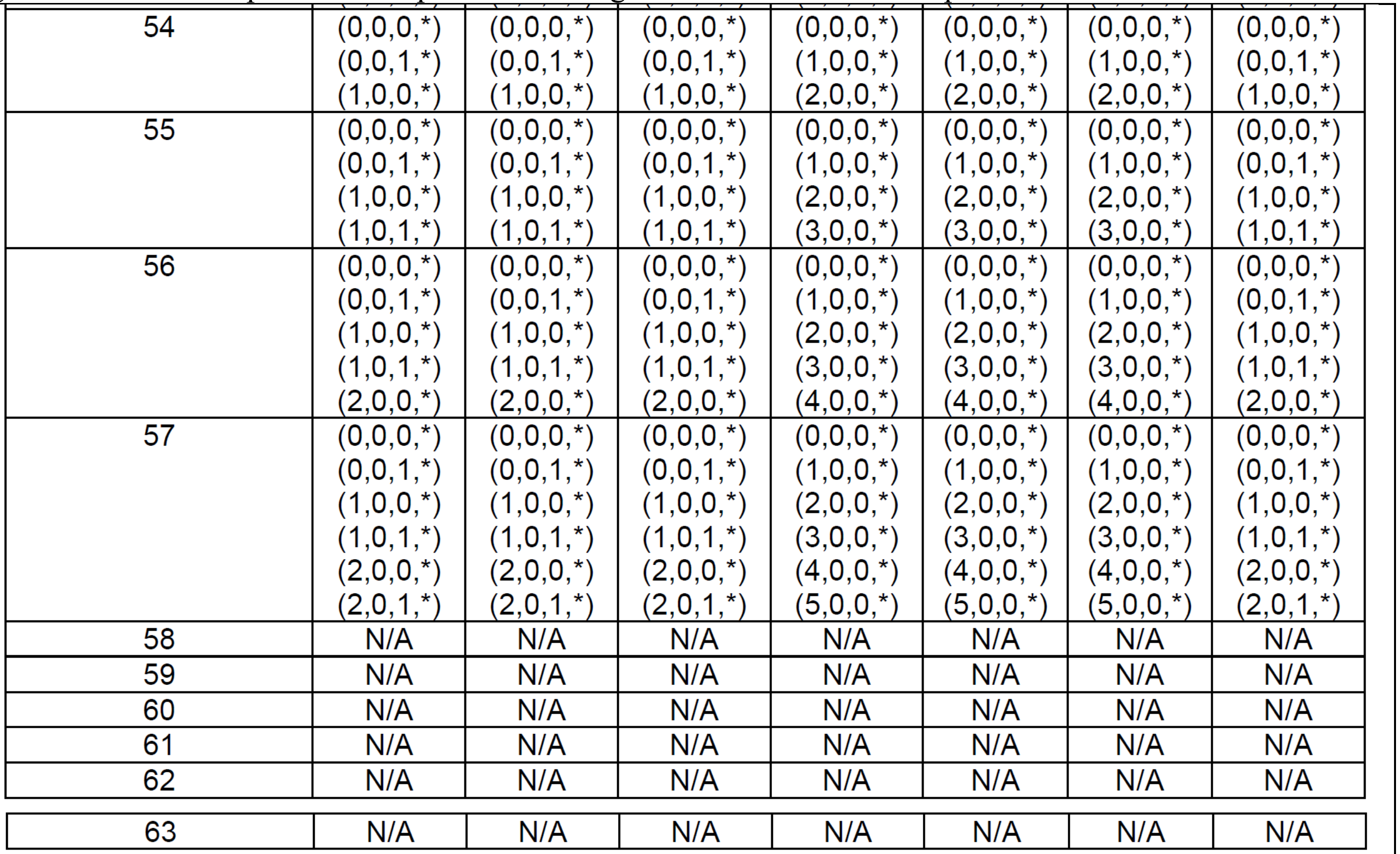
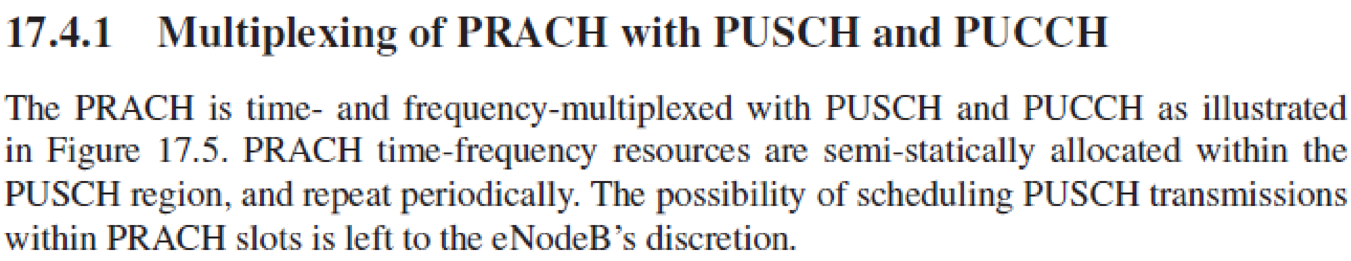
US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

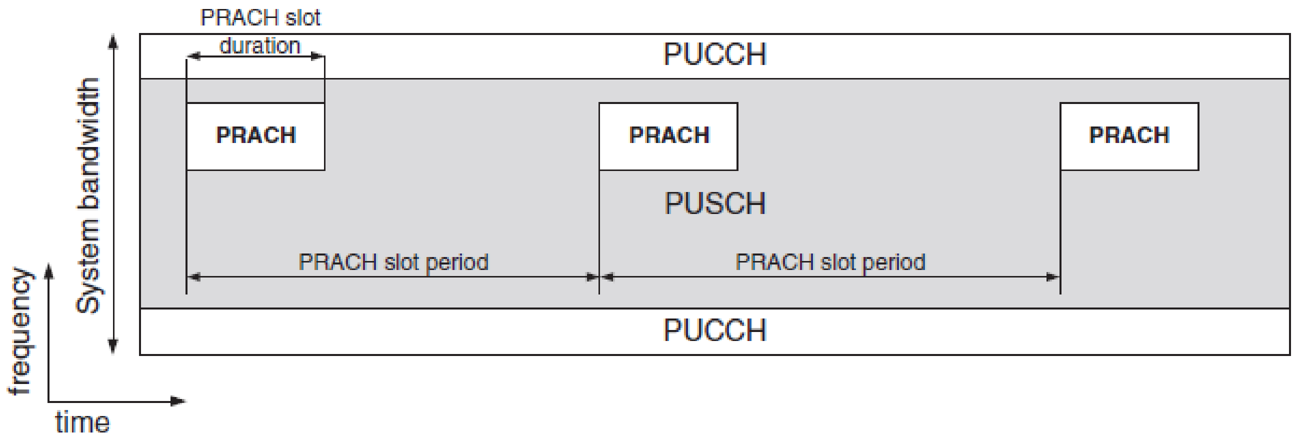
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



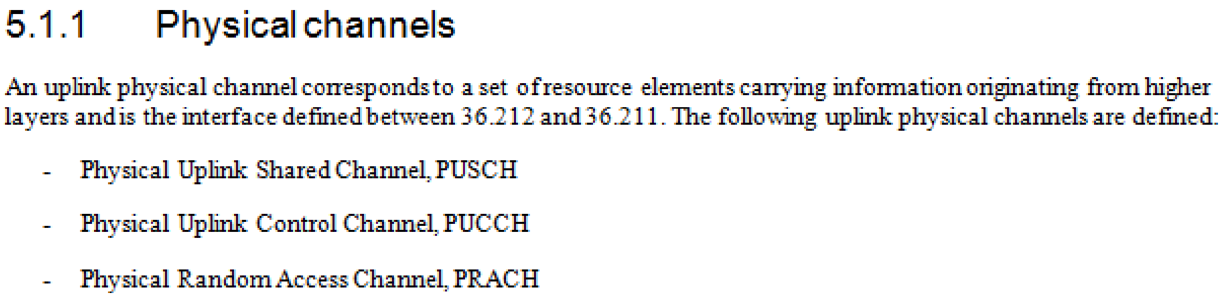
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

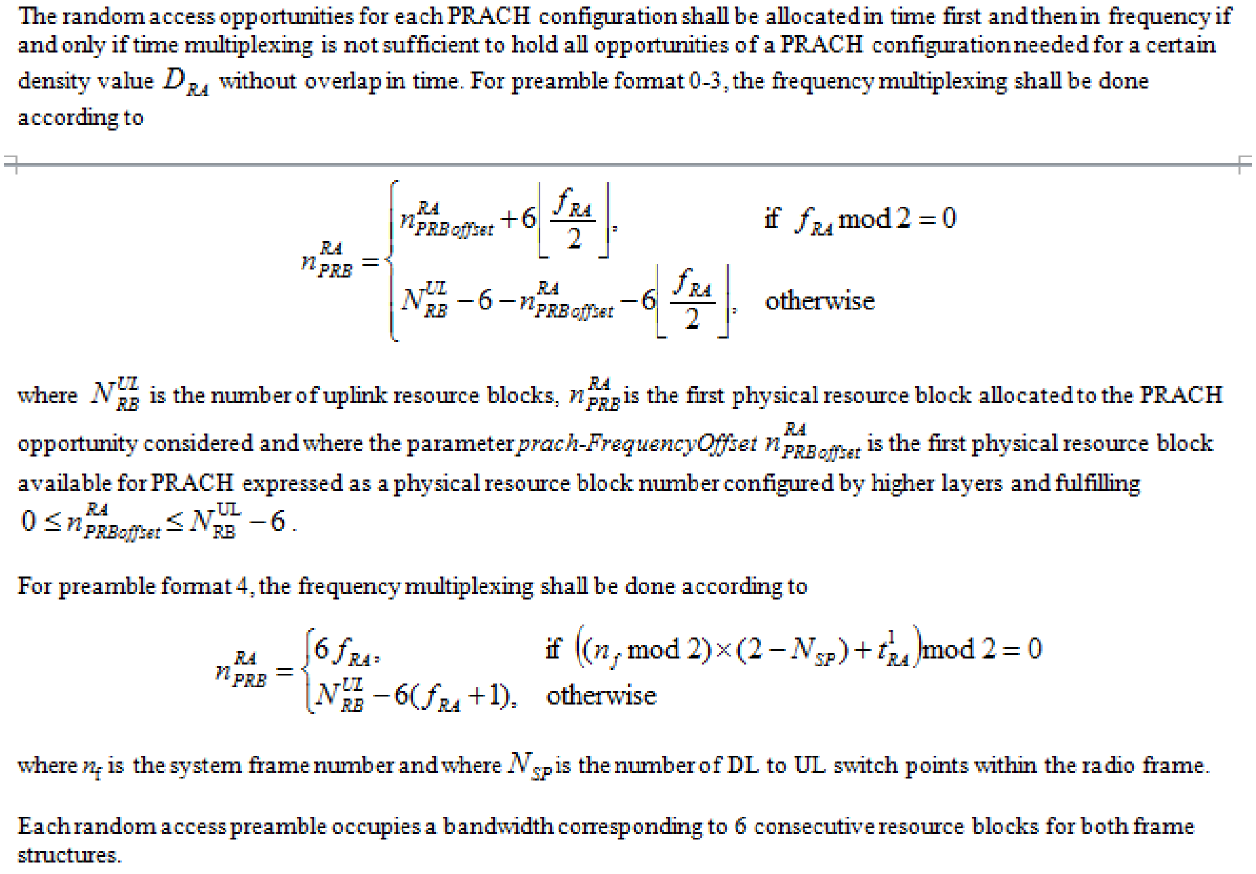
US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

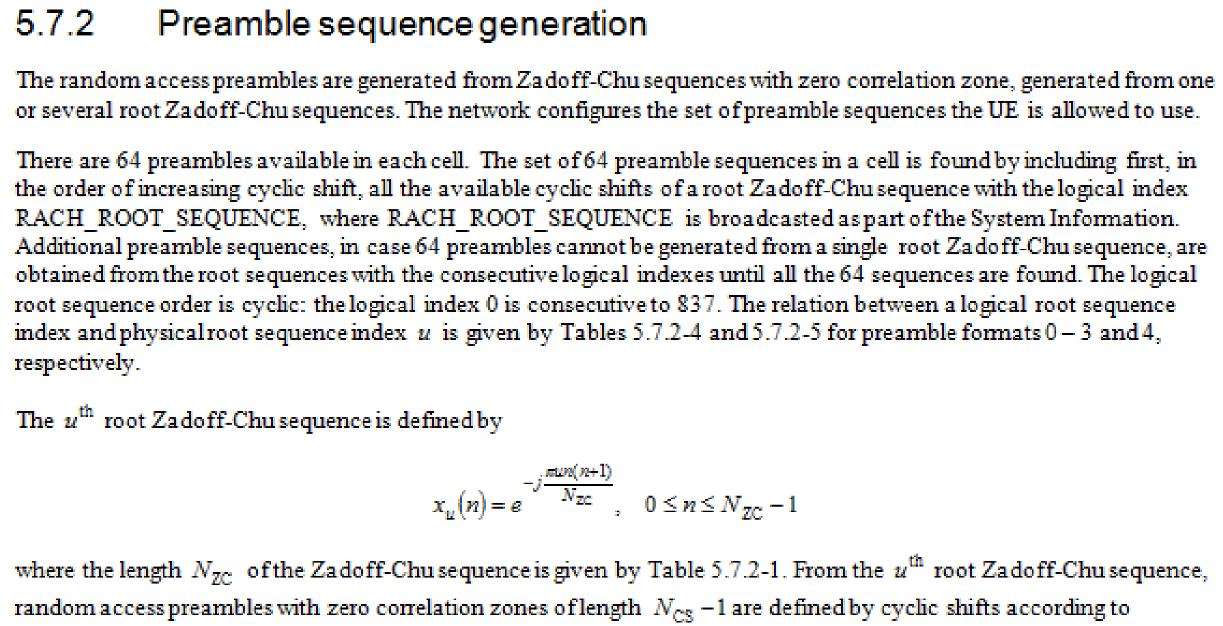
US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with Tesla's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}},\quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

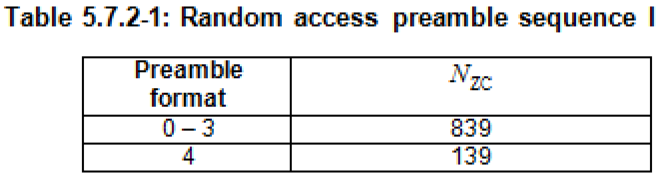
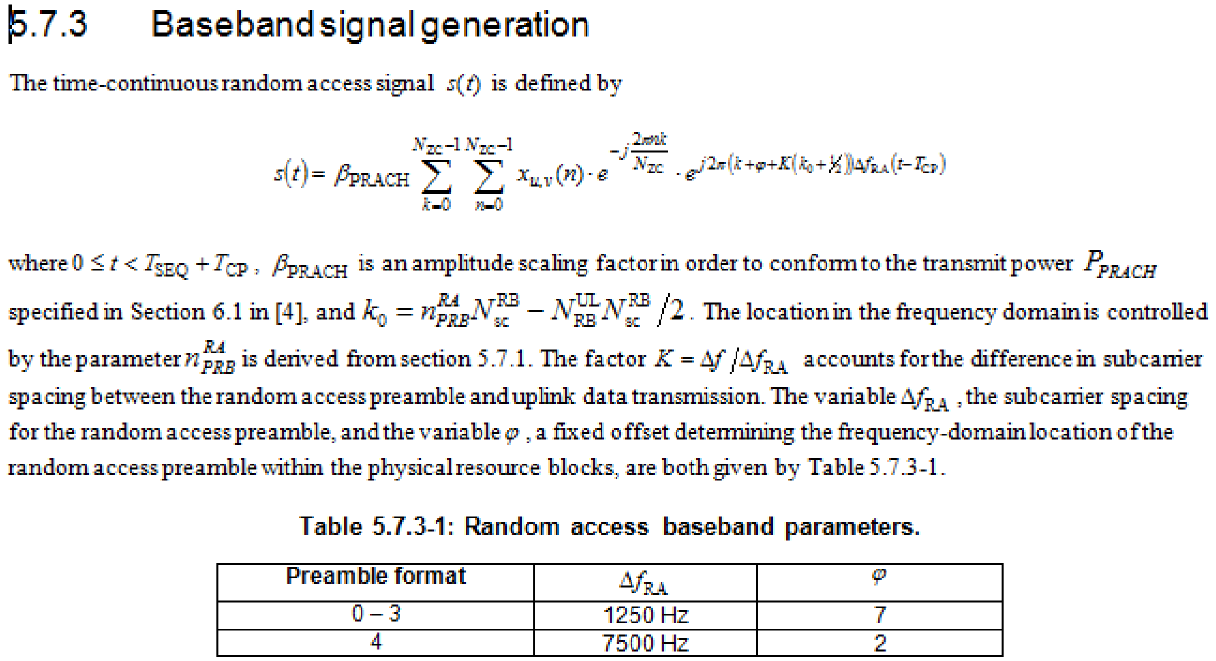


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\text{RA}}\left(t-T_{\text{CP}}\right)}$$

where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

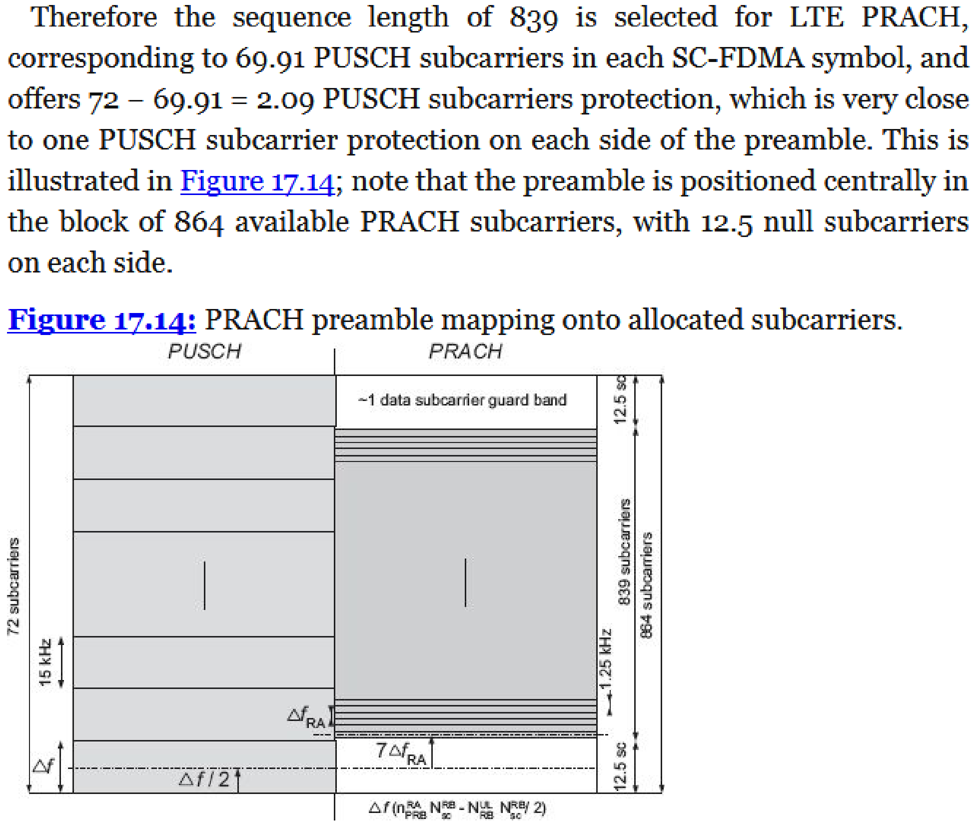
Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28

"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

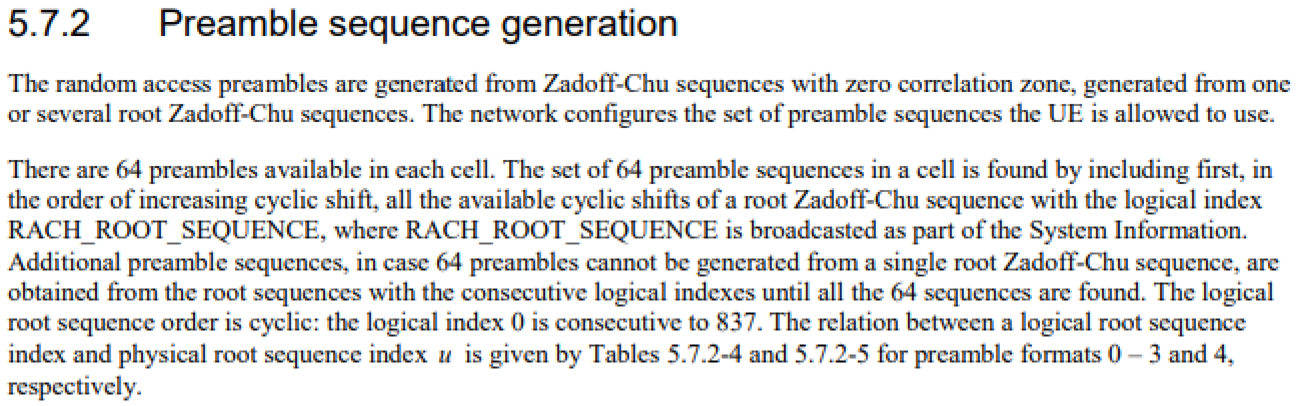
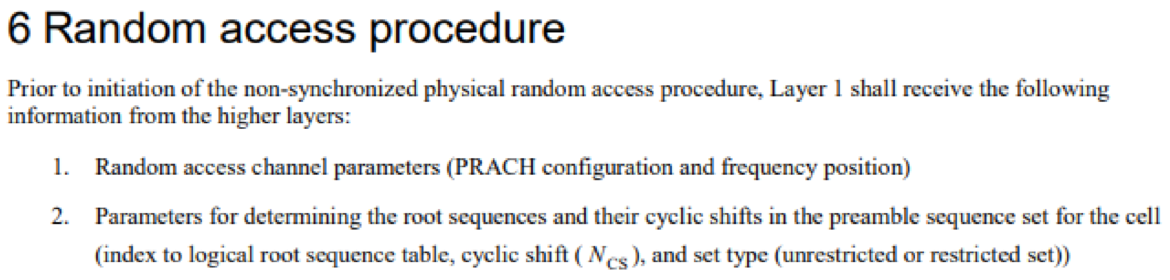


Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Tesla's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information. 5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39. 6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

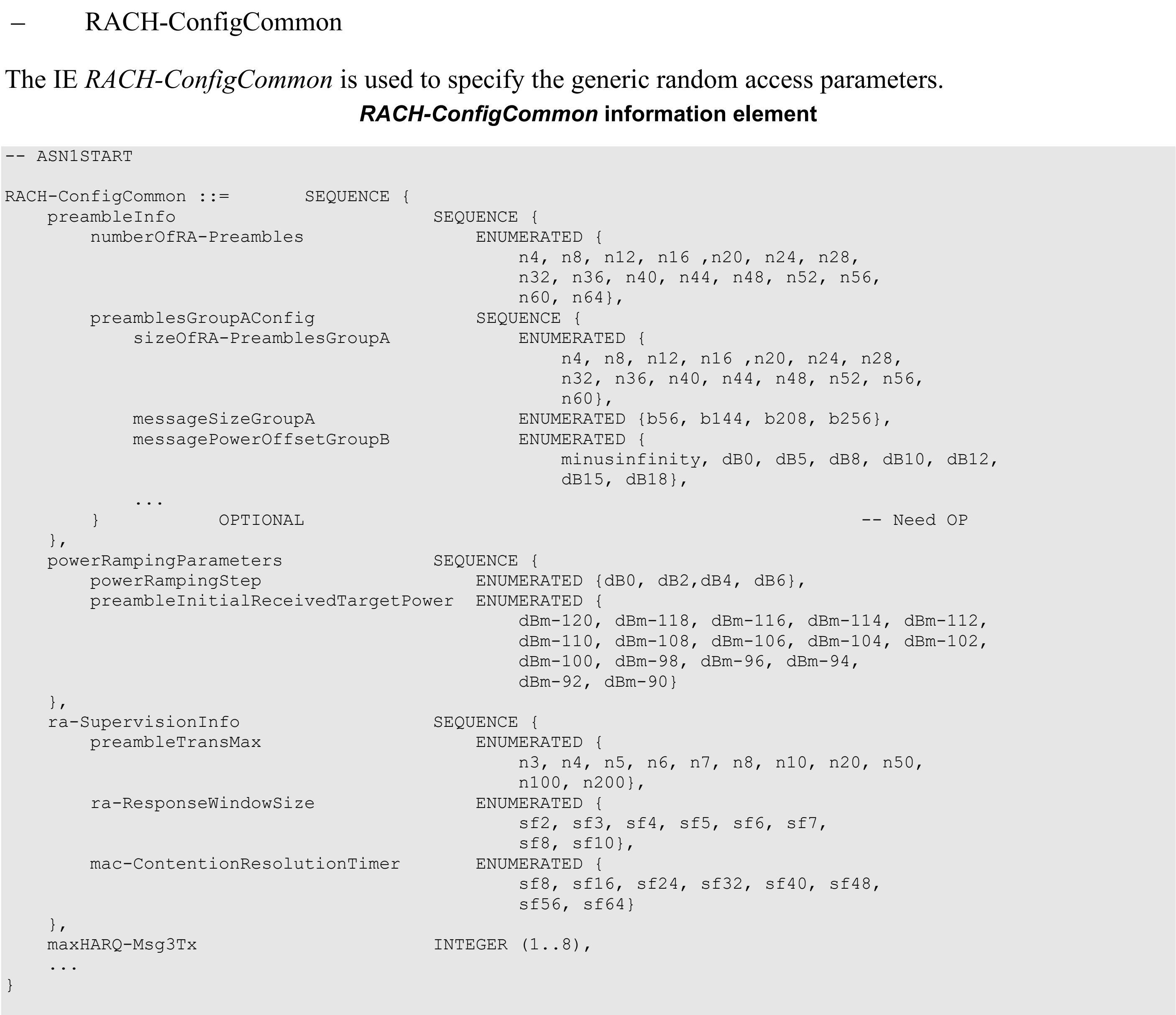
The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

See e.g., 36.331 V8.21.0 at pp. 128-129.



– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

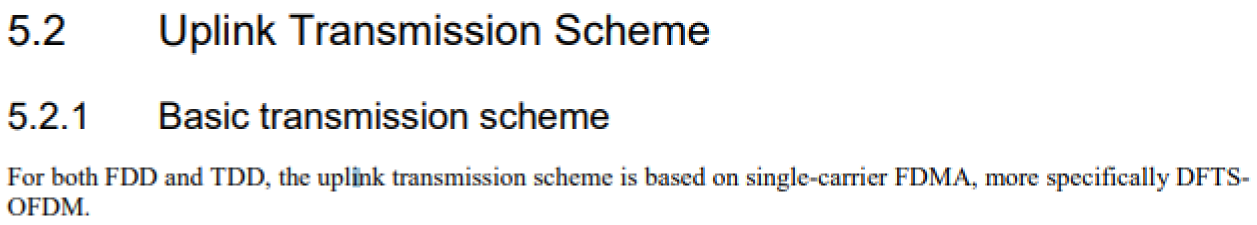
RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

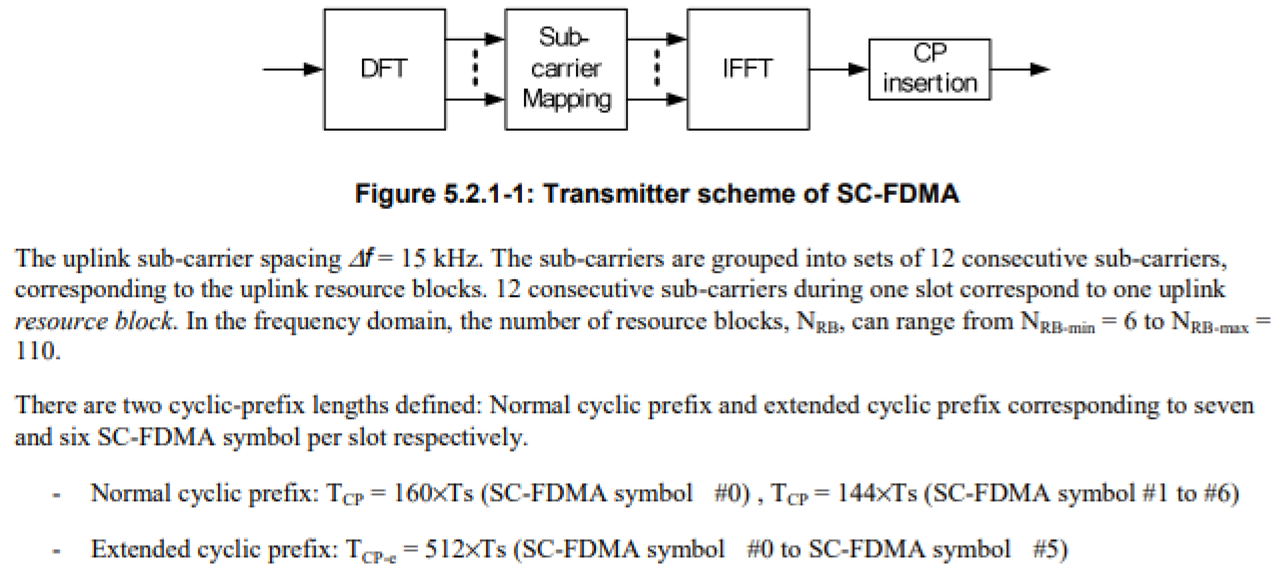
US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 Tesla’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Tesla’s Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

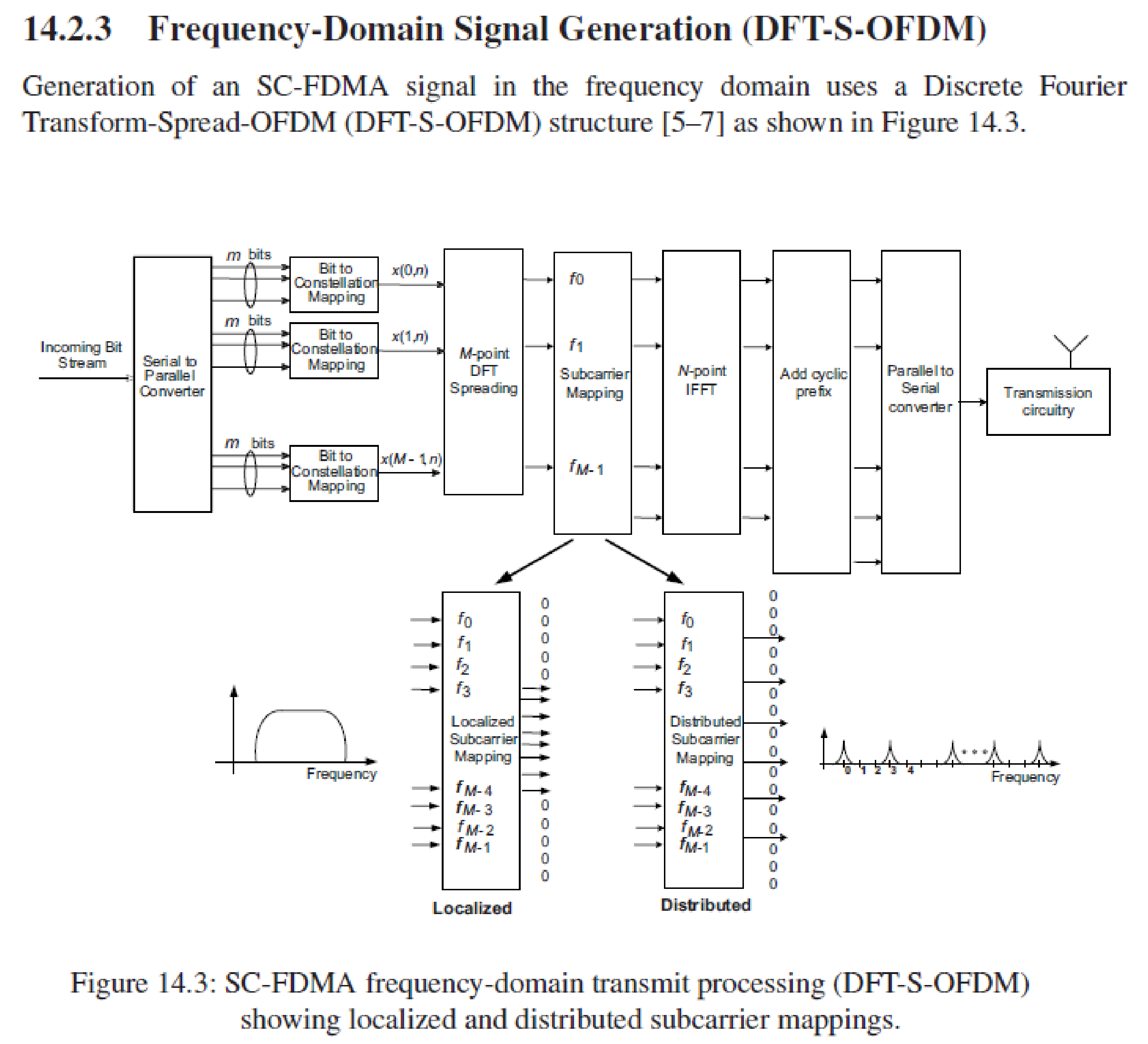
US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

	 **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

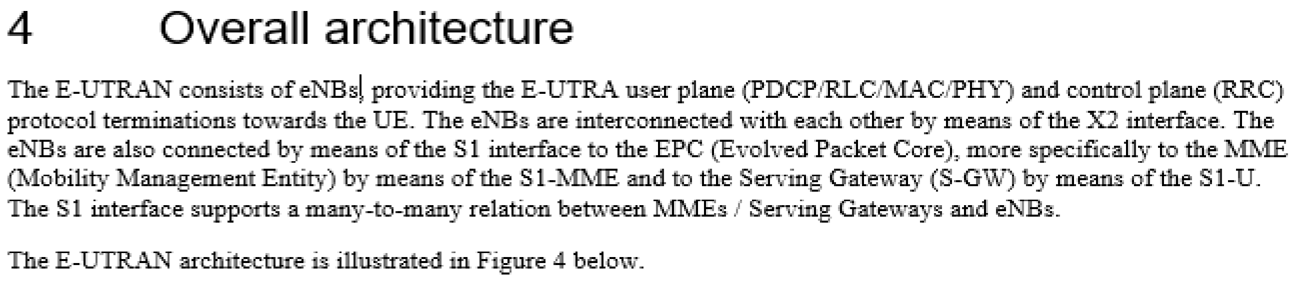
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

See also Claim 10.

Plaintiff's Infringement Contentions to Mercedes-Benz

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, Mercedes's Accused Instrumentalities meet the preamble of claim 1 of the '908 patent. *E.g.,* Mercedes's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Mercedes offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

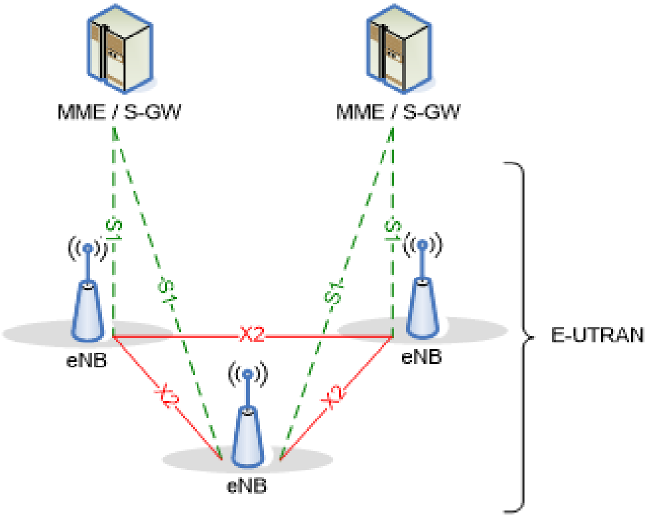
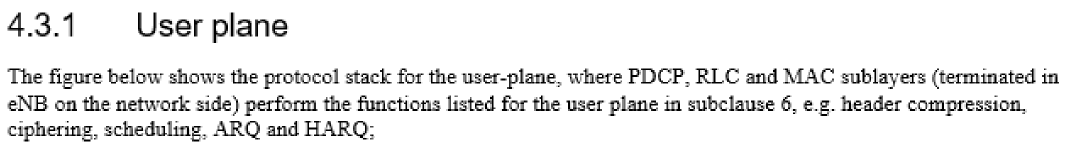


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

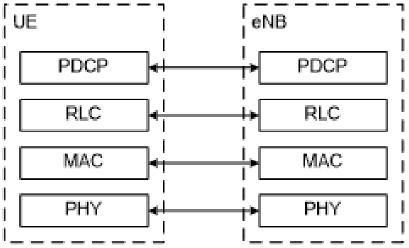


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

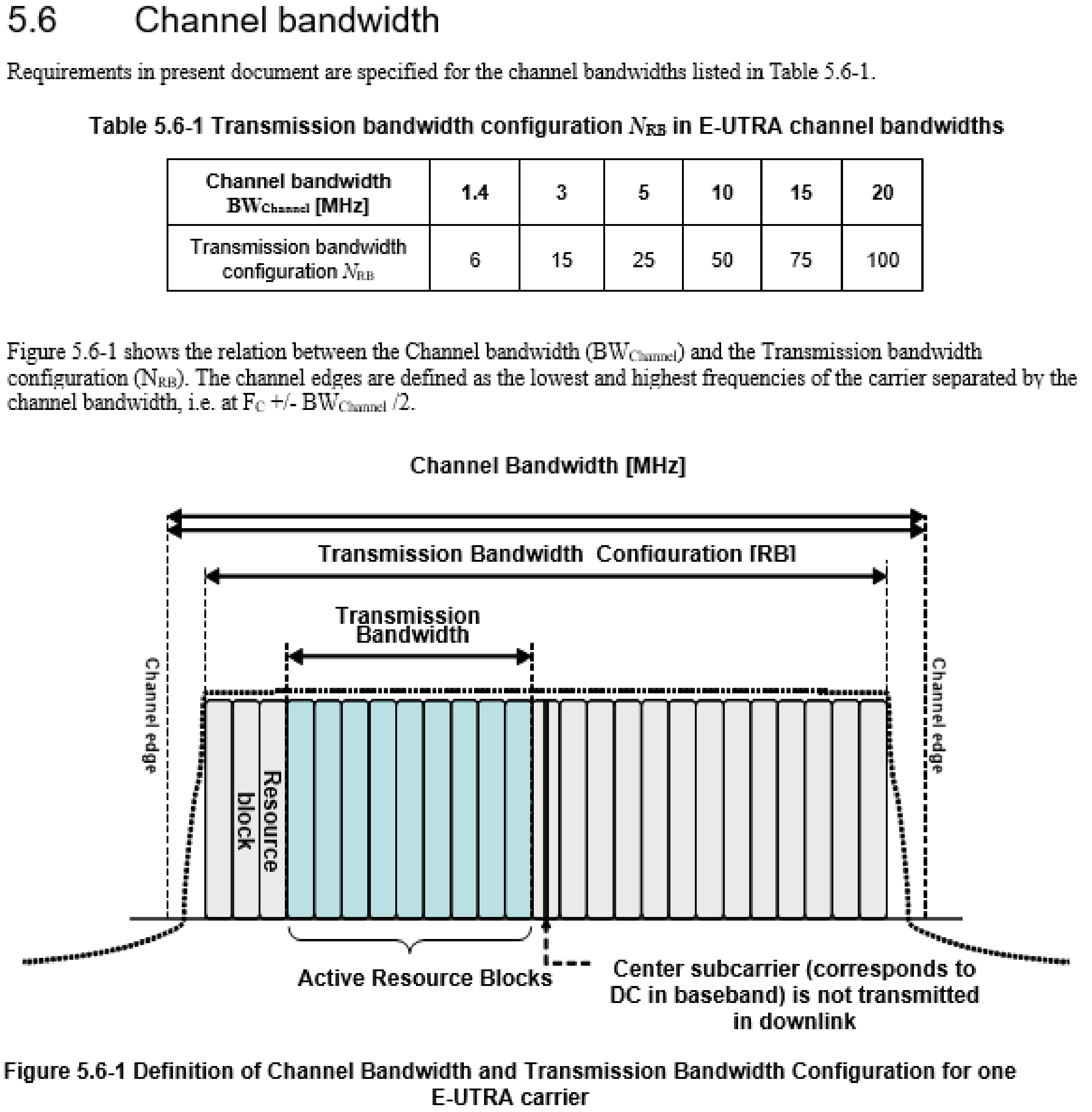
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Mercedes’s Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, Mercedes’s Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

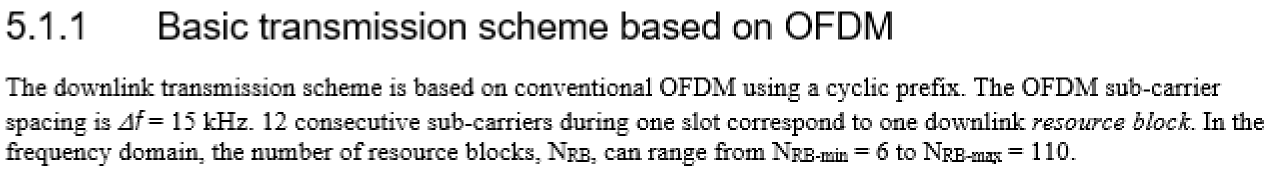
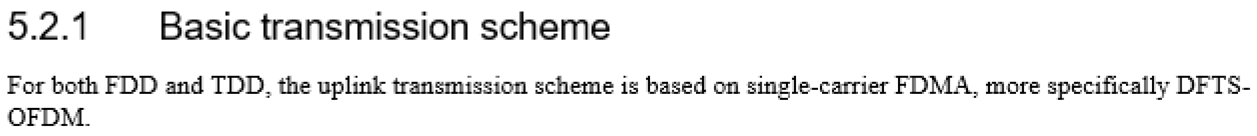
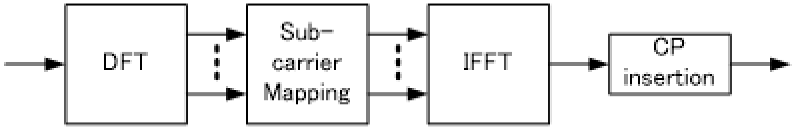
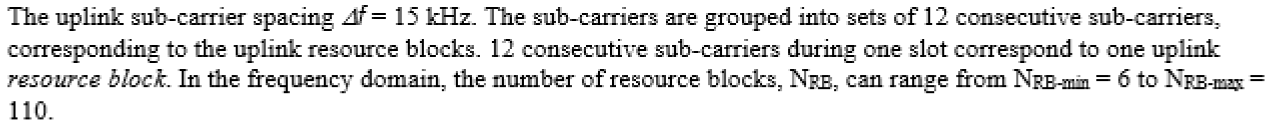
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

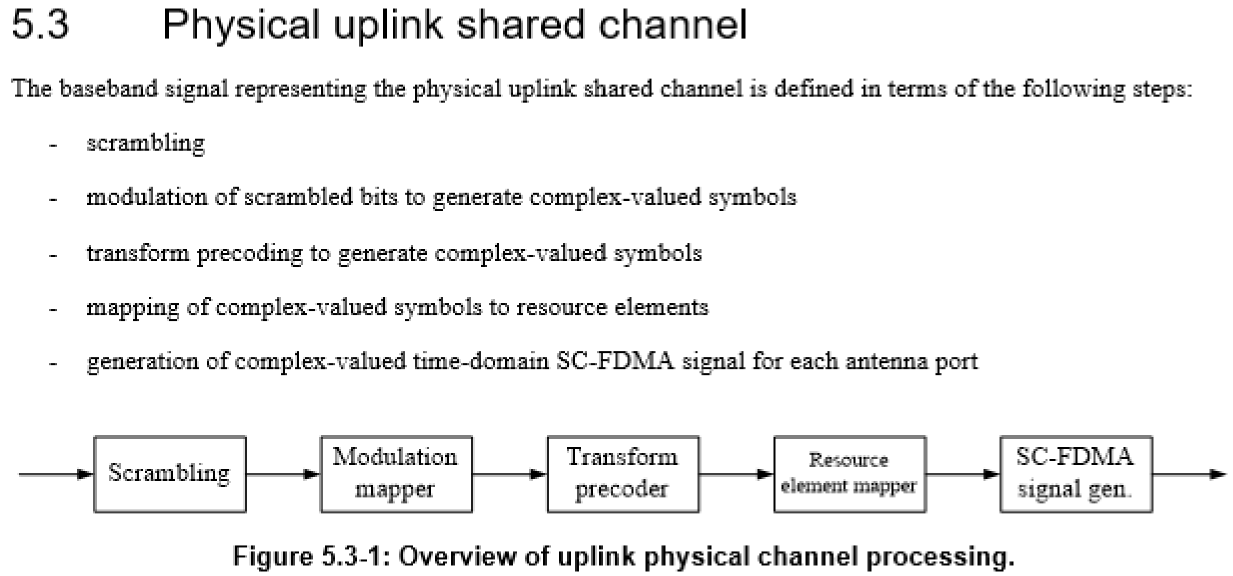
US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

	For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).  **5.1.1 Basic transmission scheme based on OFDM** The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from N_{RB-min} = 6 to N_{RB-max} = 110. See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.  **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.  **Figure 5.2.1-1: Transmitter scheme of SC-FDMA**  The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from N_{RB-min} = 6 to N_{RB-max} = 110. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28. The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”



5.3 Physical uplink shared channel

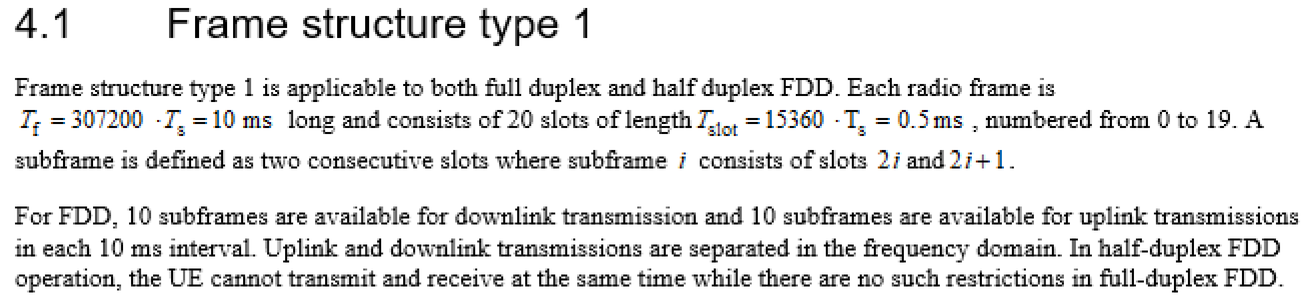
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



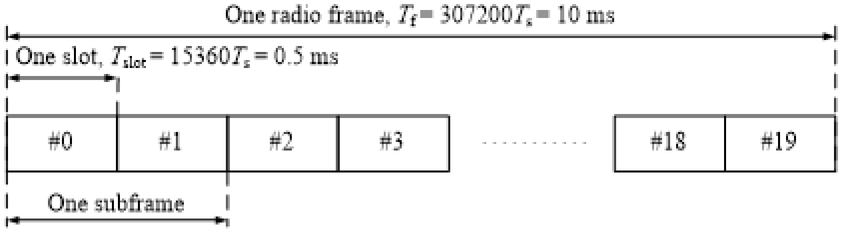
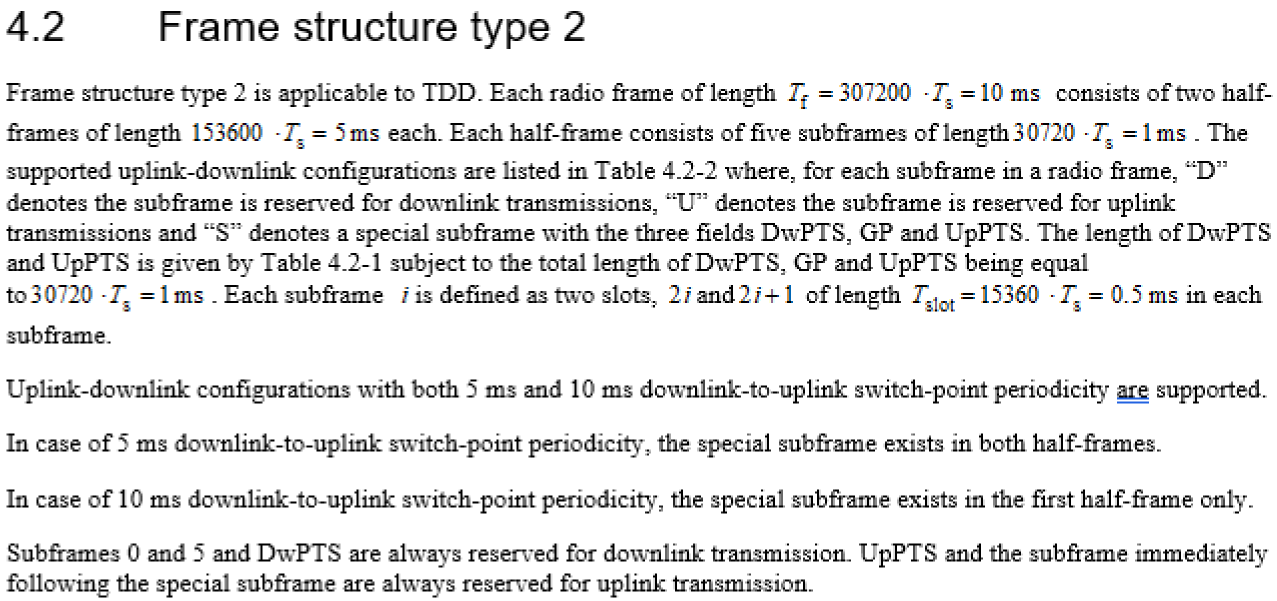
4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **Figure 4.1-1: Frame structure type 1.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.  4.2 Frame structure type 2 Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms . The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms . Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe. Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported. In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames. In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only. Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

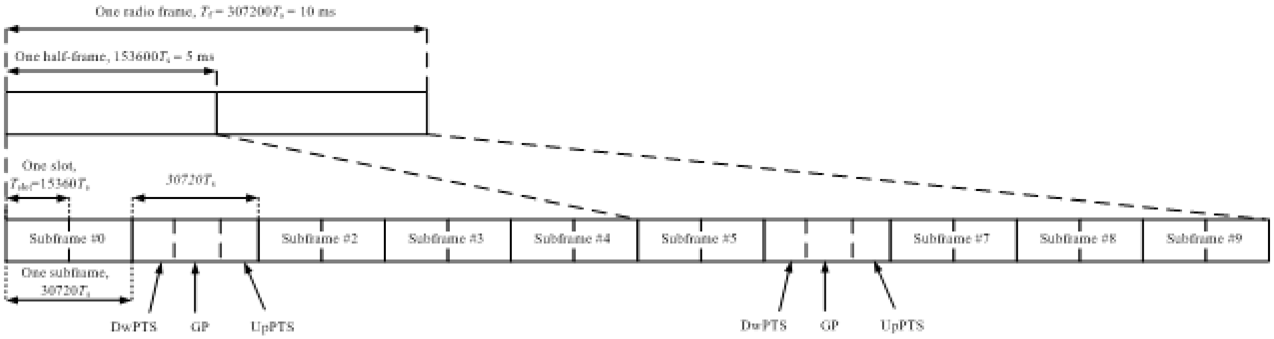
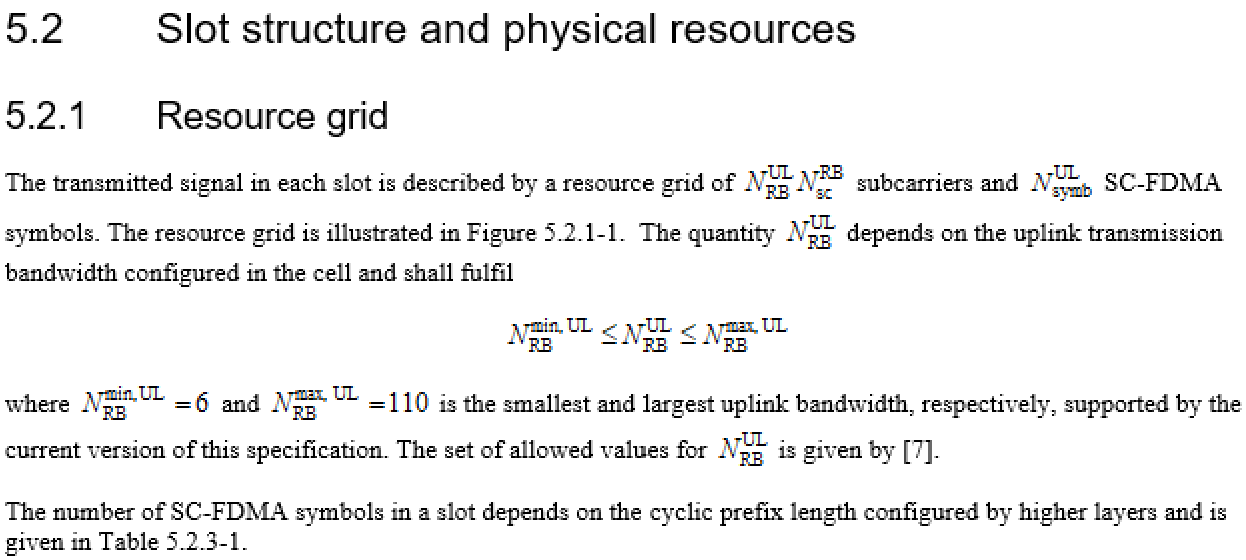


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

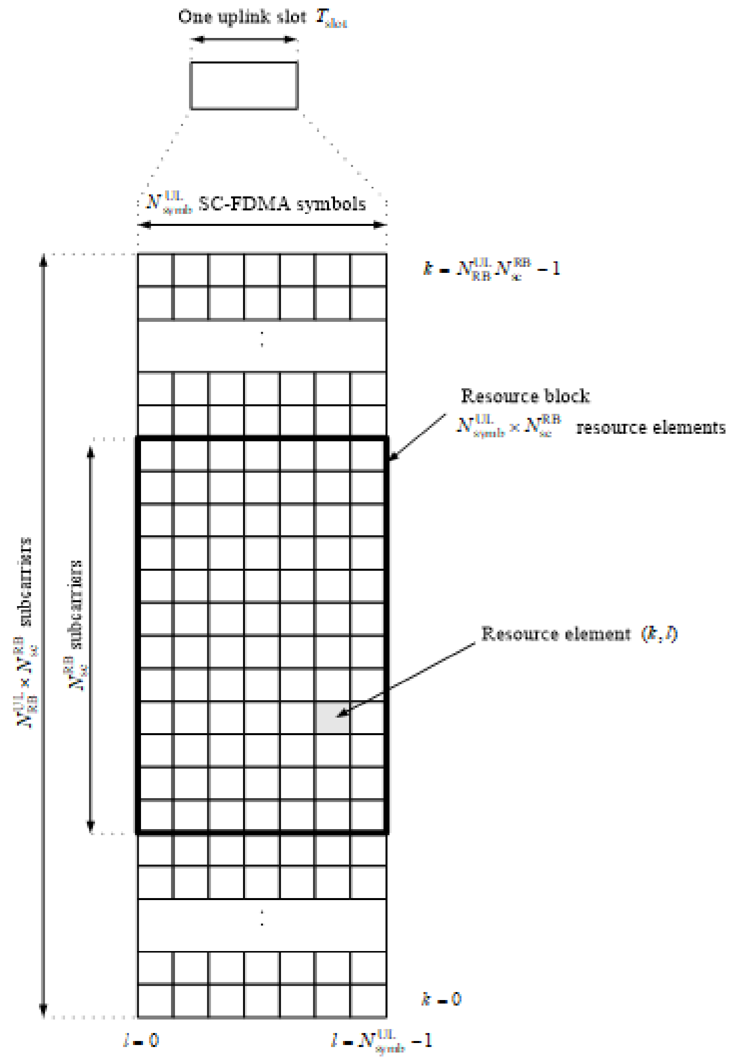
$$N_{\mathrm{RB}}^{\mathrm{min,UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{max,UL}}$$

where $N_{\mathrm{RB}}^{\mathrm{min,UL}} = 6$ and $N_{\mathrm{RB}}^{\mathrm{max,UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

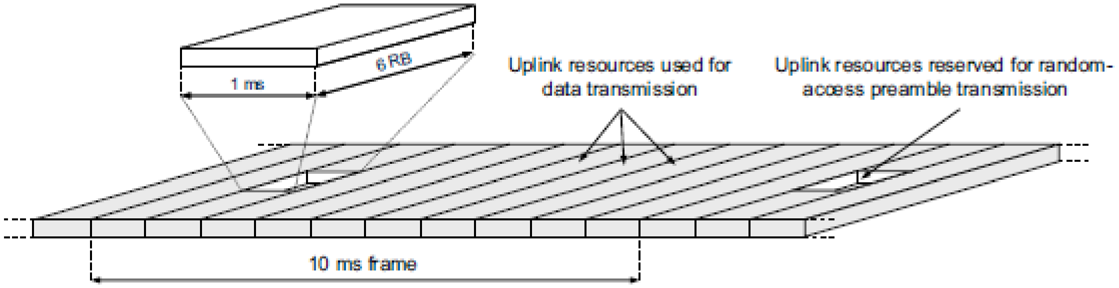
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 1(b)

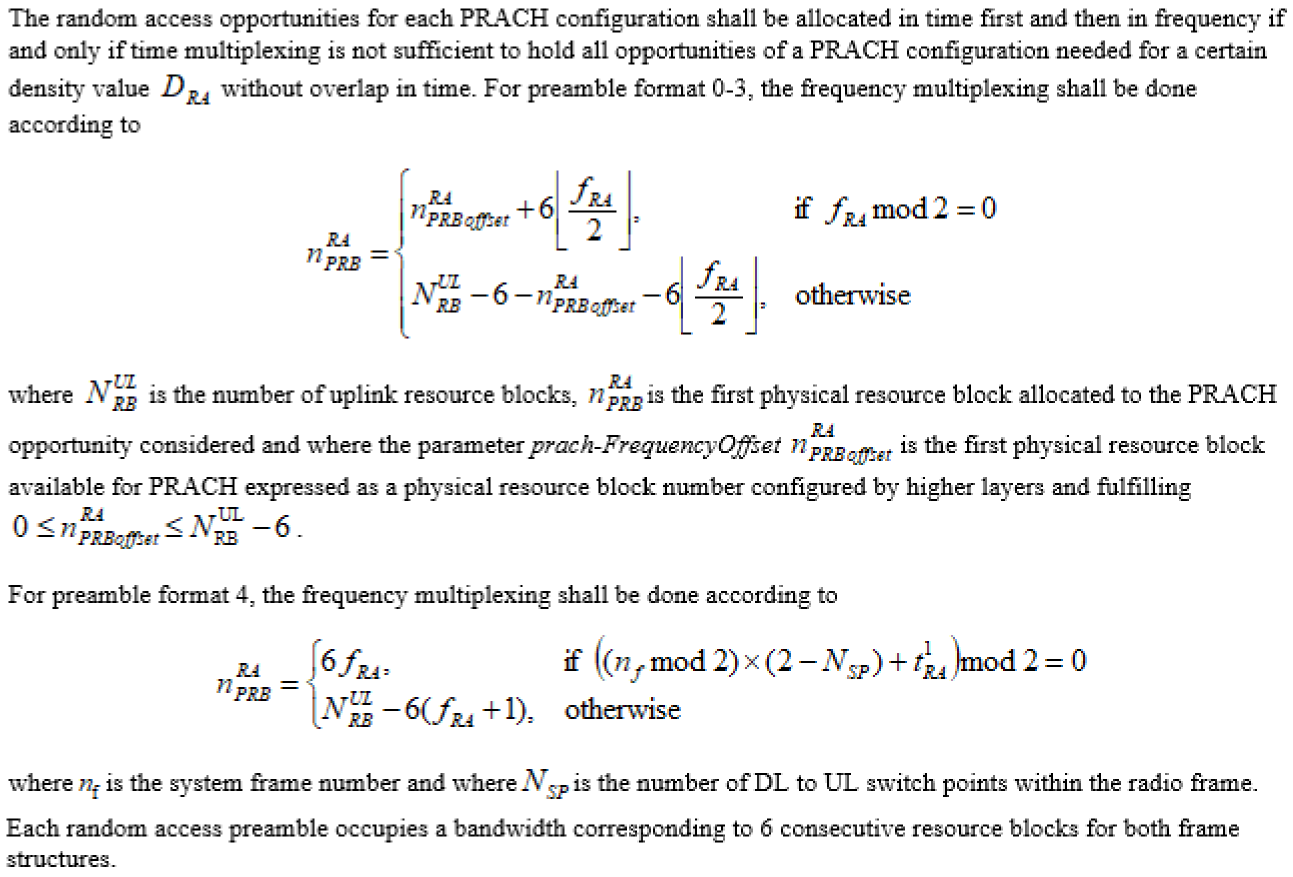
"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	Mercedes’s Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

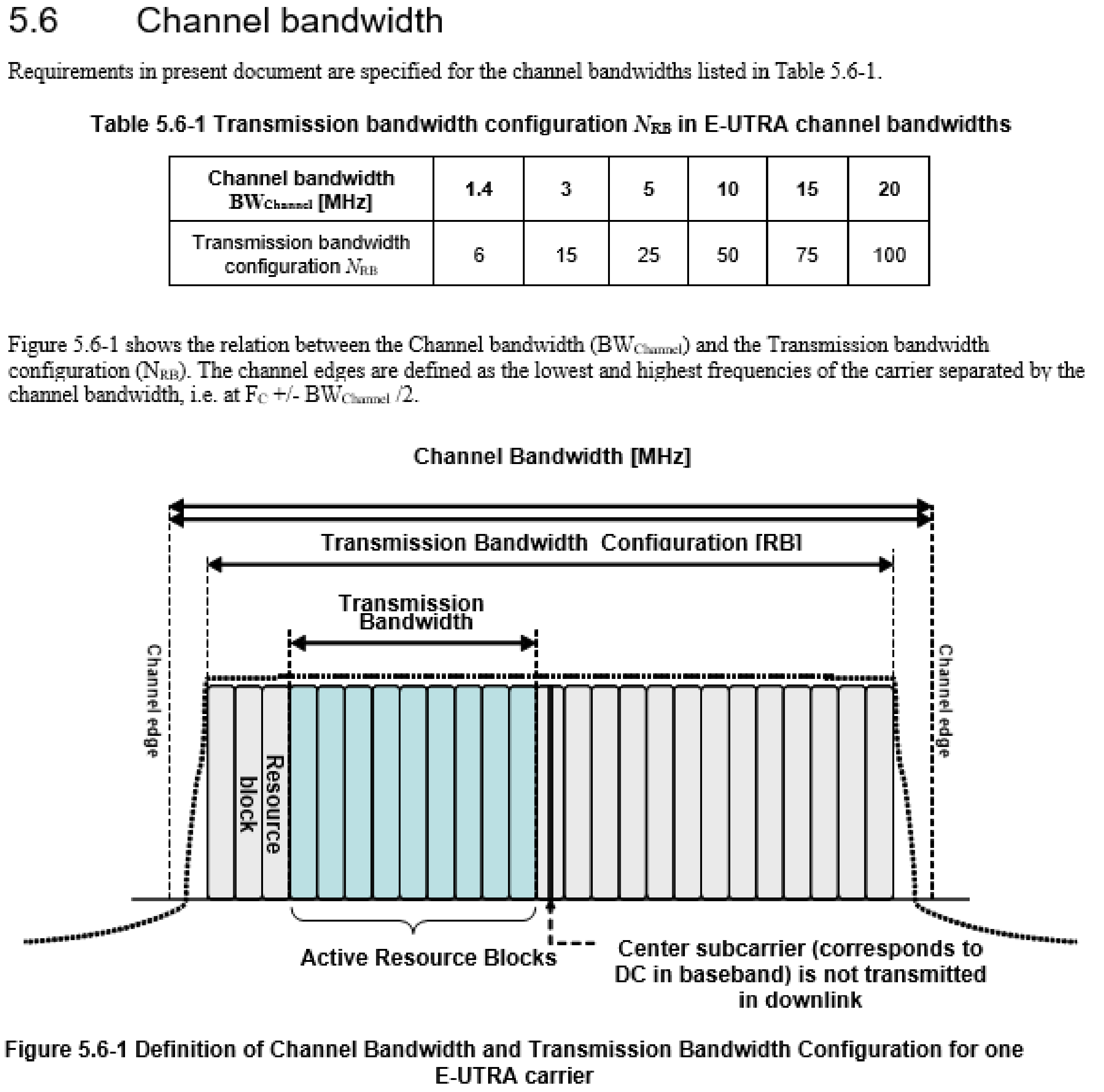
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

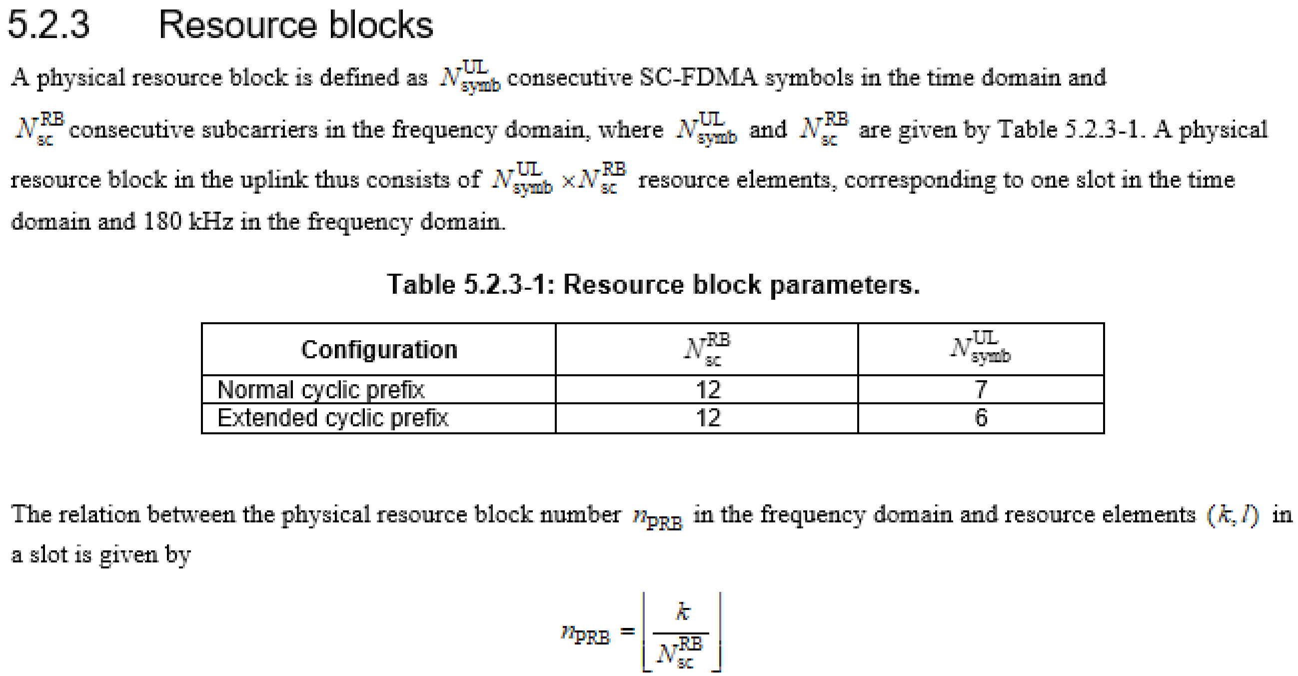
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

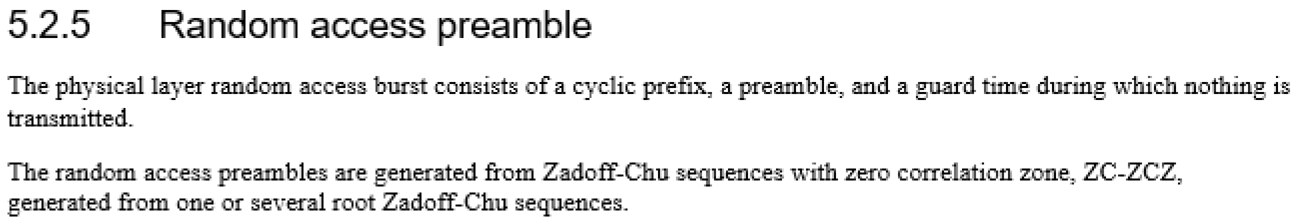
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

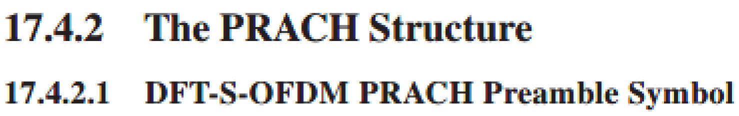


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

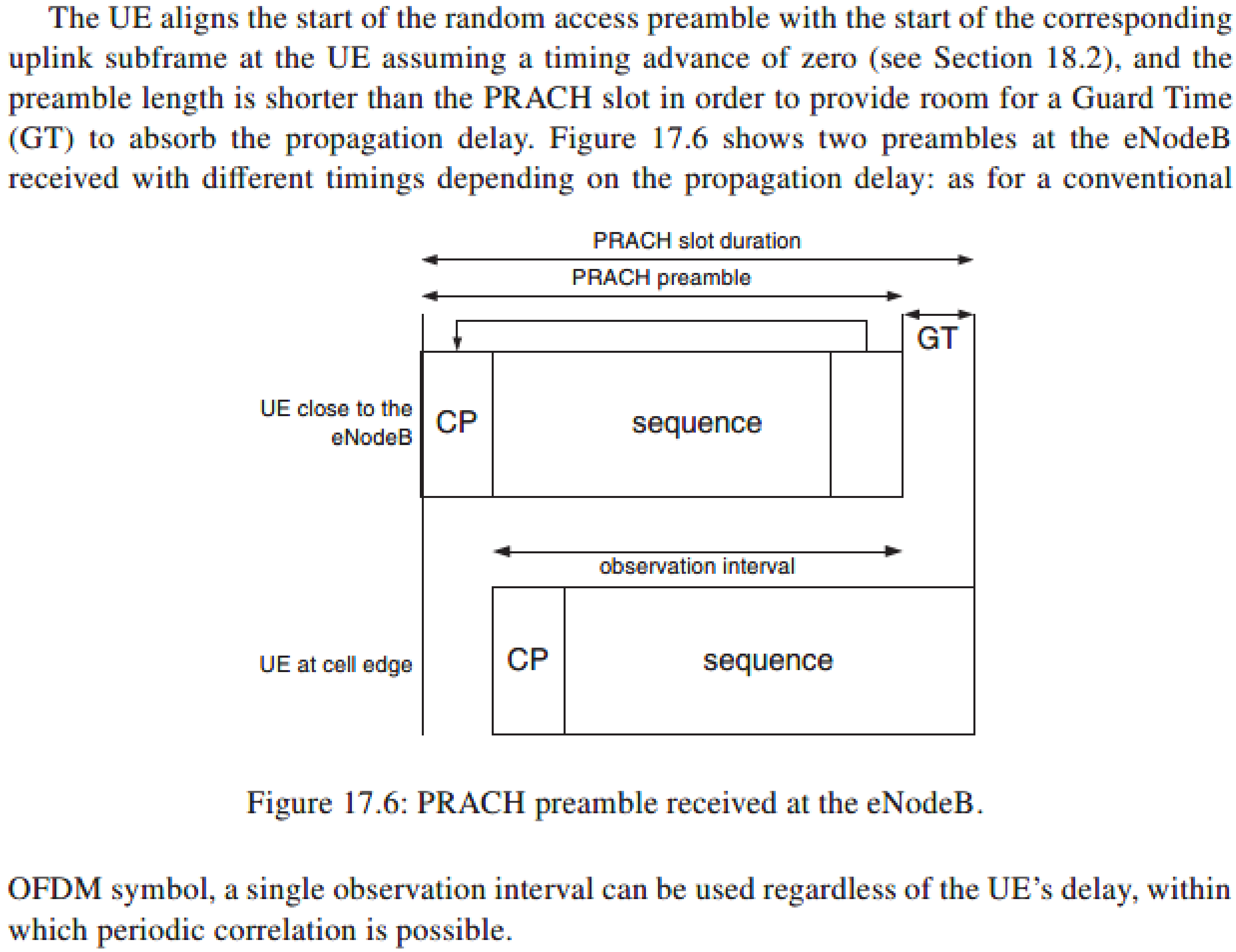
See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.



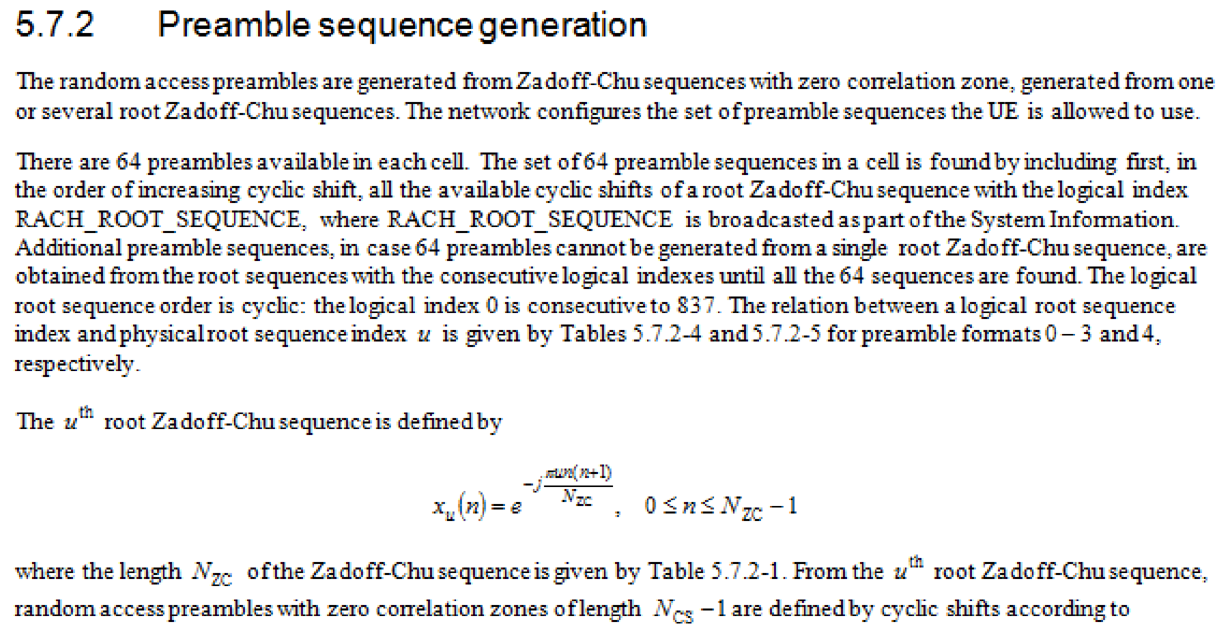
17.4.2 The PRACH Structure

17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

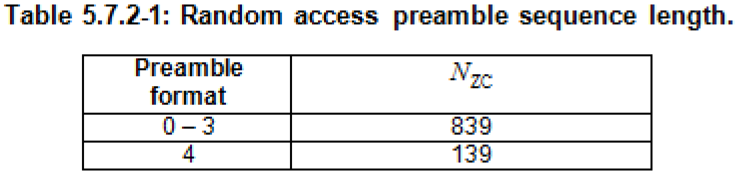
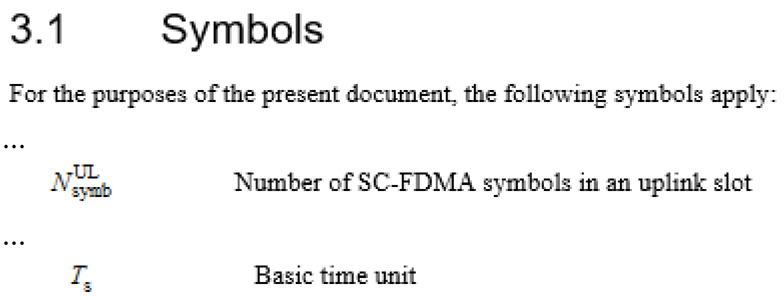
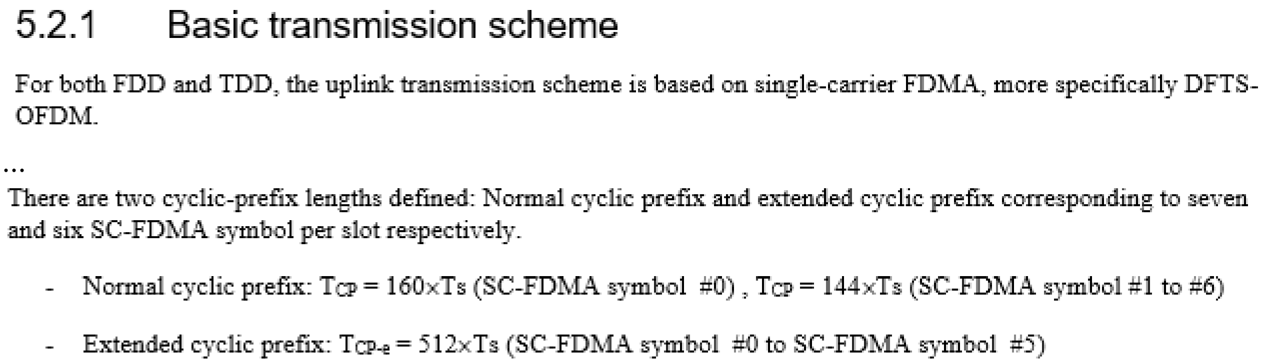


Table 5.7.2-1: Random access preamble sequence length.

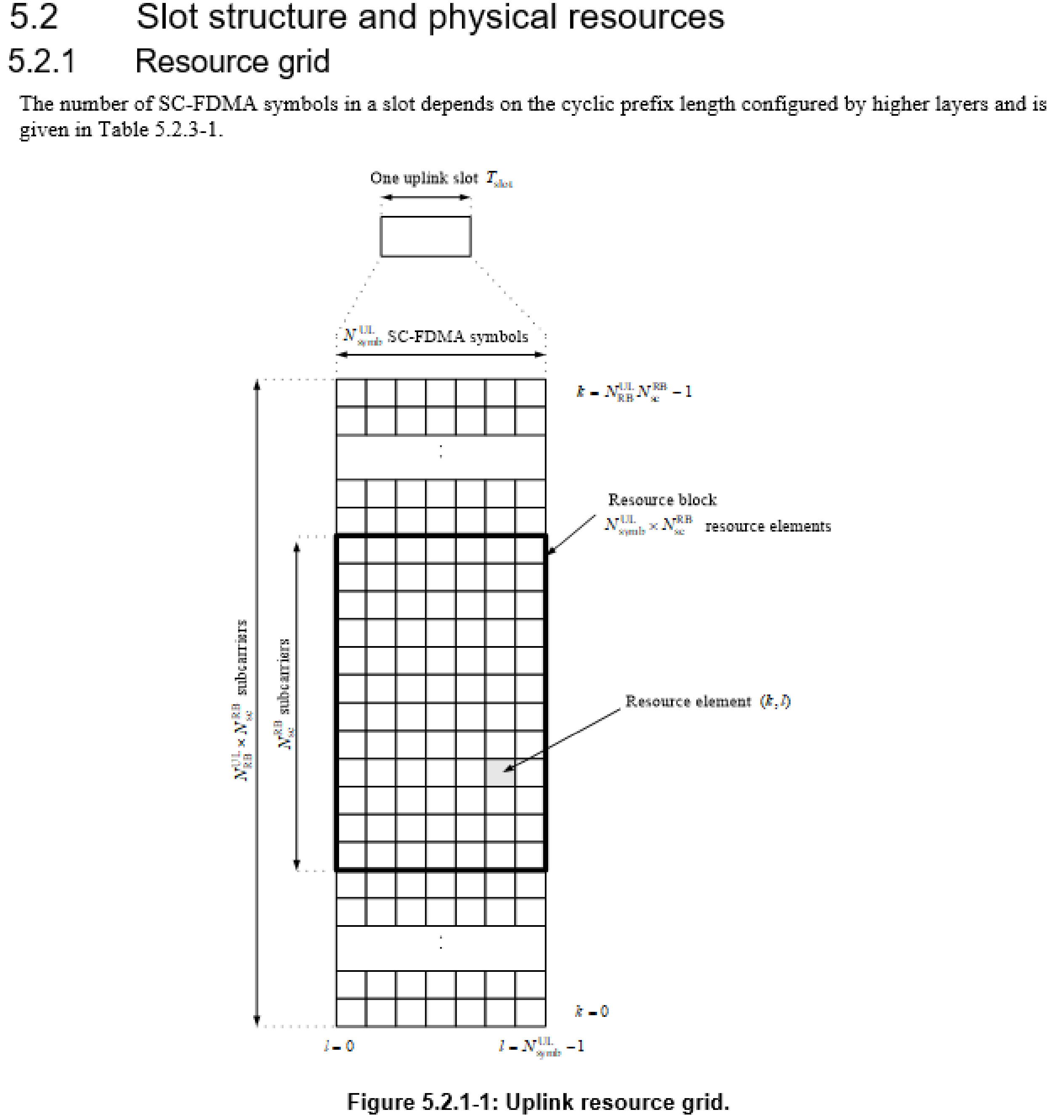
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using Mercedes's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs. 3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals. 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”



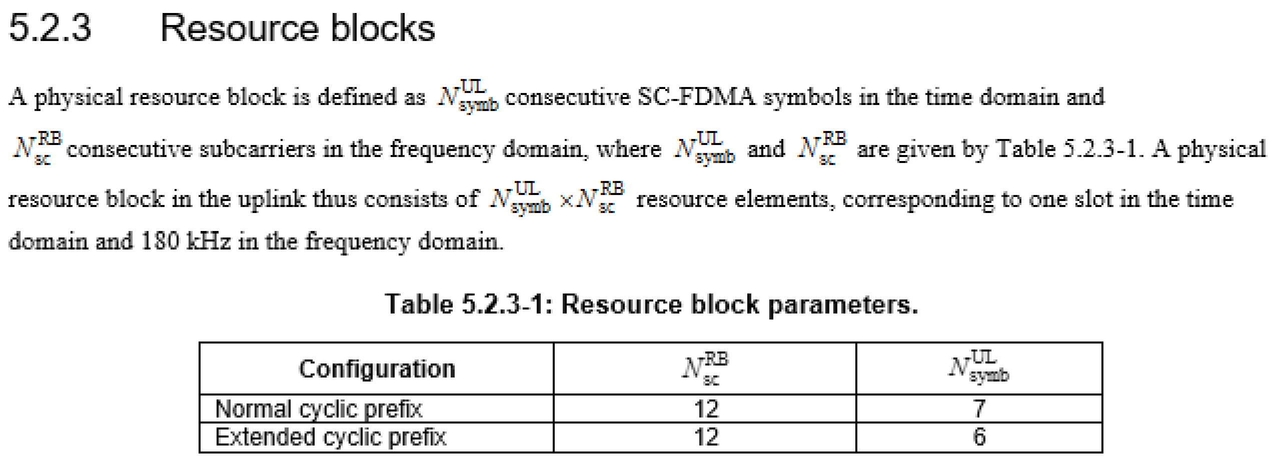
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

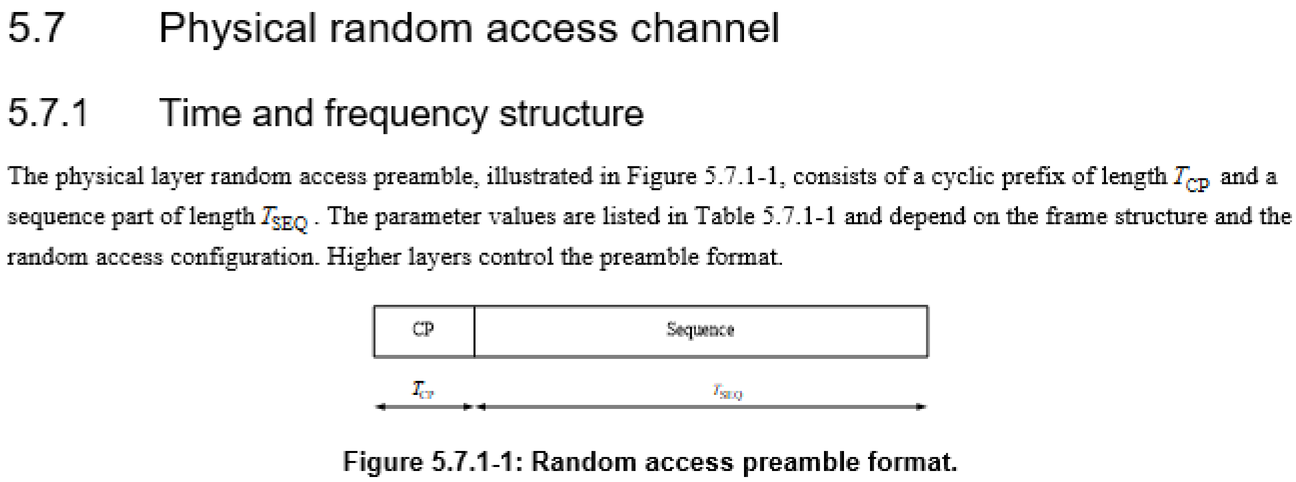
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols"

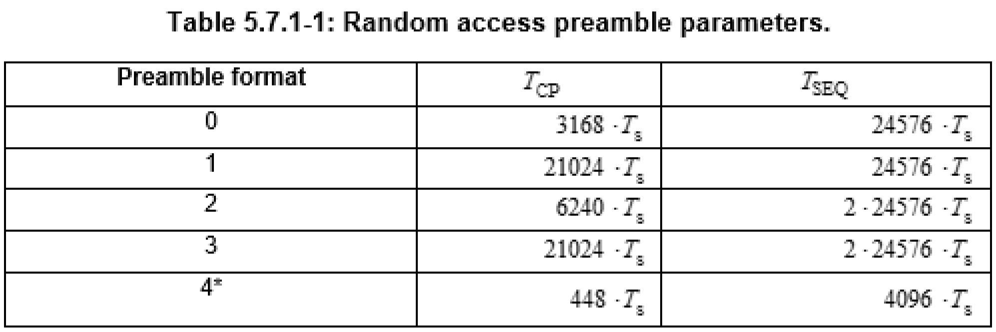
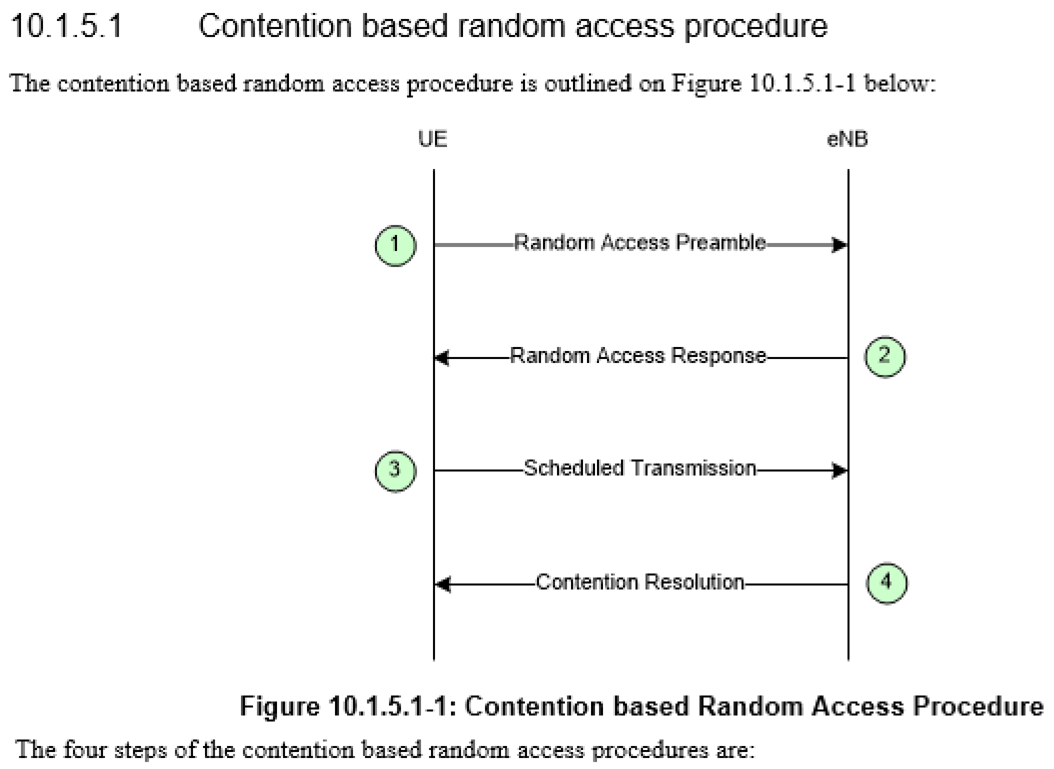


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
“a receiver configured to receive, from the base station, a response message”

a receiver configured to receive, from the base station, a response message.	Mercedes’s Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

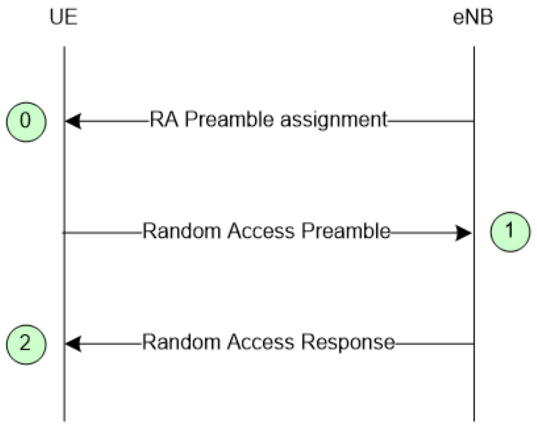
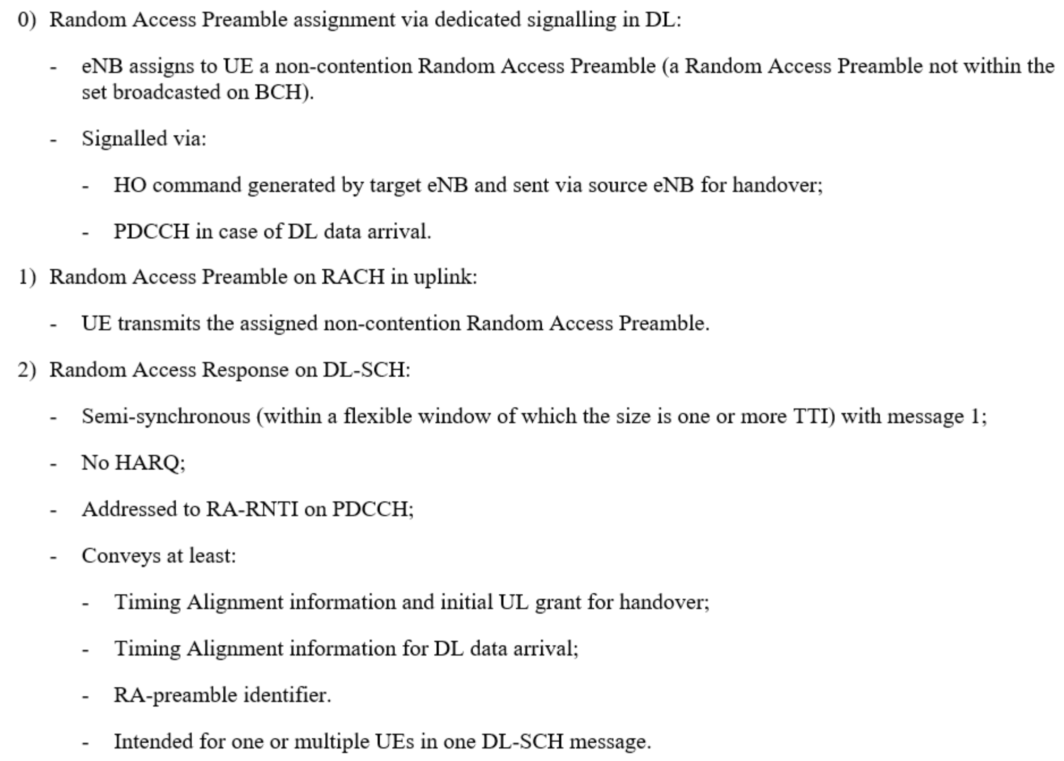


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

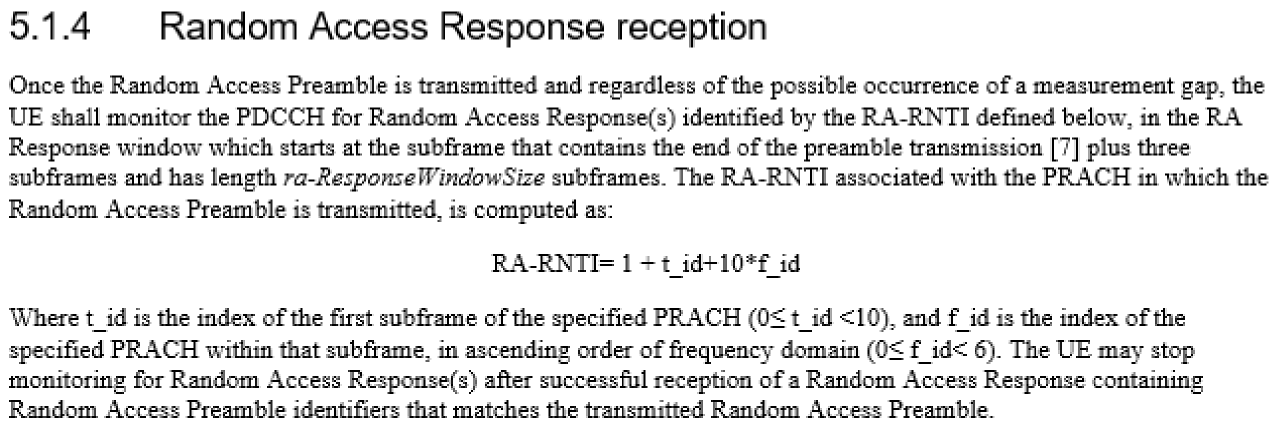
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

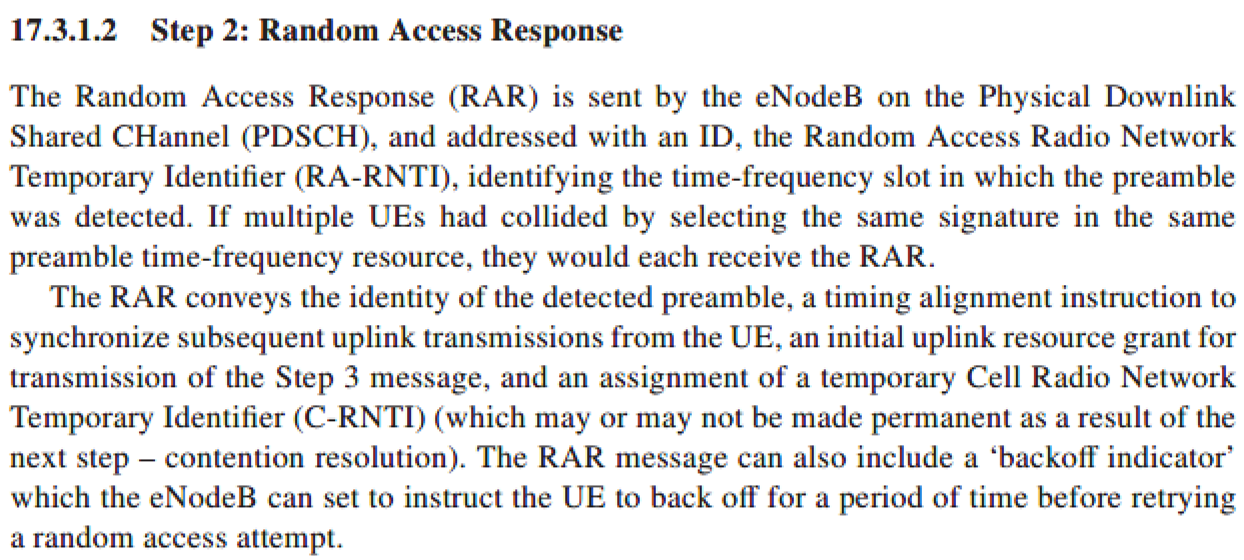
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

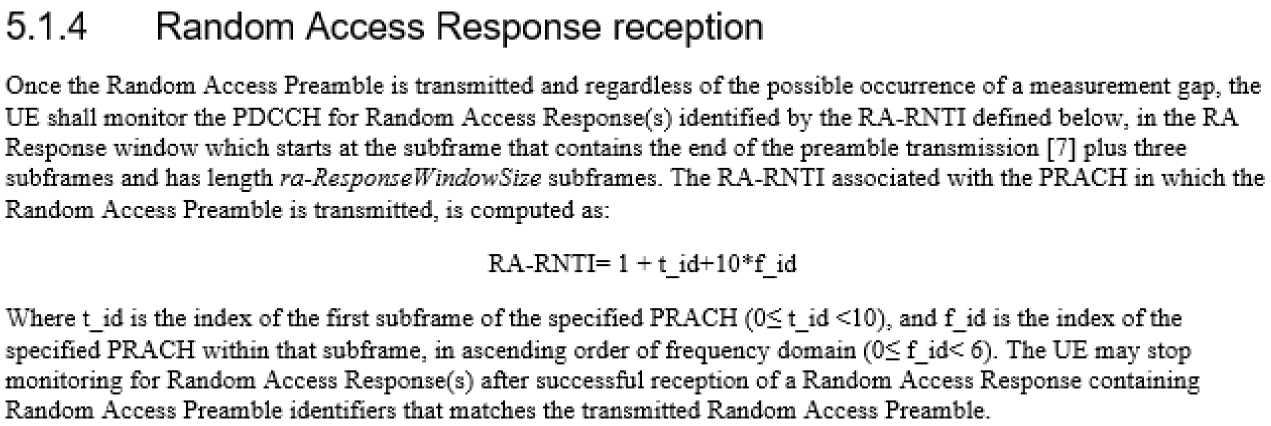
US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

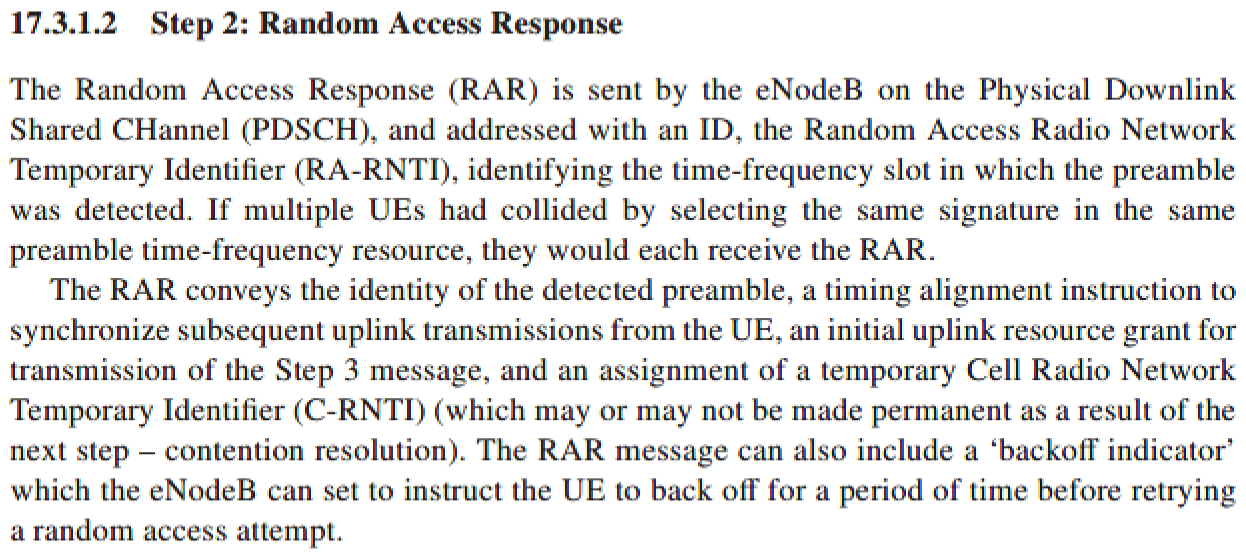
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

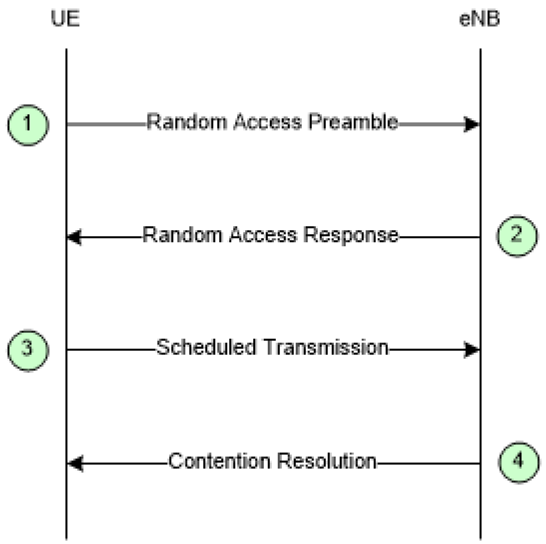
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

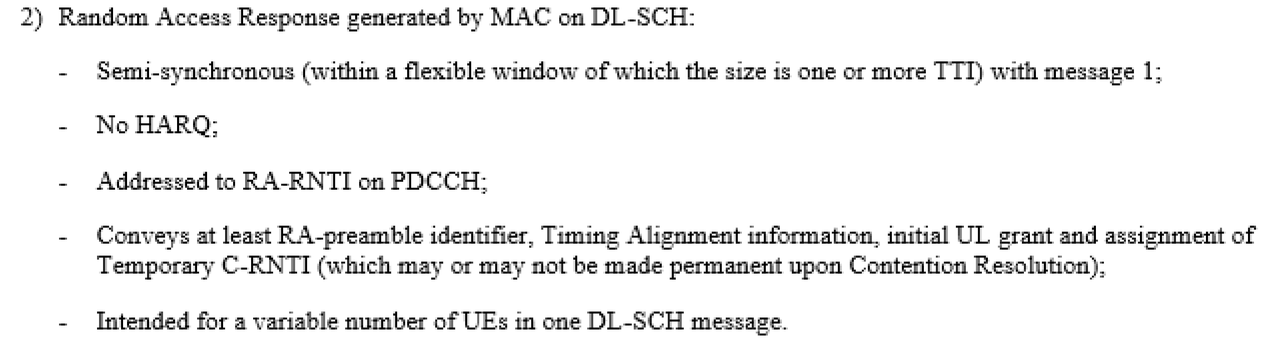
the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of Mercedes’s Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

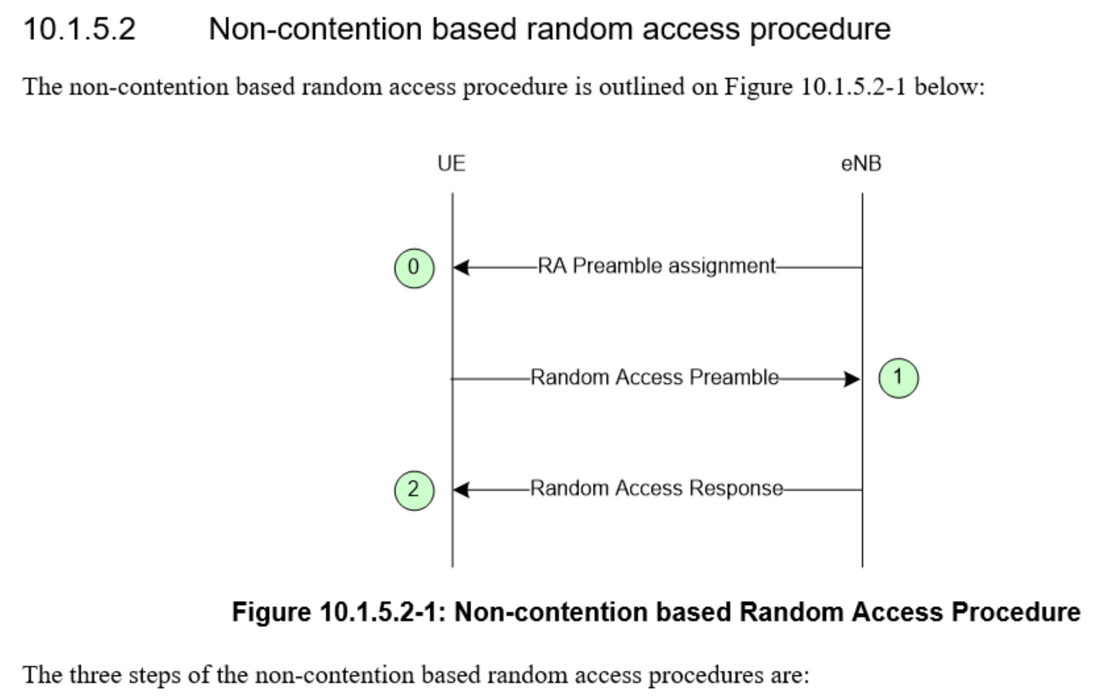
on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in Mercedes's Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:  **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



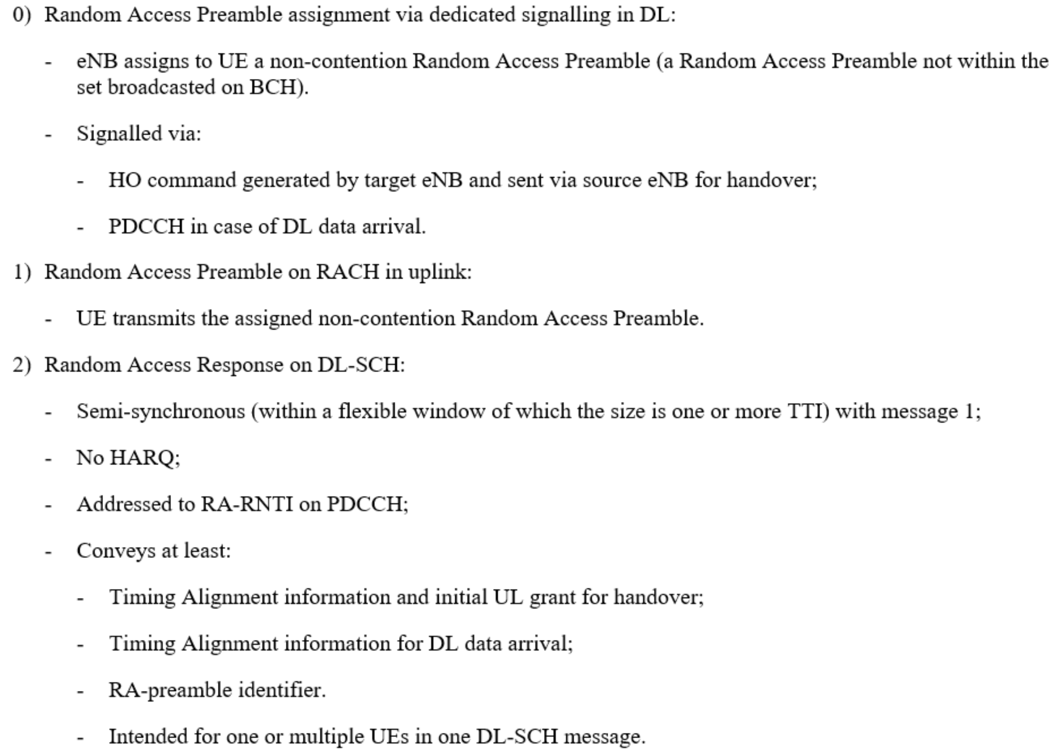
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

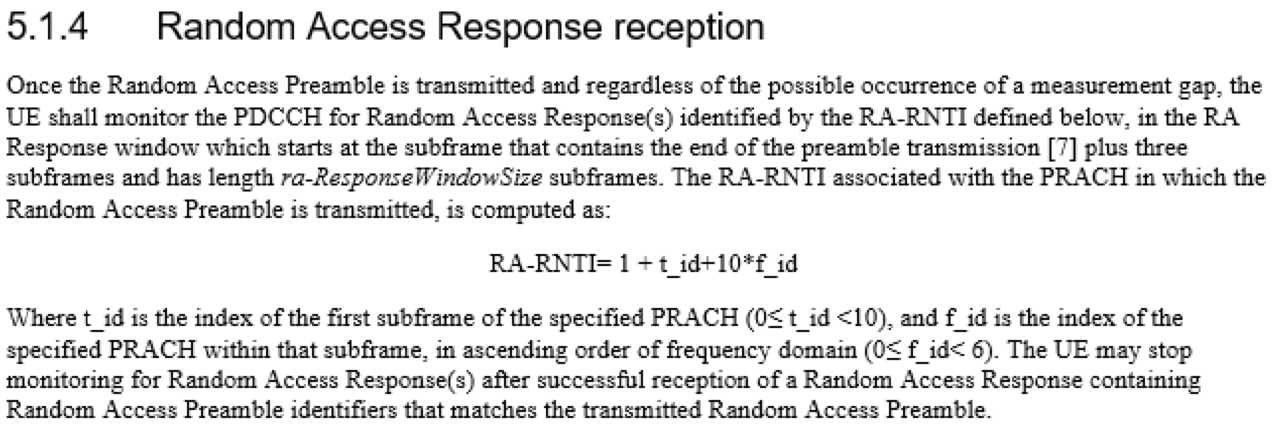


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

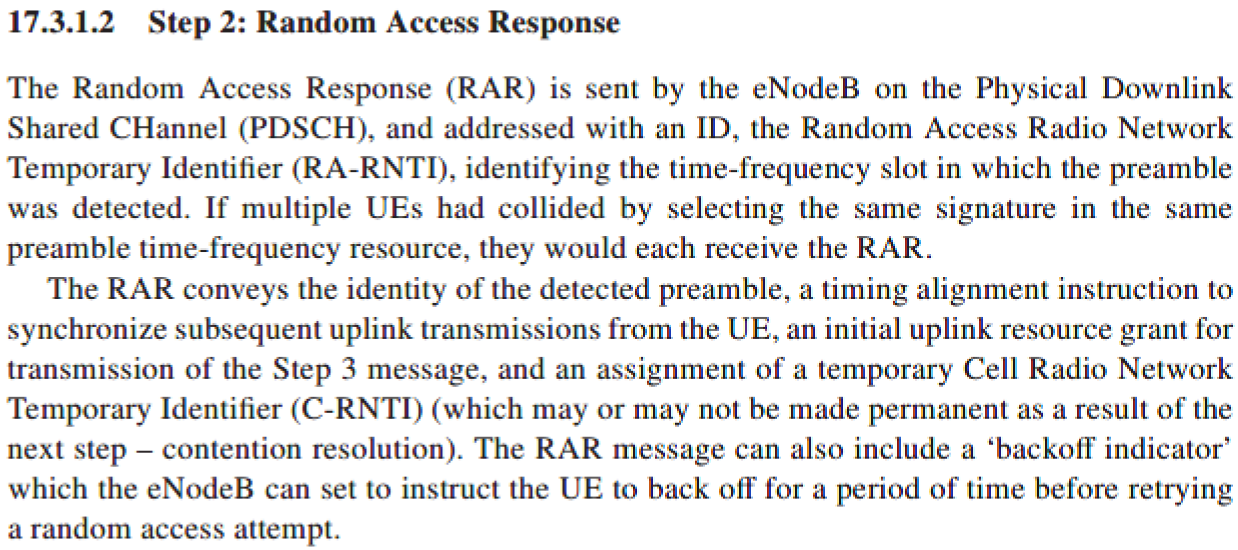
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

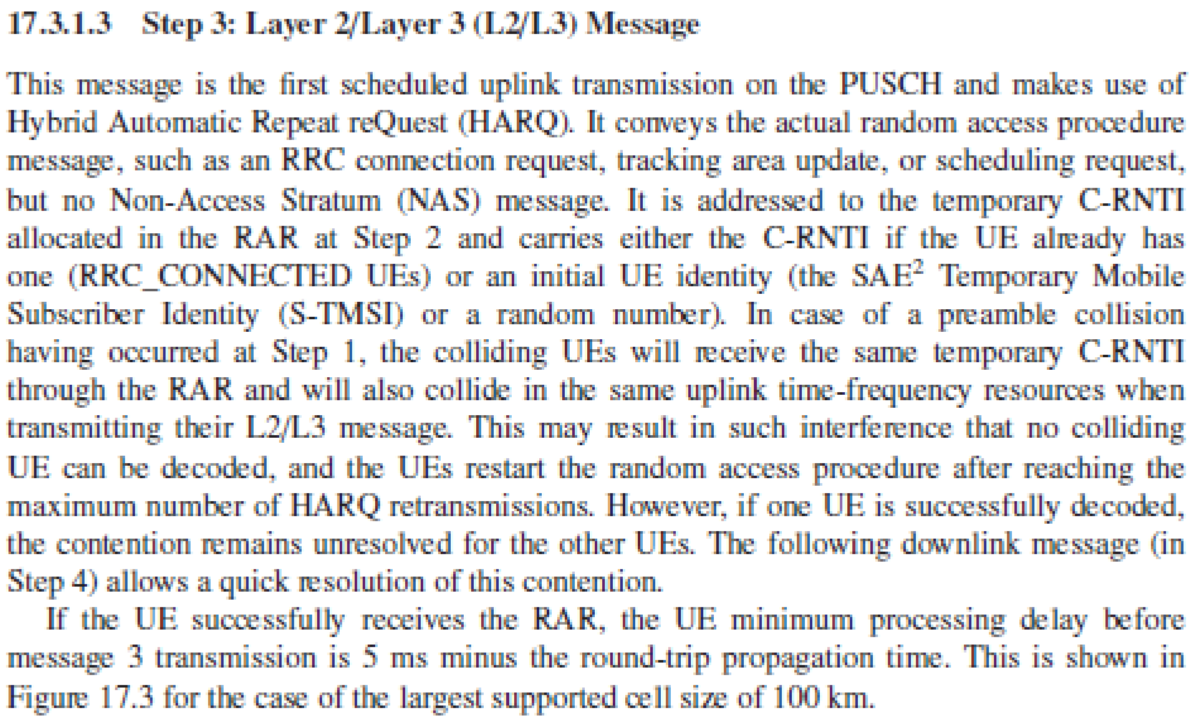
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

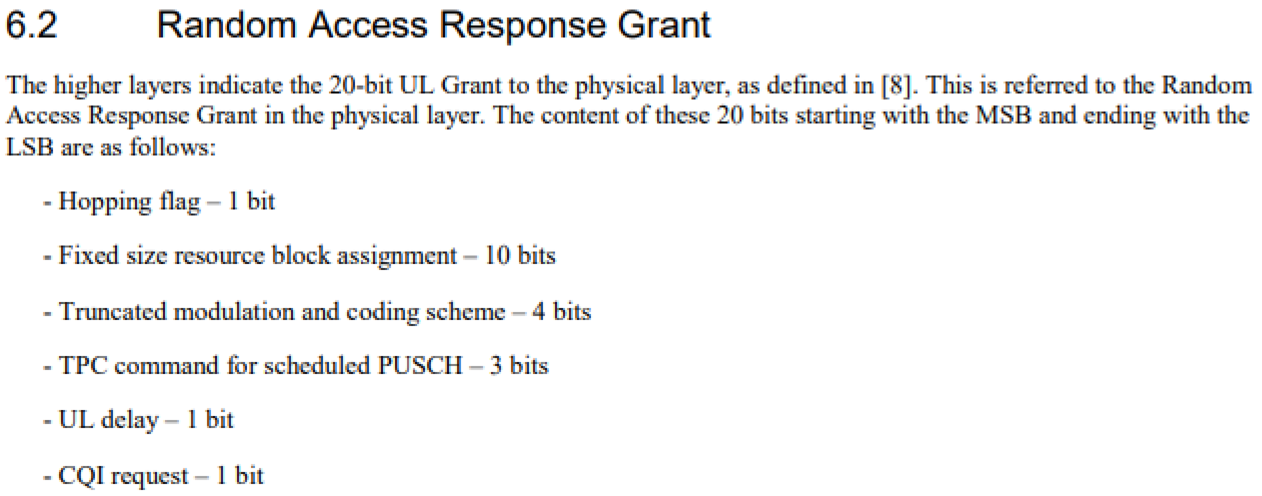
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

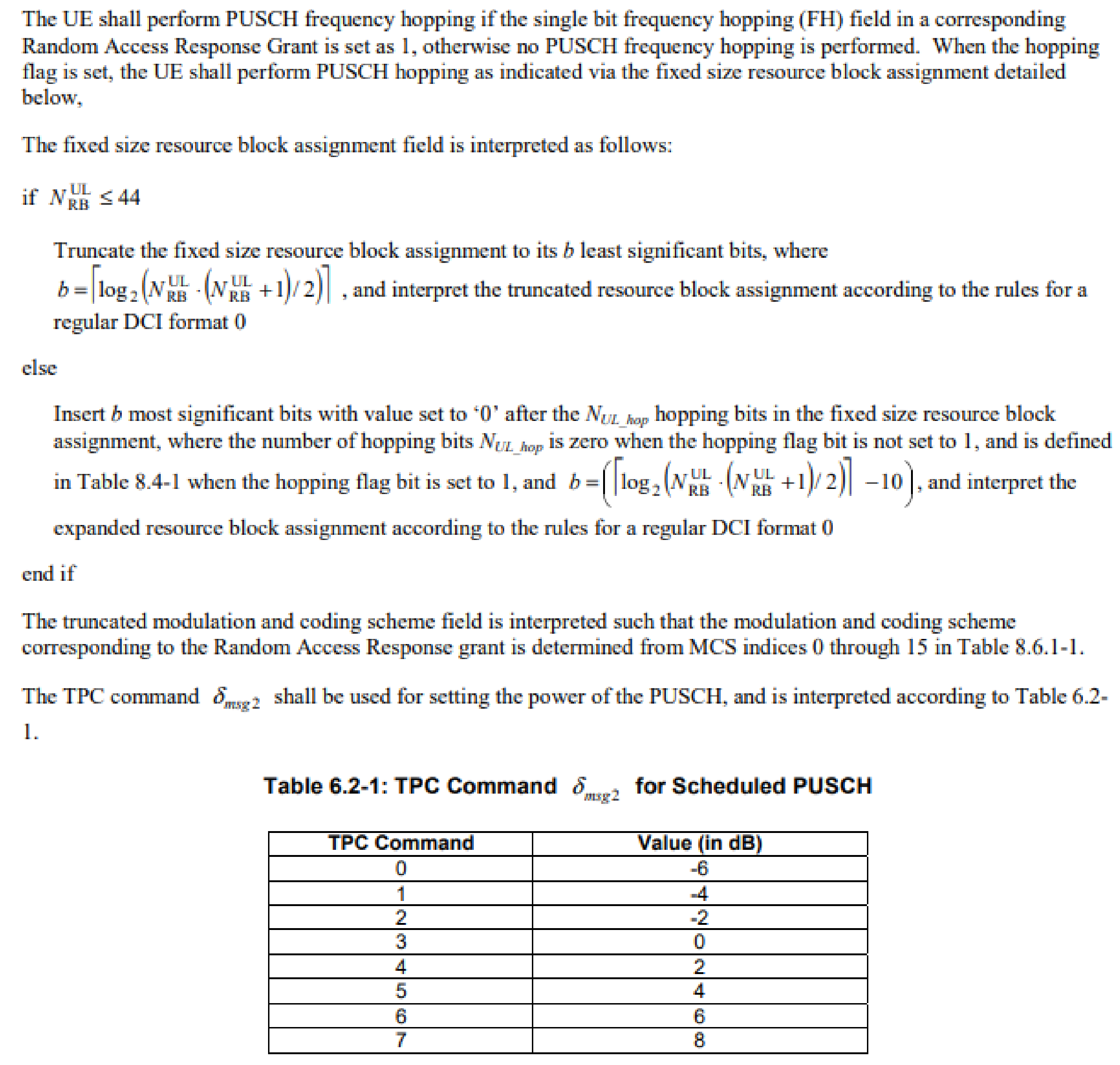
US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
"The mobile station of claim 2, wherein the response message includes power adjustment information and"

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of Mercedes's Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
“The mobile station of claim 2, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

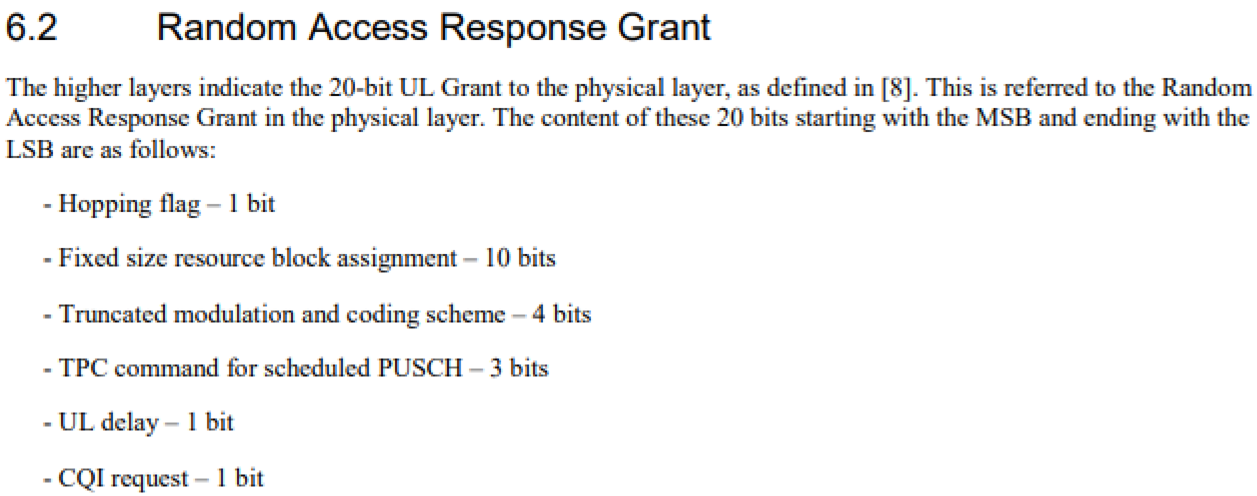
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

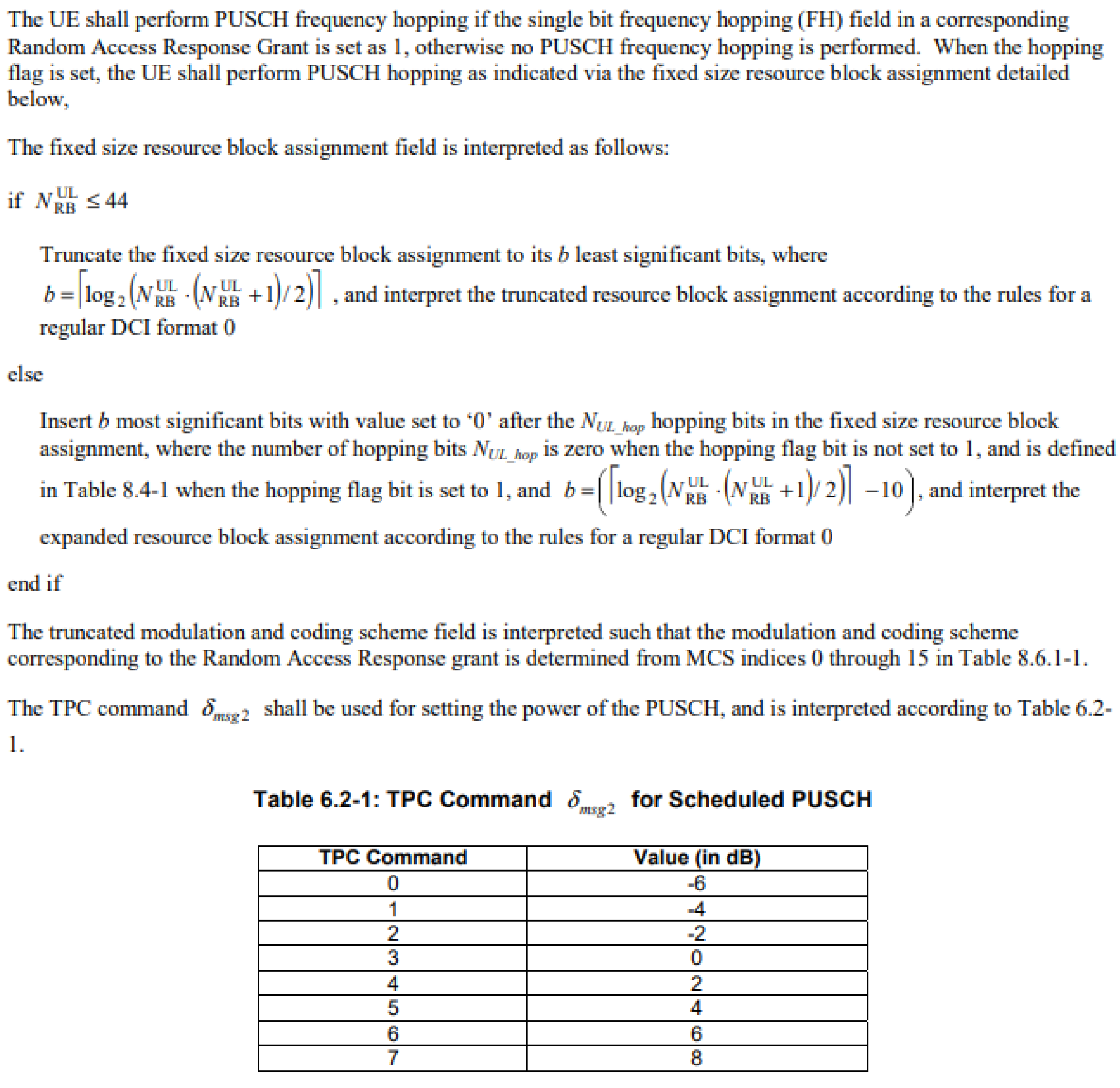
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of Mercedes’s Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

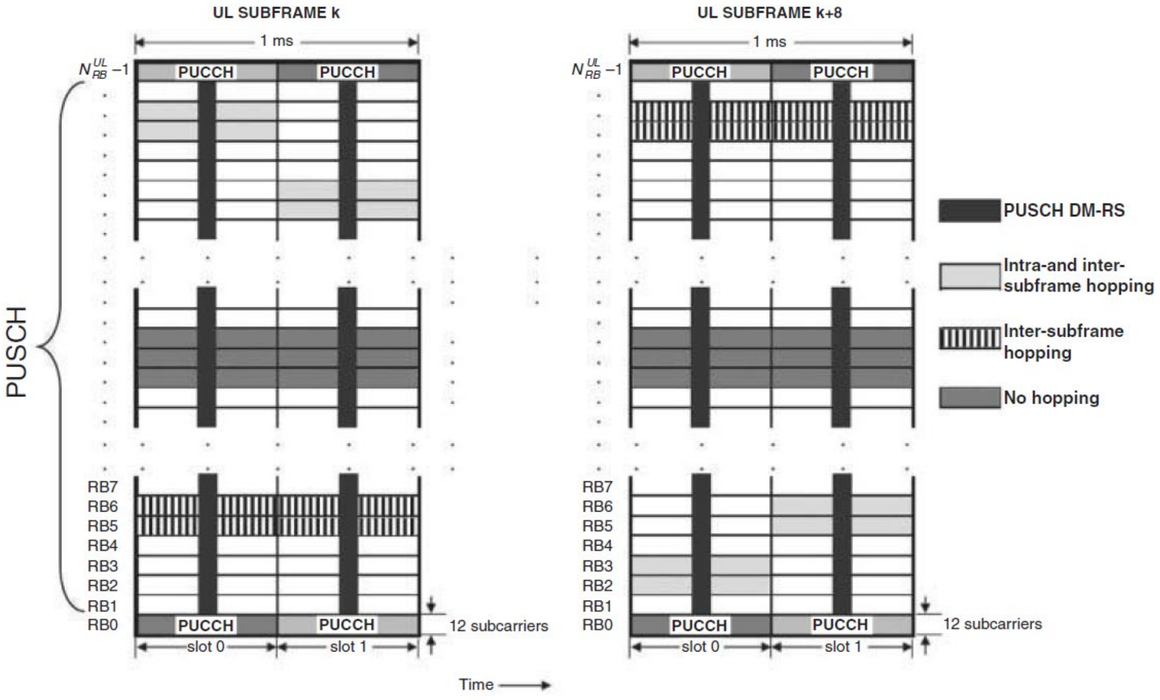
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

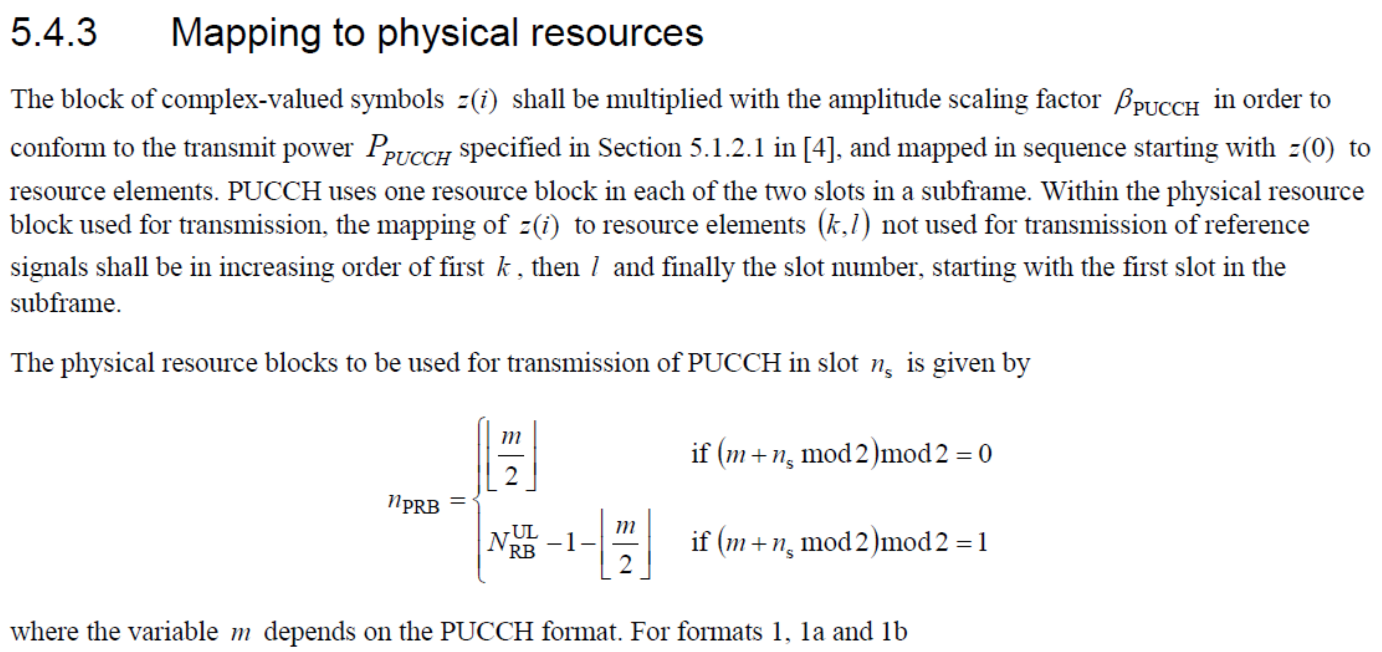
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of Mercedes's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure"). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4
“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	**5.4.3 Mapping to physical resources** The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 4
“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

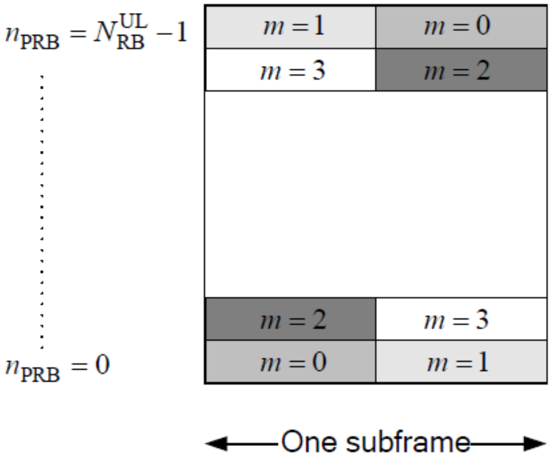


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

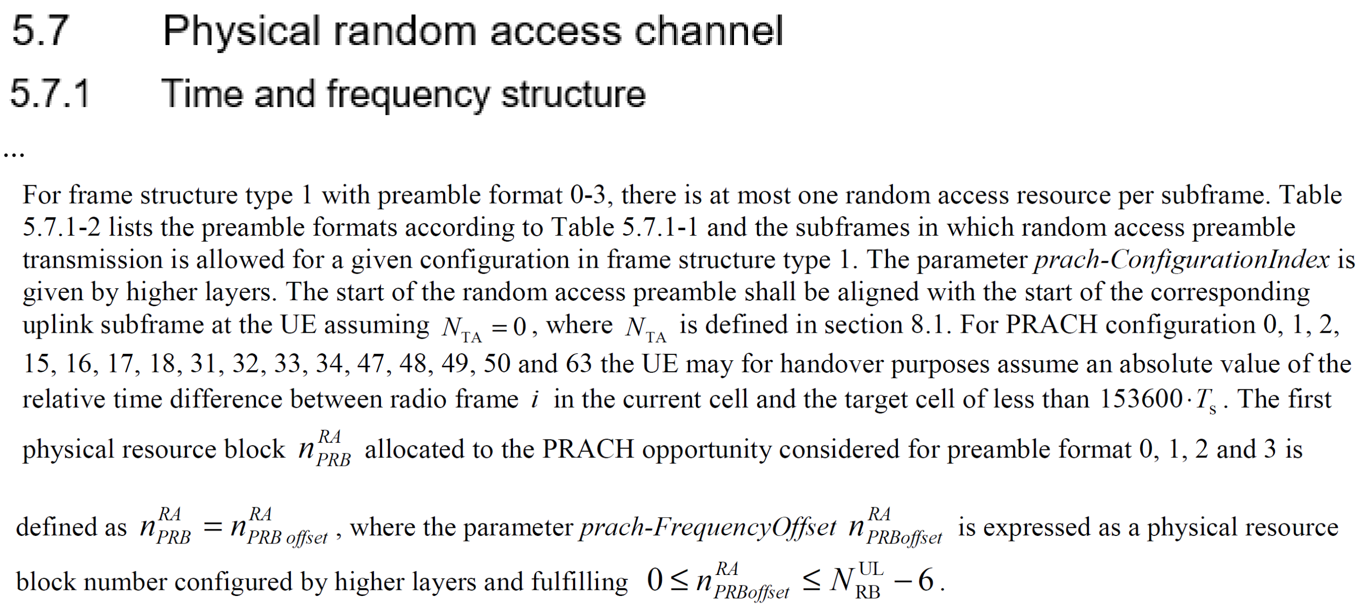
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

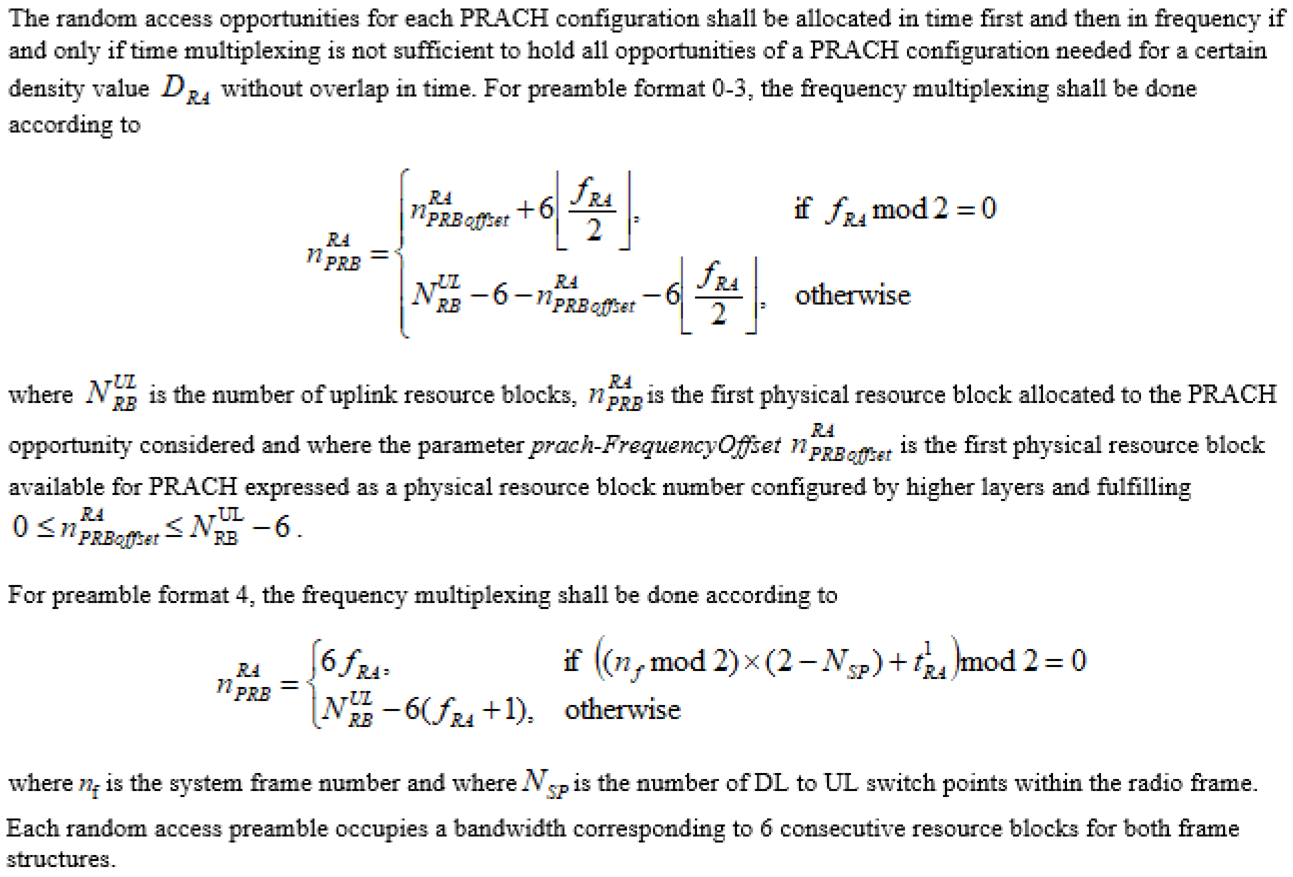
...

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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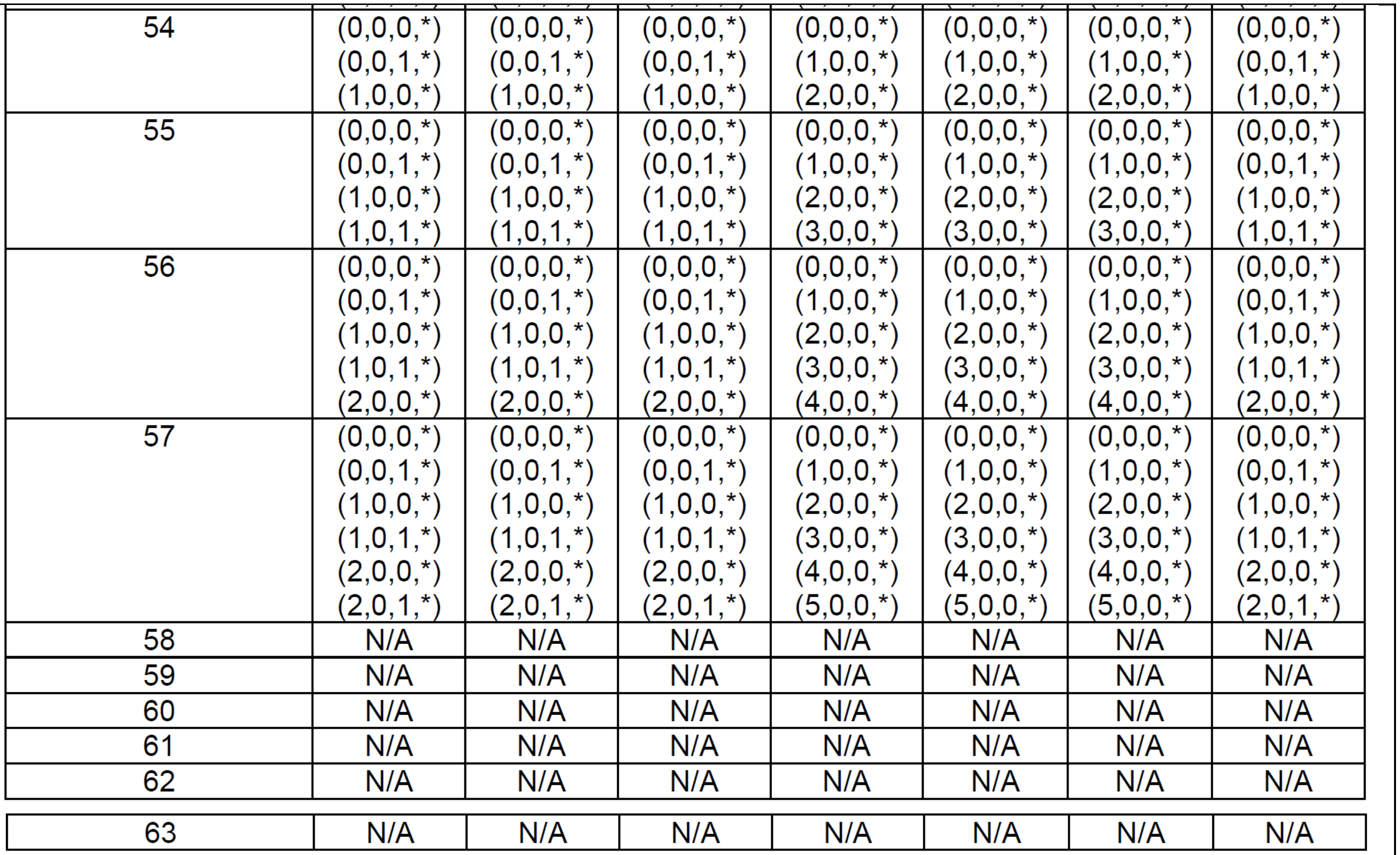
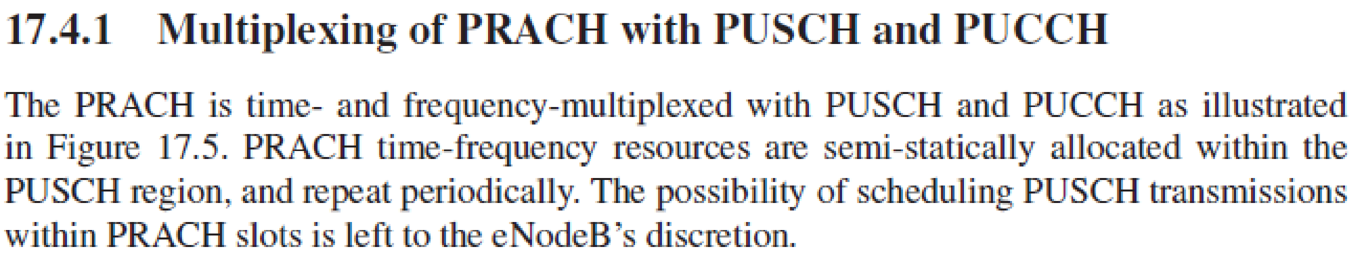


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

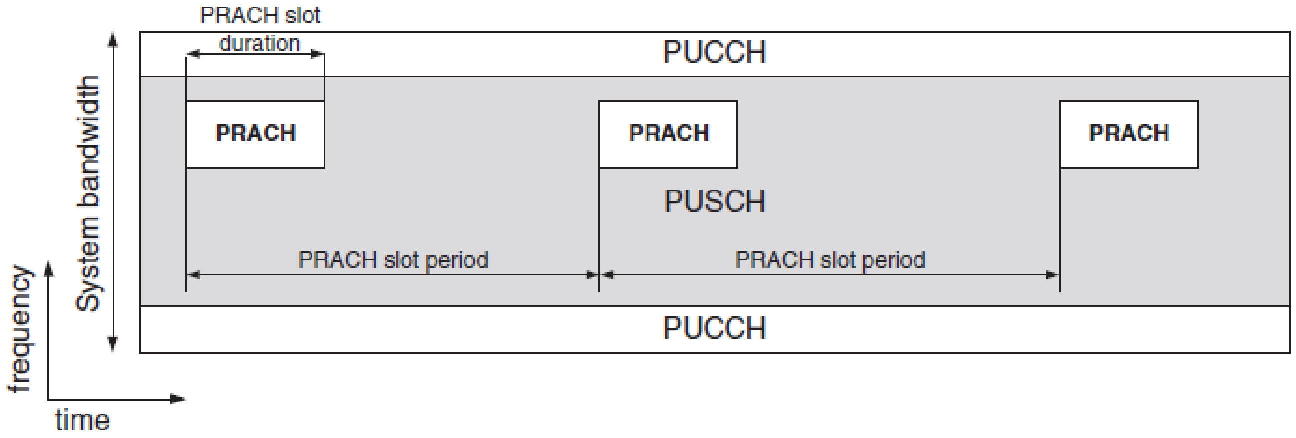
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



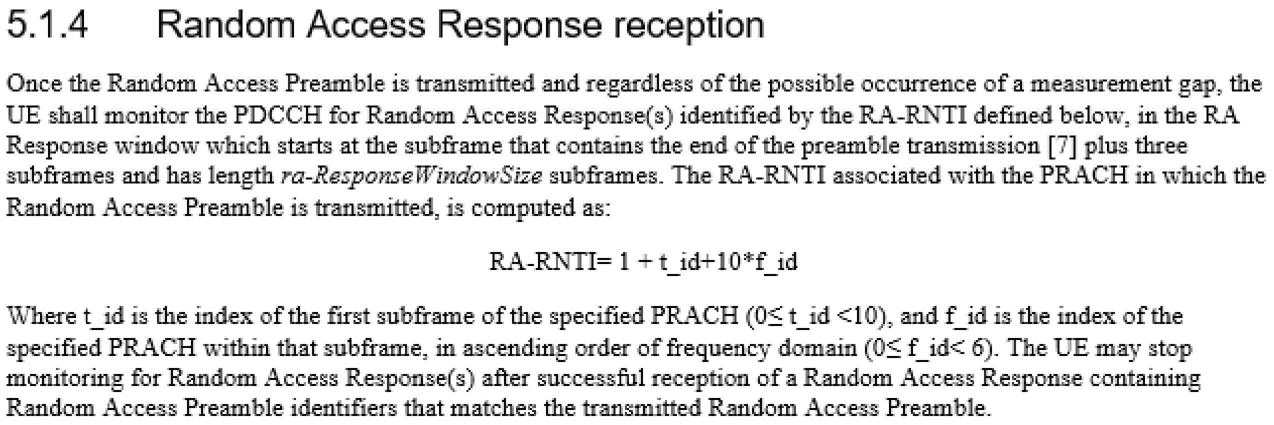
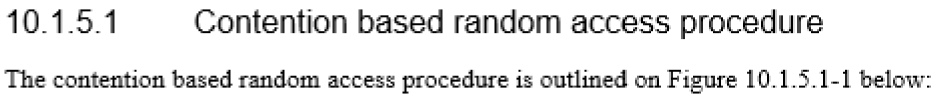
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 4
"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Mercedes's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5

"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

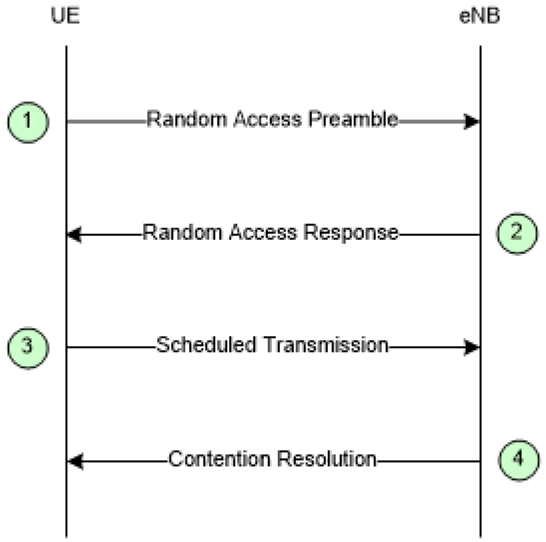


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

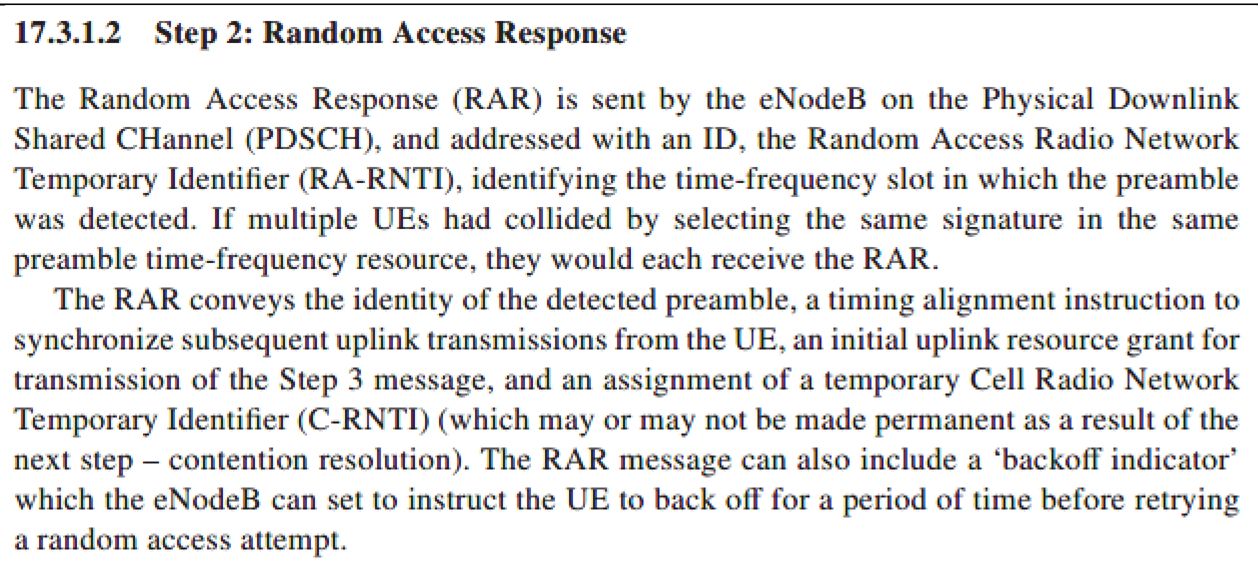
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 6
"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Mercedes's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

<table>
<tr>
<td>7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.</td>
<td>

See Claim 1.

The frequency band used with Mercedes's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,*

For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.

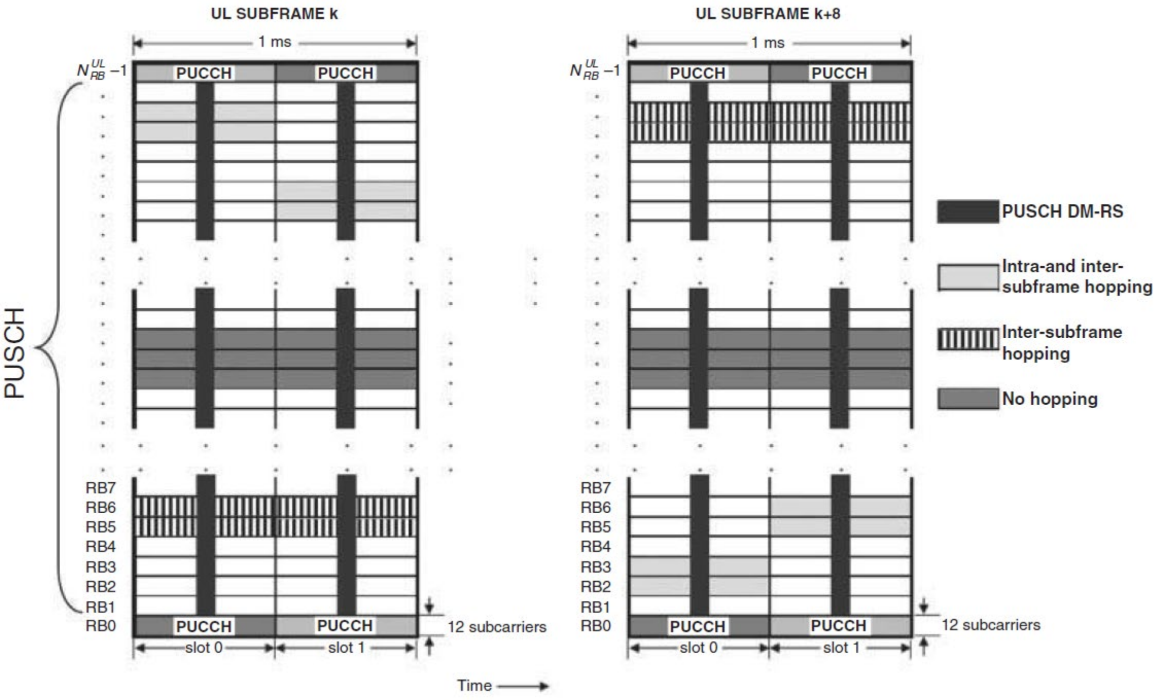


Figure 16.3: Uplink physical data channel processing.

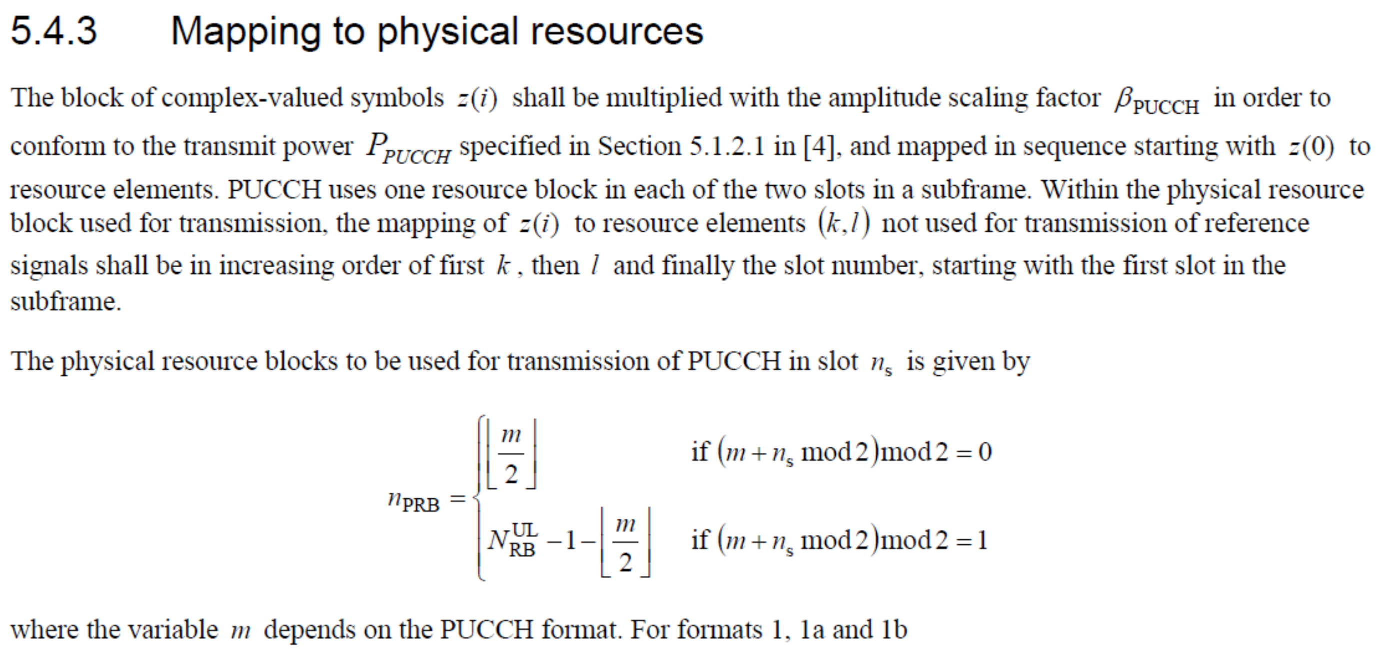
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

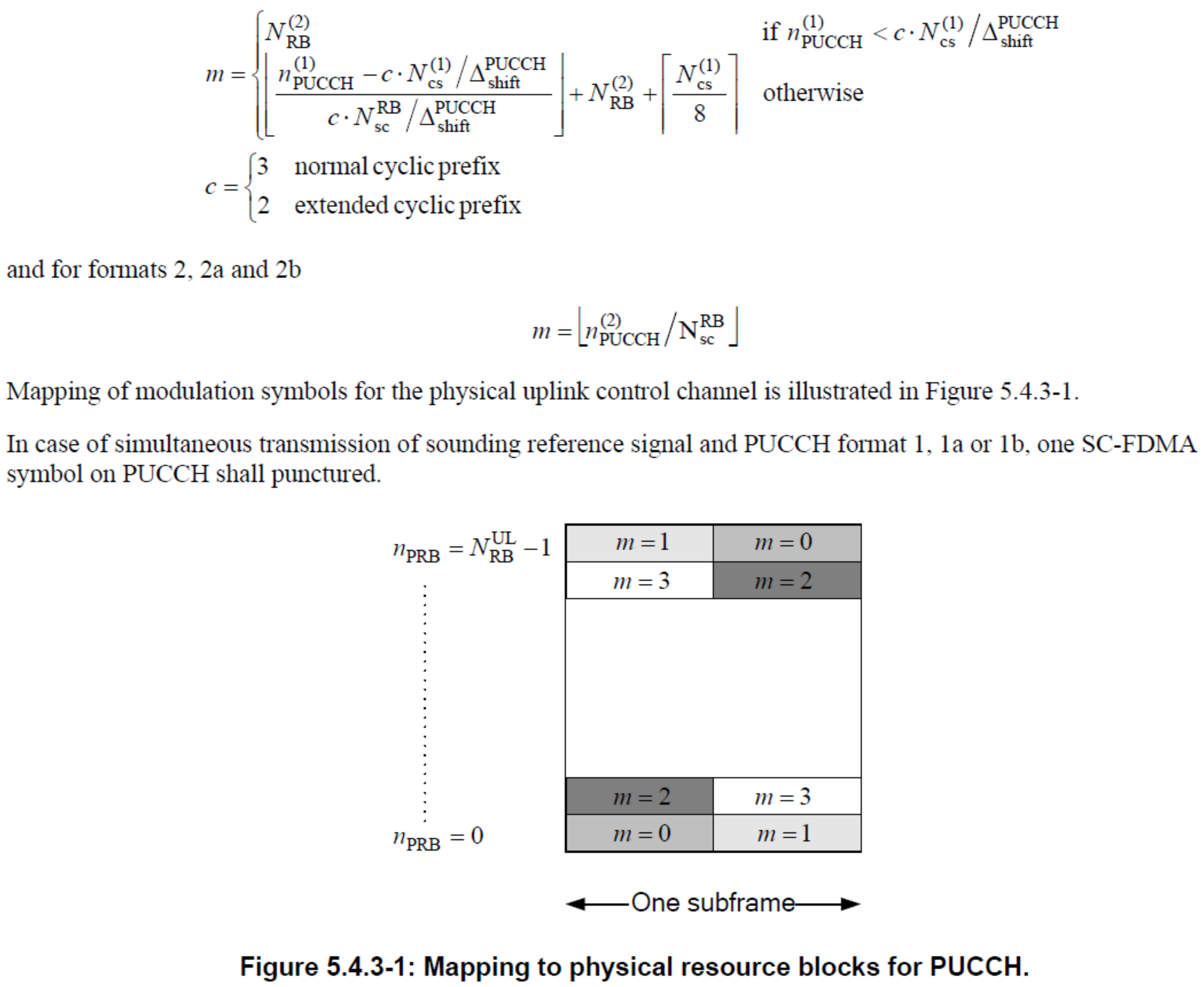
The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } \left(m + n_{\mathrm{s}} \bmod 2\right) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

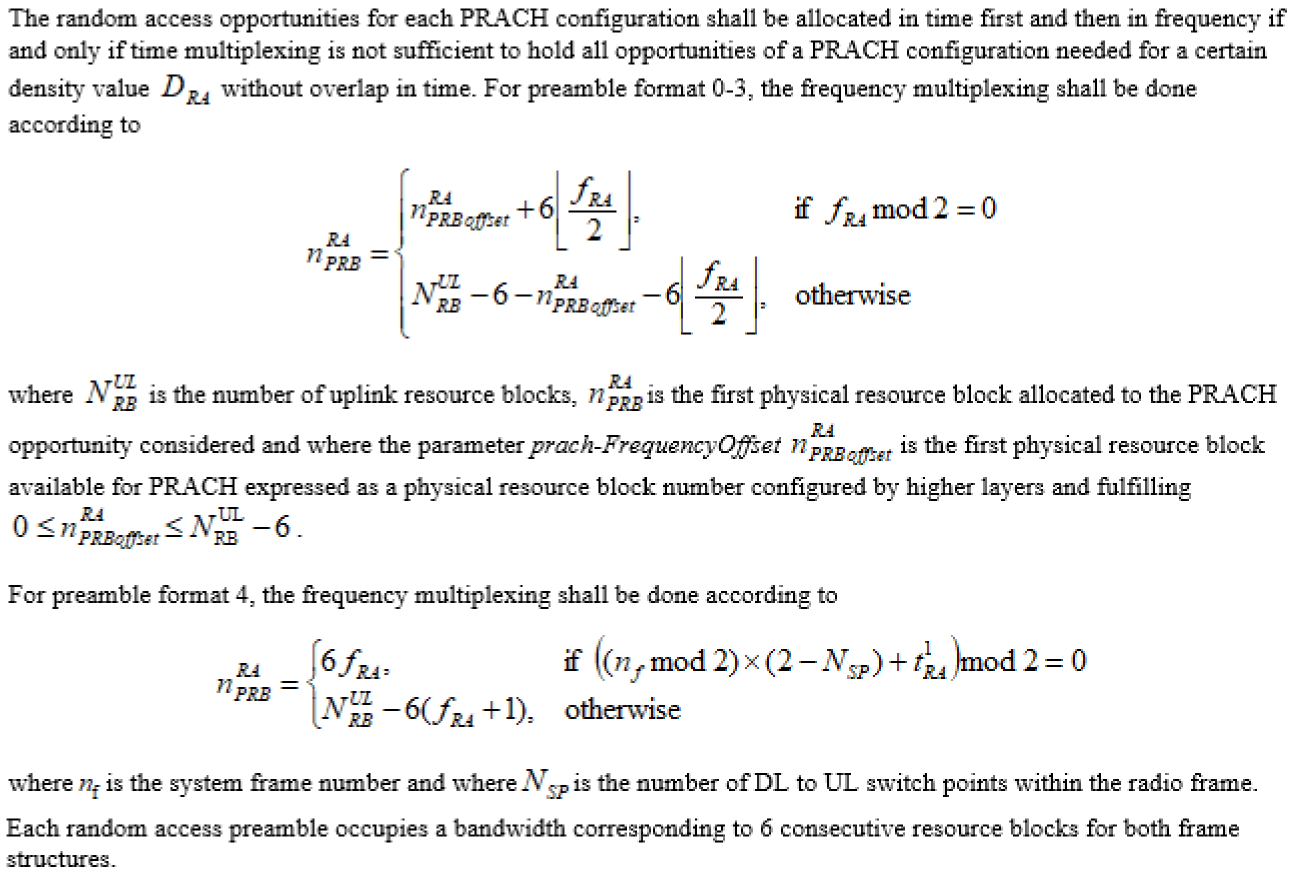
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH. 5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \leq n_{PRBoffset}^{RA} \leq N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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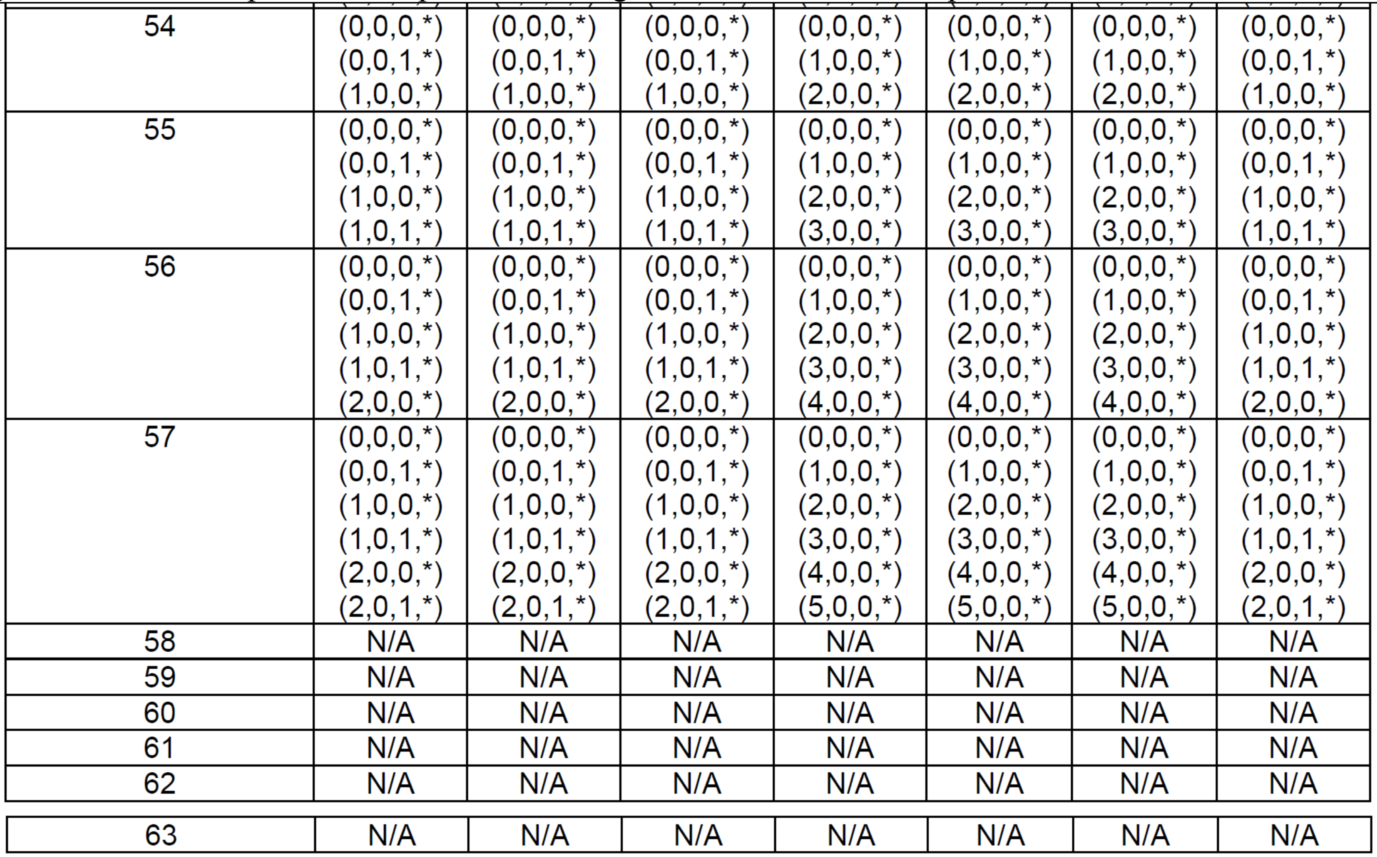
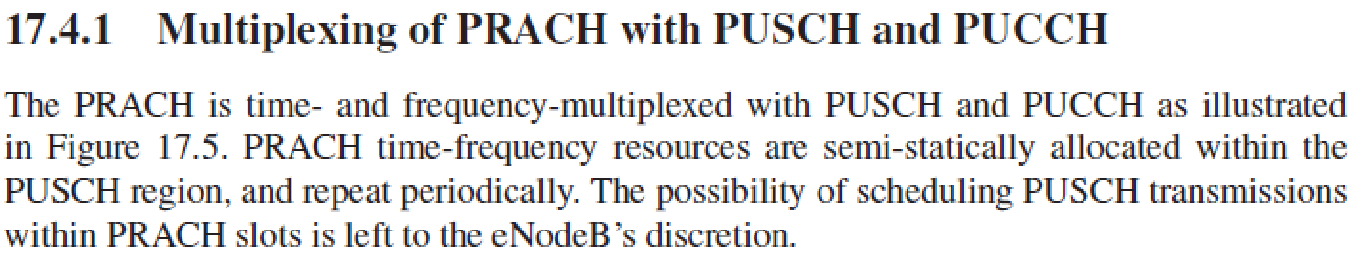
US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

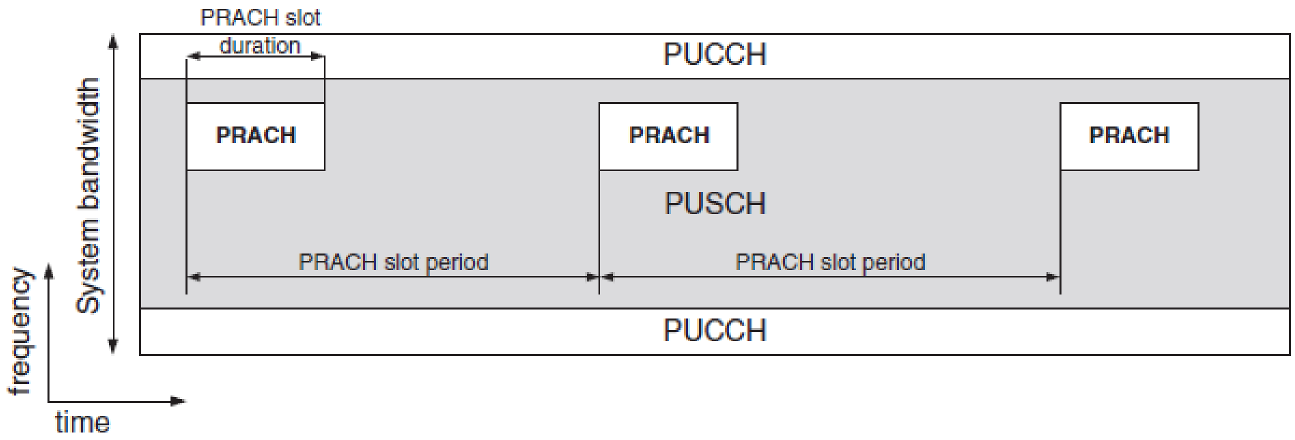
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



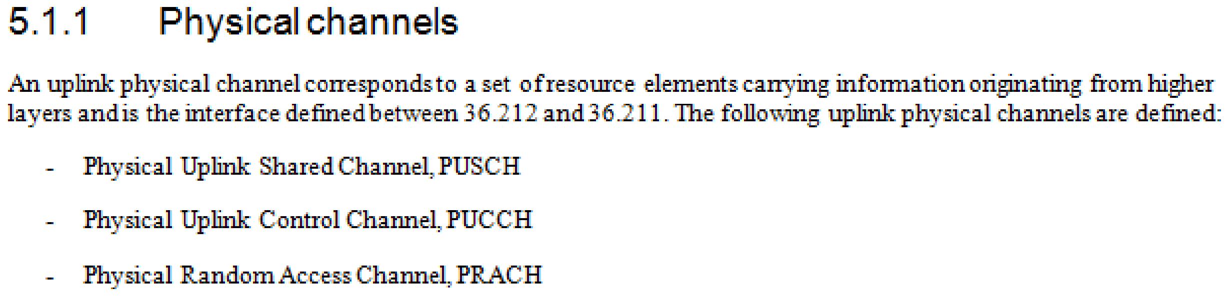
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

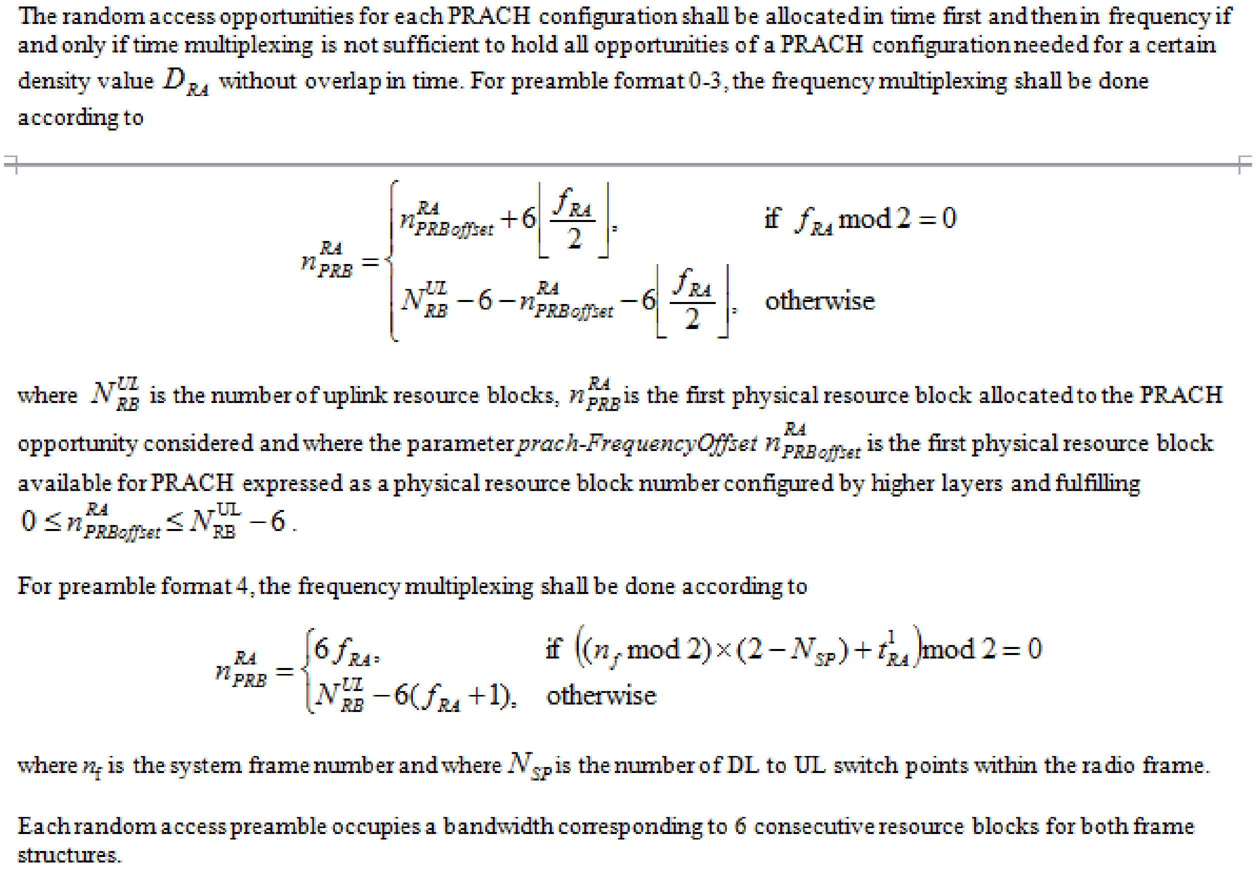
US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

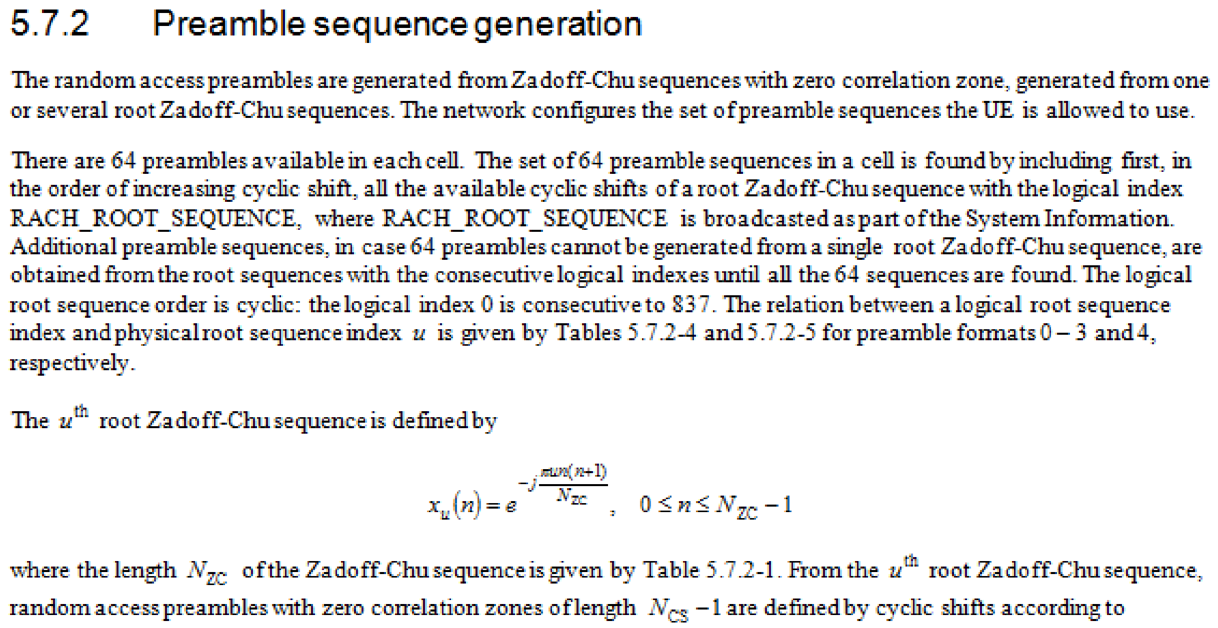
US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Mercedes’s Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

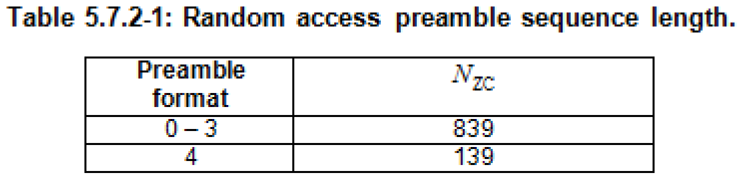
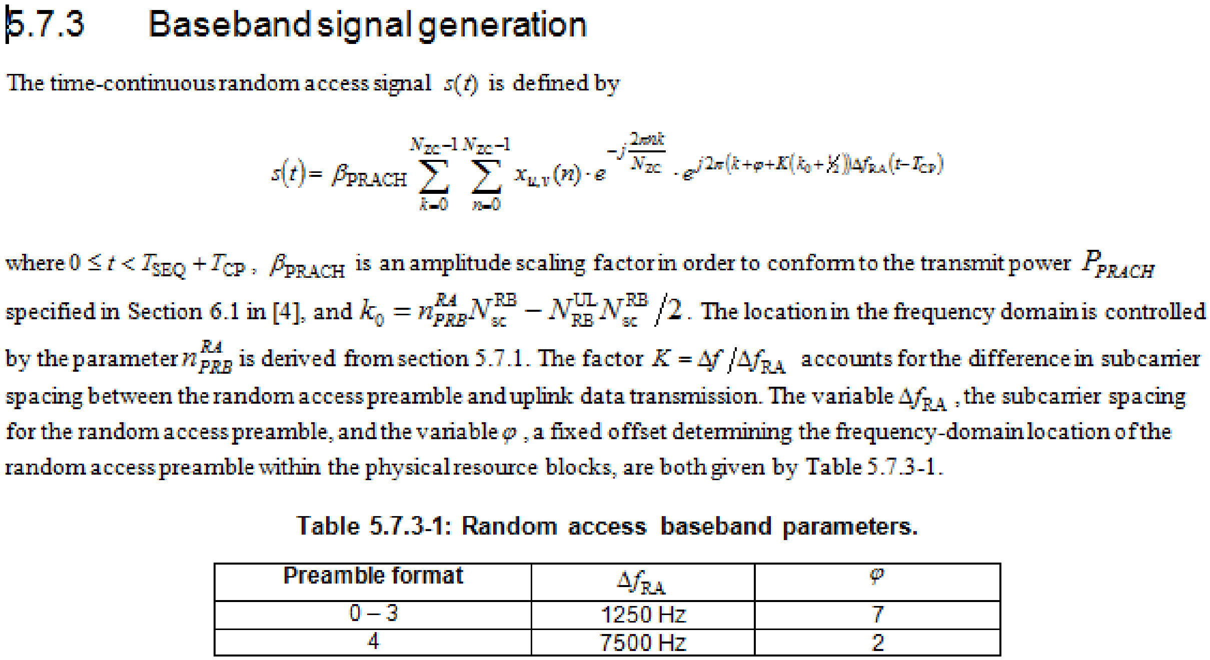


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

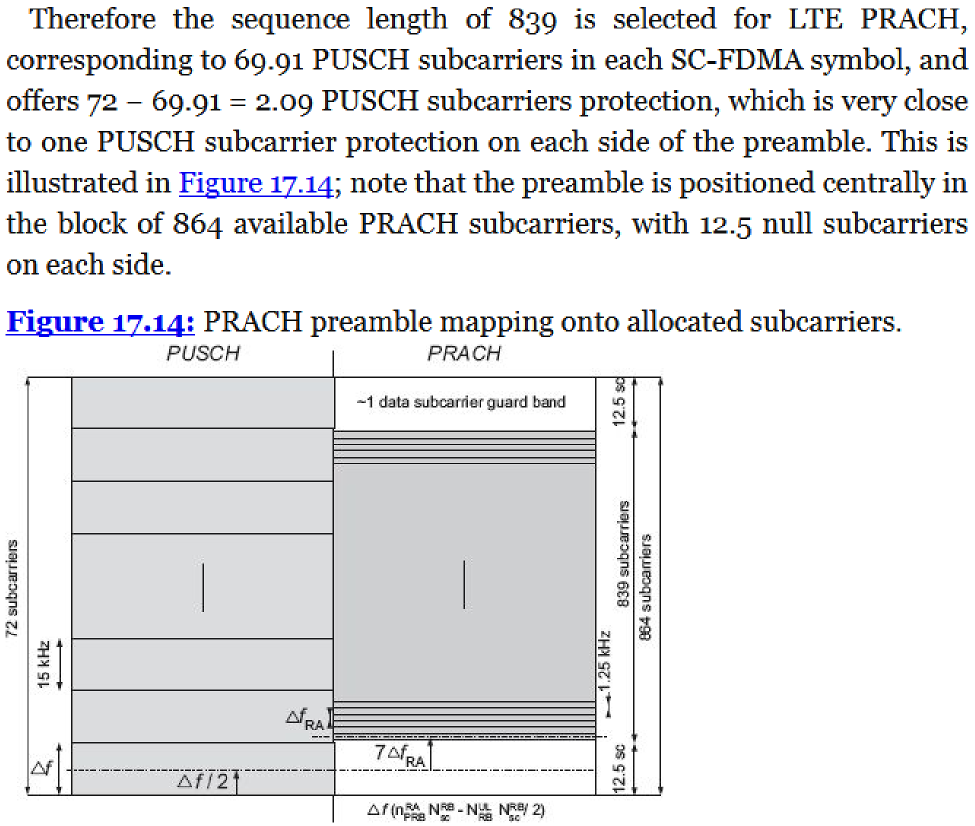
$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

where $0 \le t < T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}} - N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

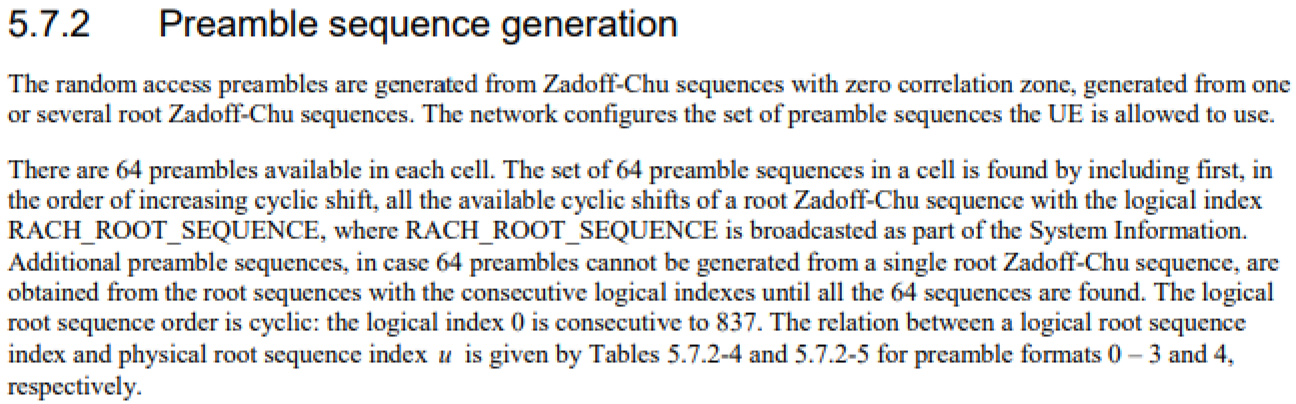
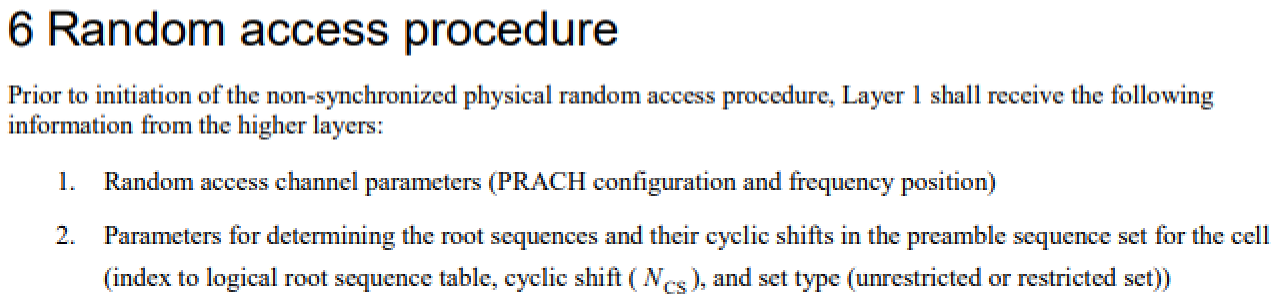


Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 9
“The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Mercedes’s Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information. 5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39. 6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

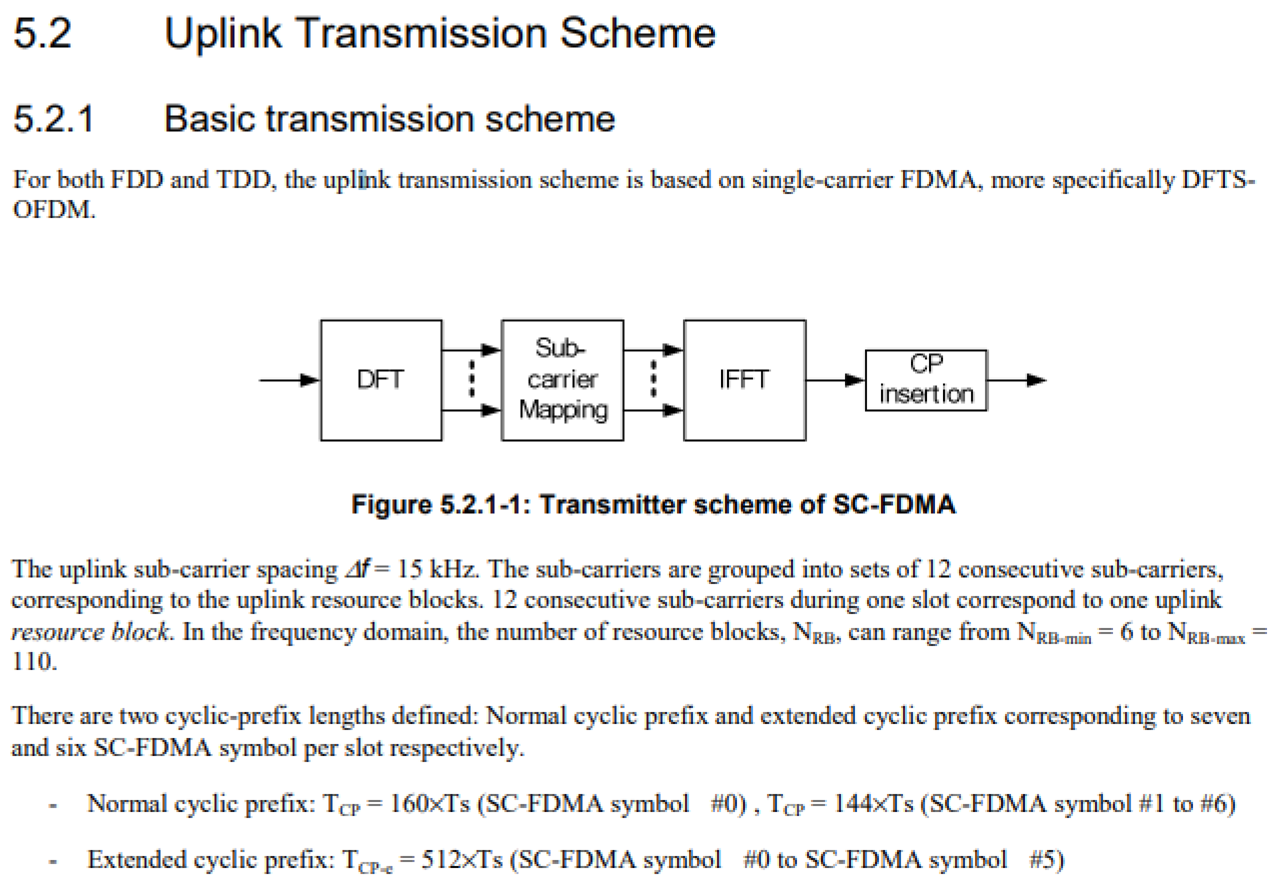
```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

US Patent No. 10,833,908: Claim 10

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 1. Mercedes's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Mercedes's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

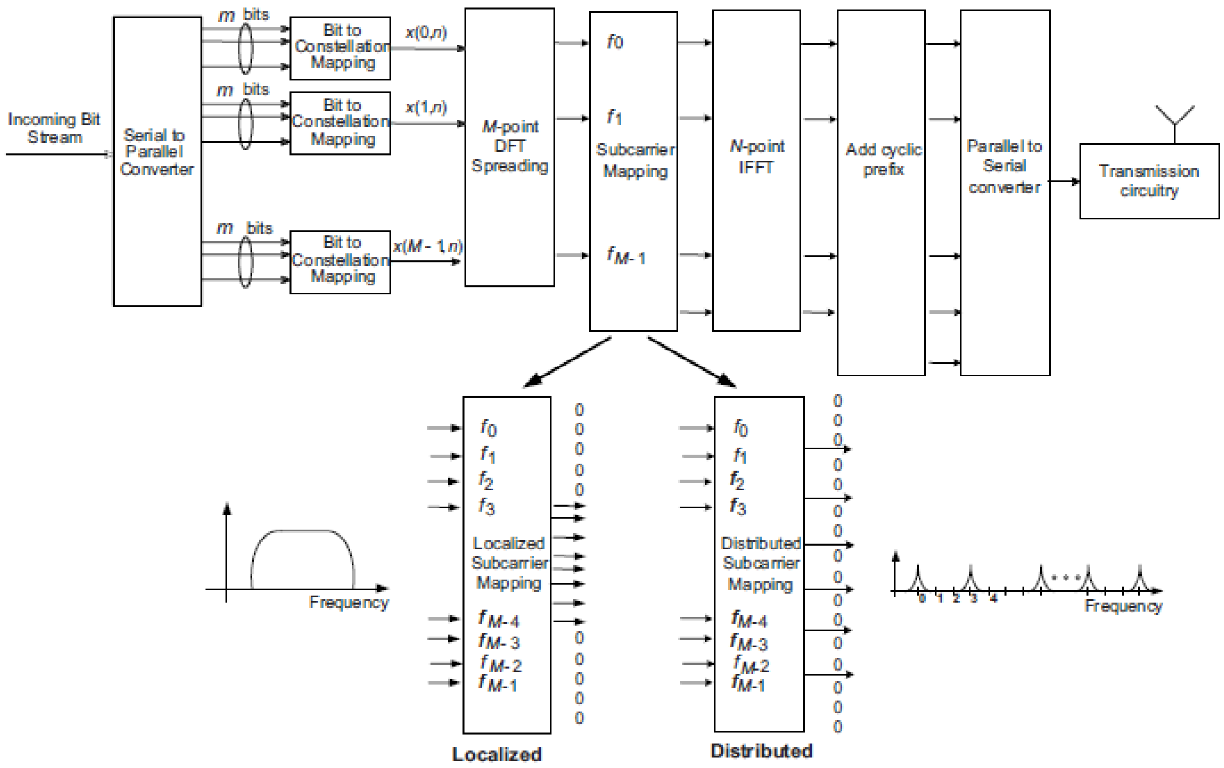
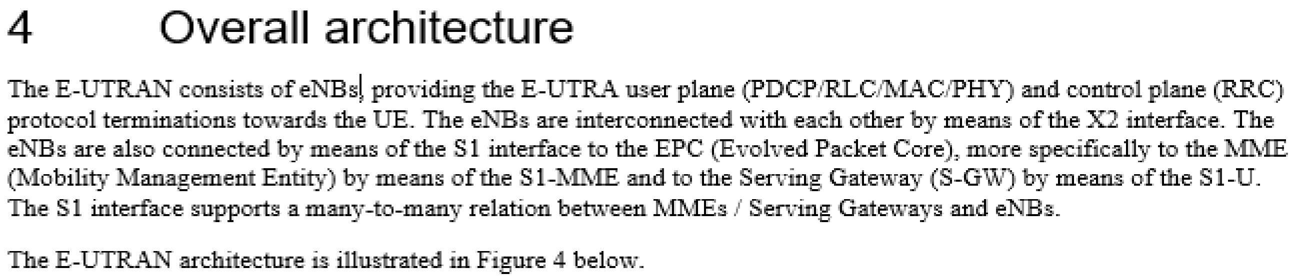


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, Mercedes's Accused Instrumentalities meet the preamble of claim 11 of the '908 patent. *E.g.,* Mercedes's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Mercedes offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

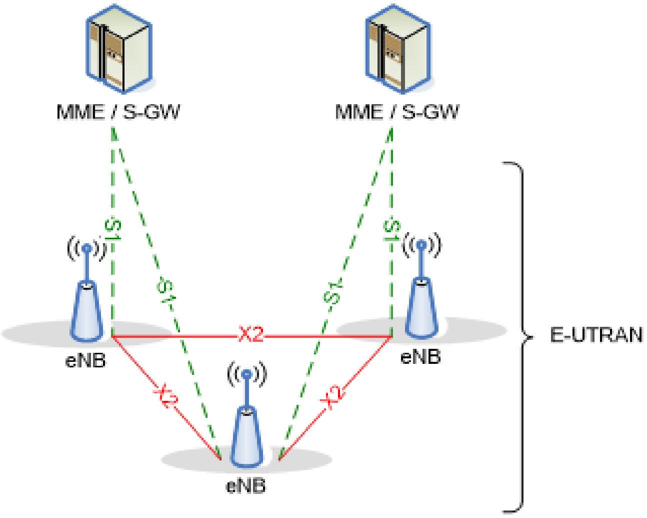


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

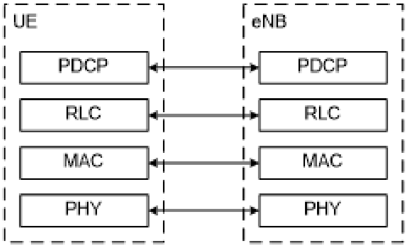


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

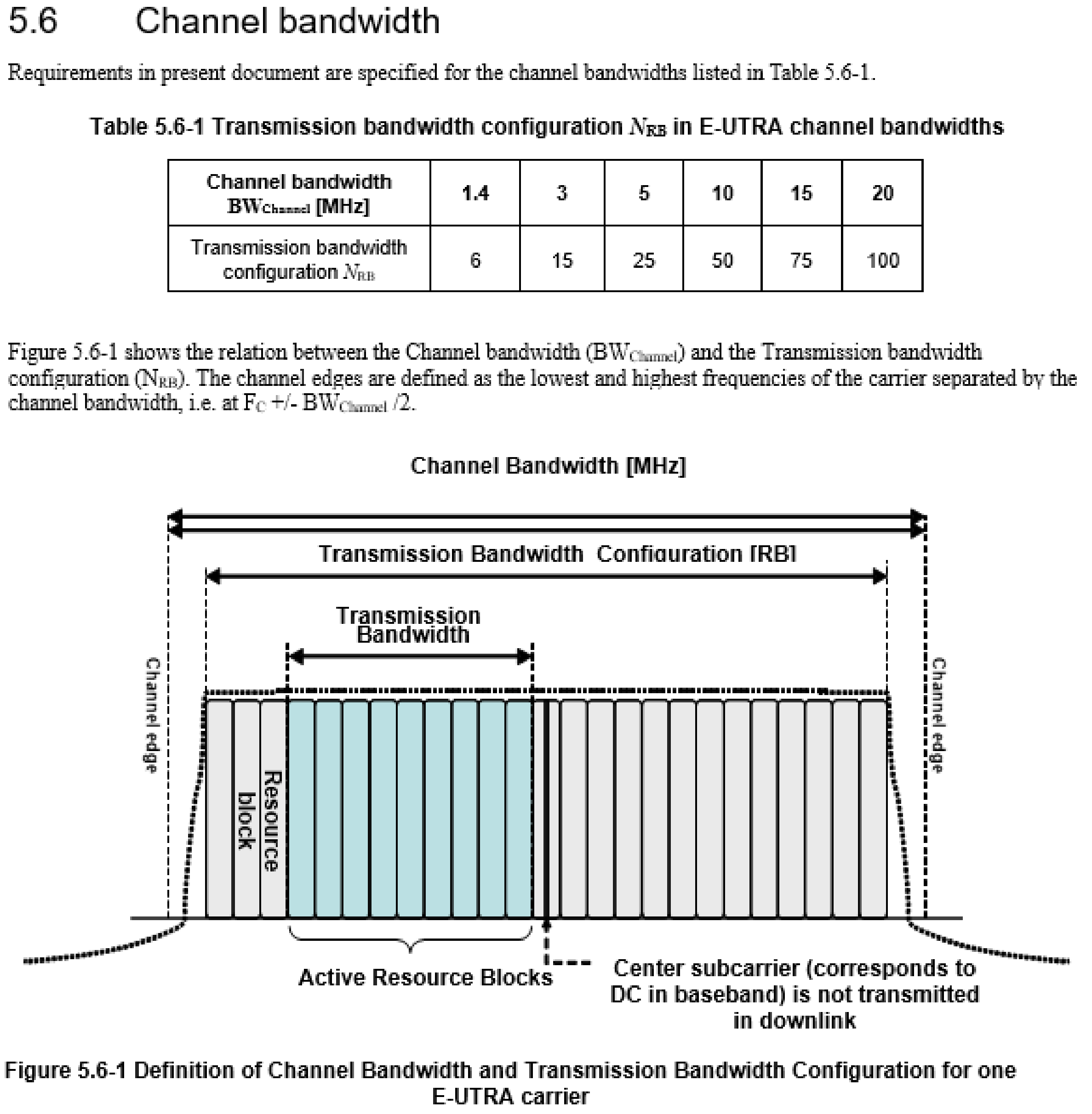
US Patent No. 10,833,908: Claim 11(b)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	Mercedes’s Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

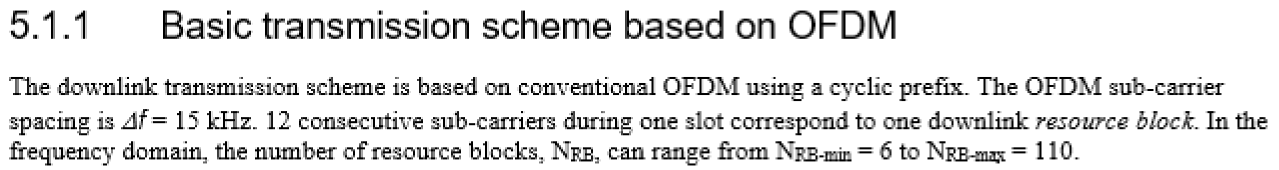
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

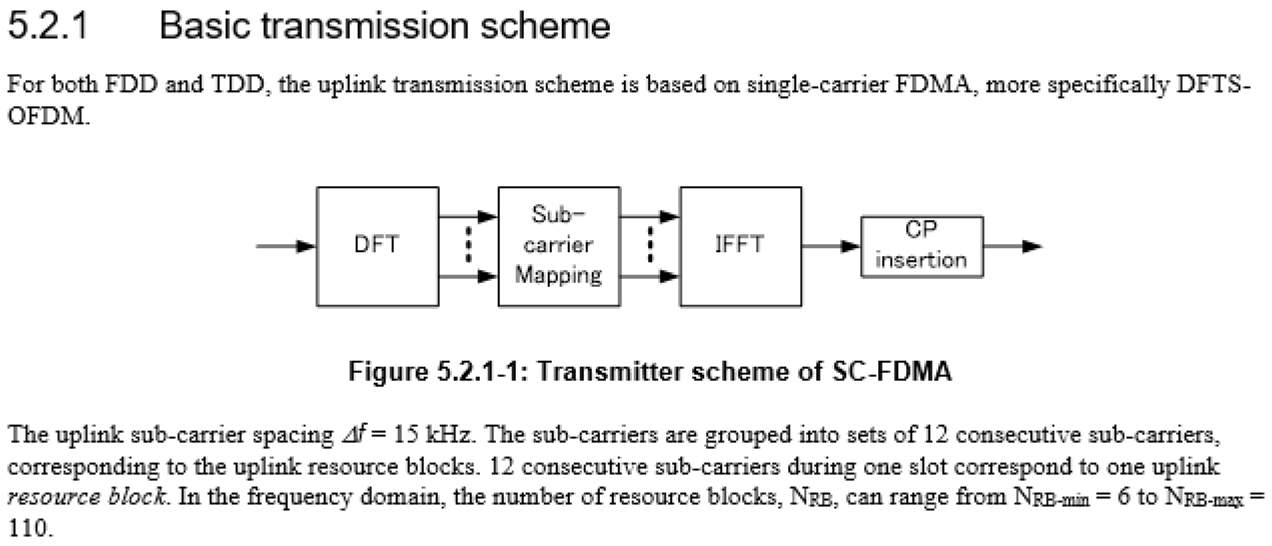
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

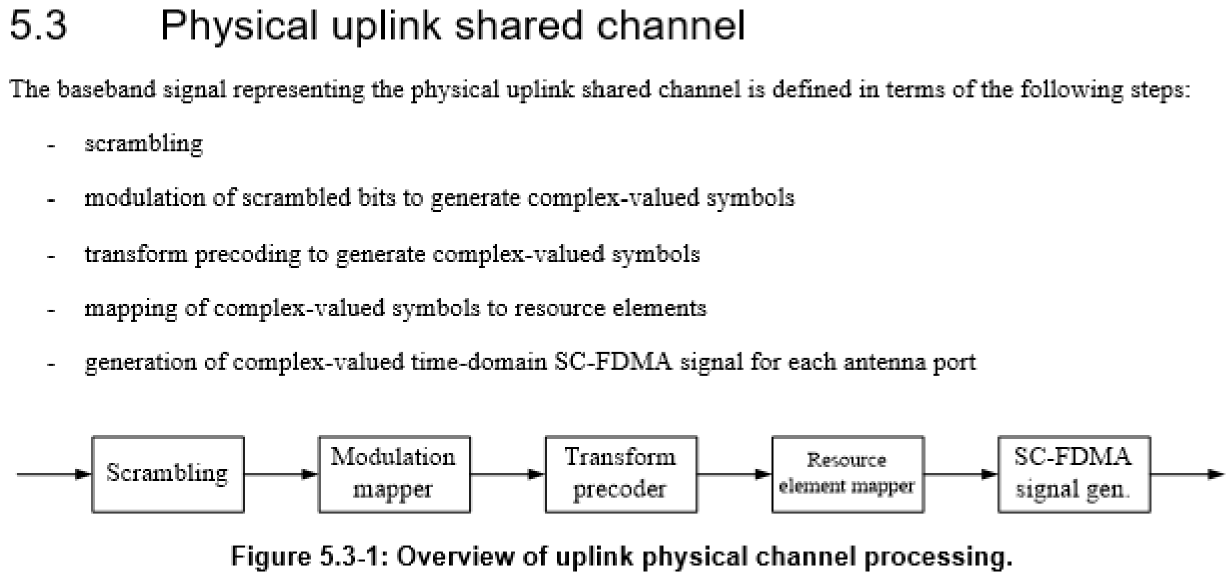
The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

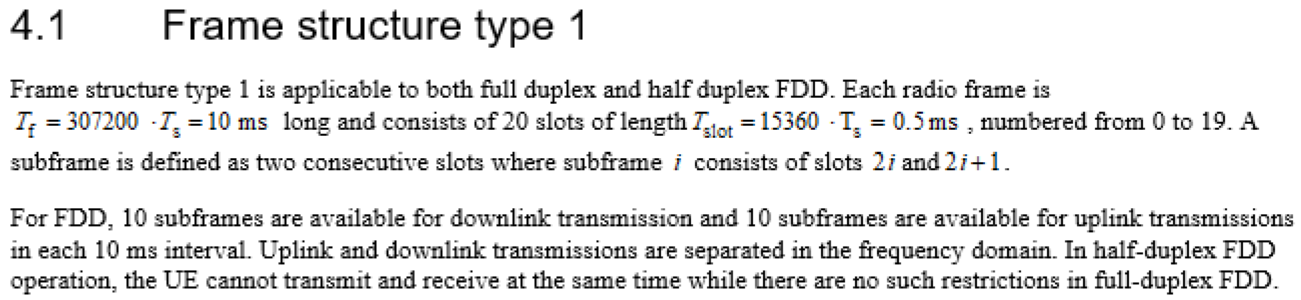
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

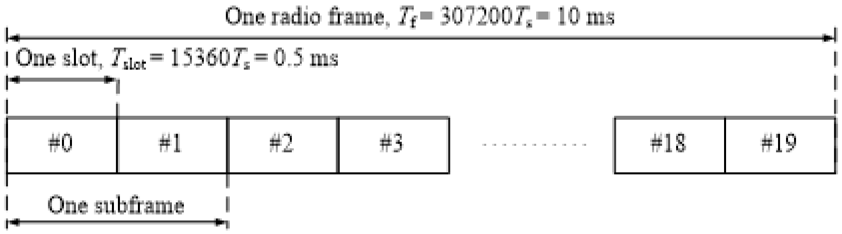
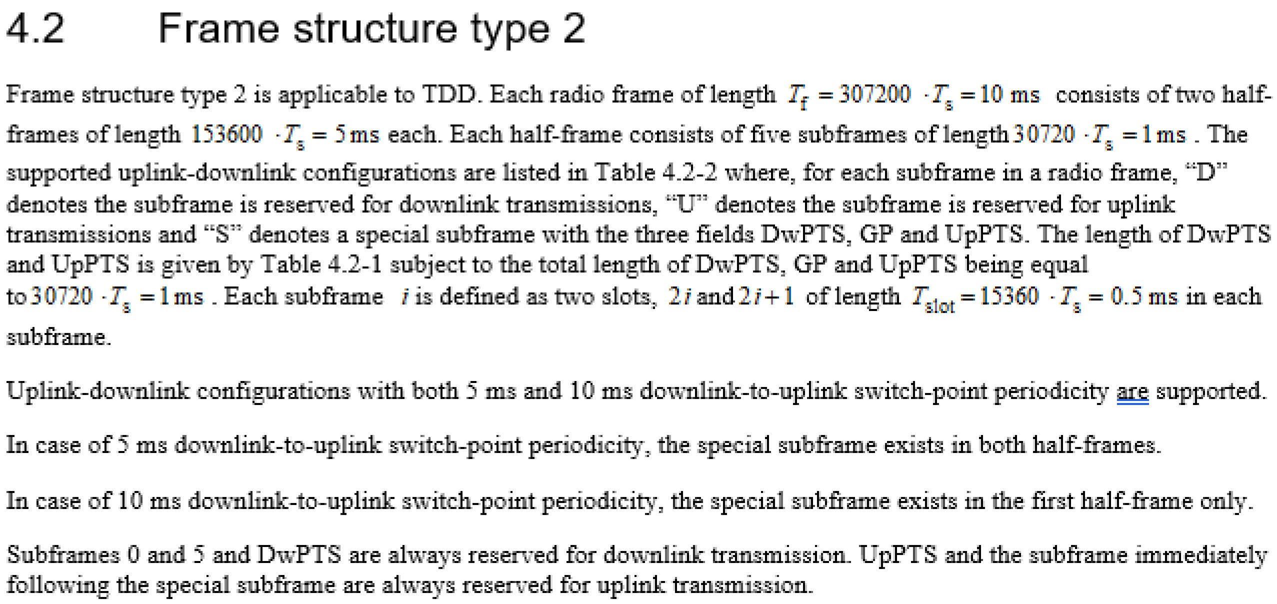


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

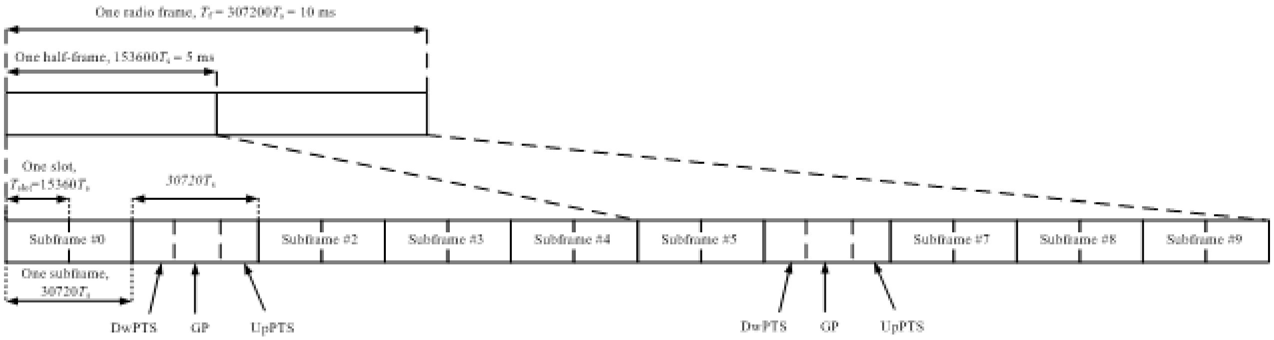
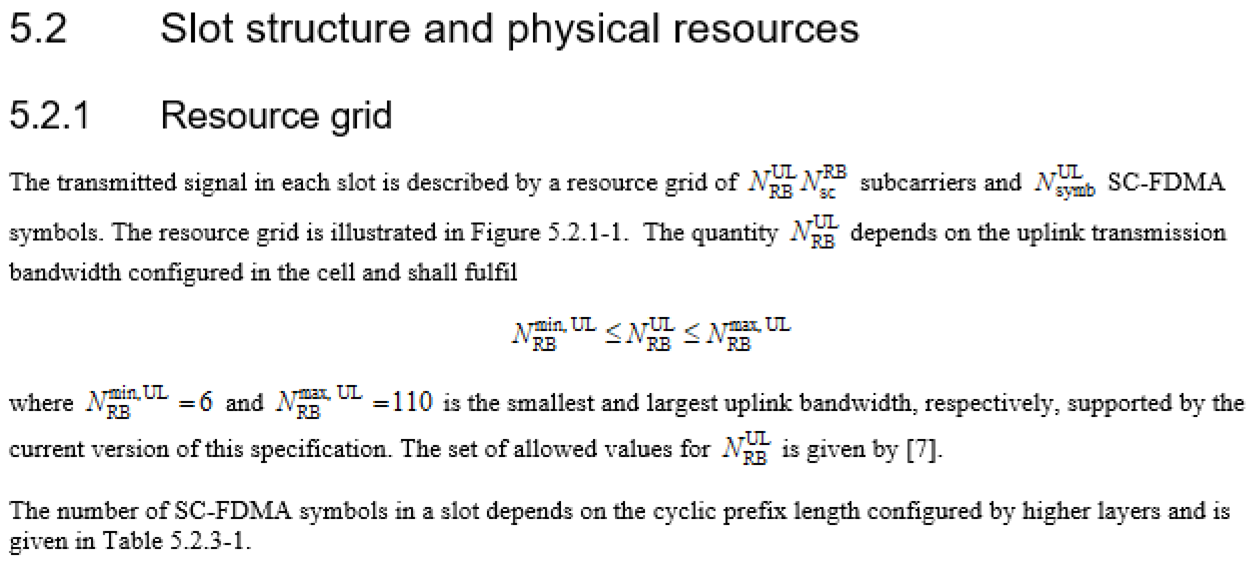


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

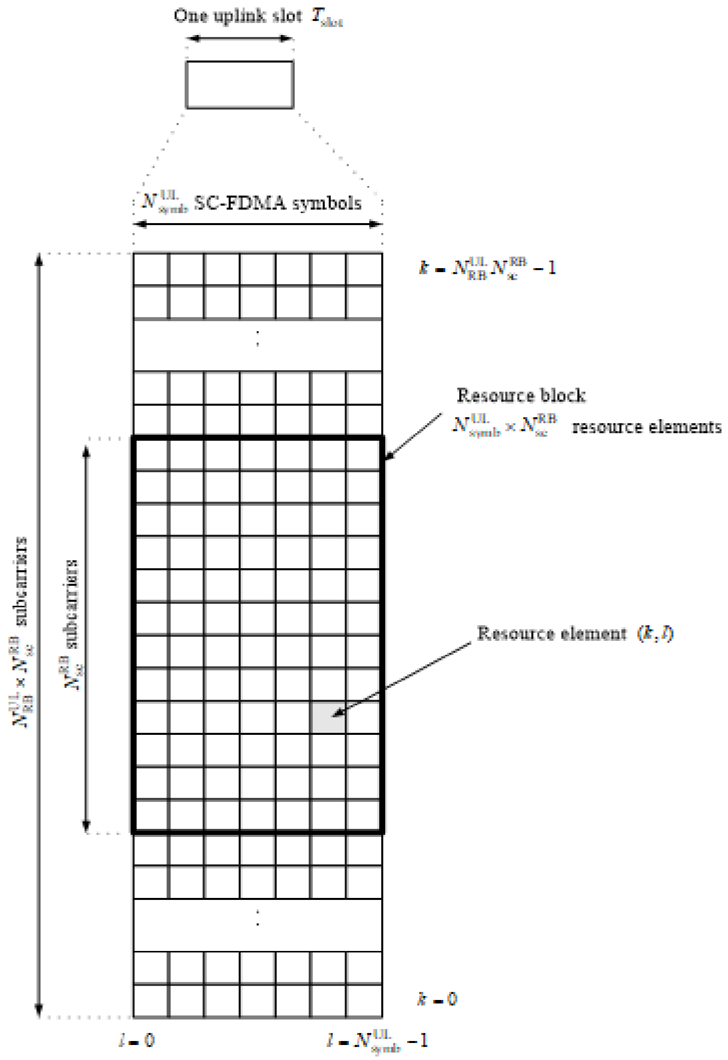
The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

$$N_{\mathrm{RB}}^{\min,\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$$

where $N_{\mathrm{RB}}^{\min,\mathrm{UL}} = 6$ and $N_{\mathrm{RB}}^{\max,\mathrm{UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

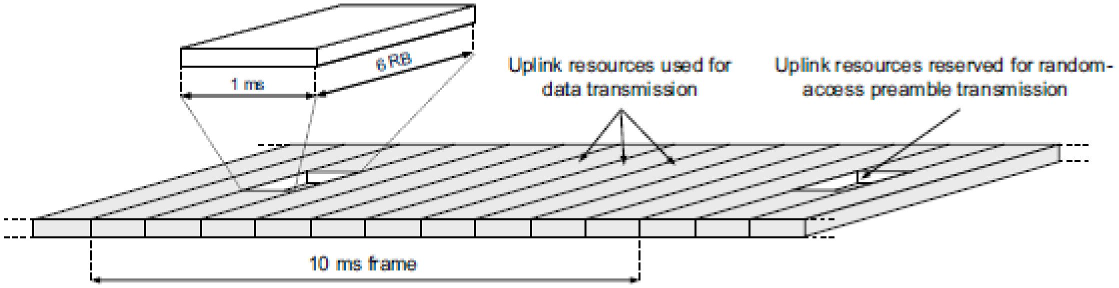
The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 11(b)

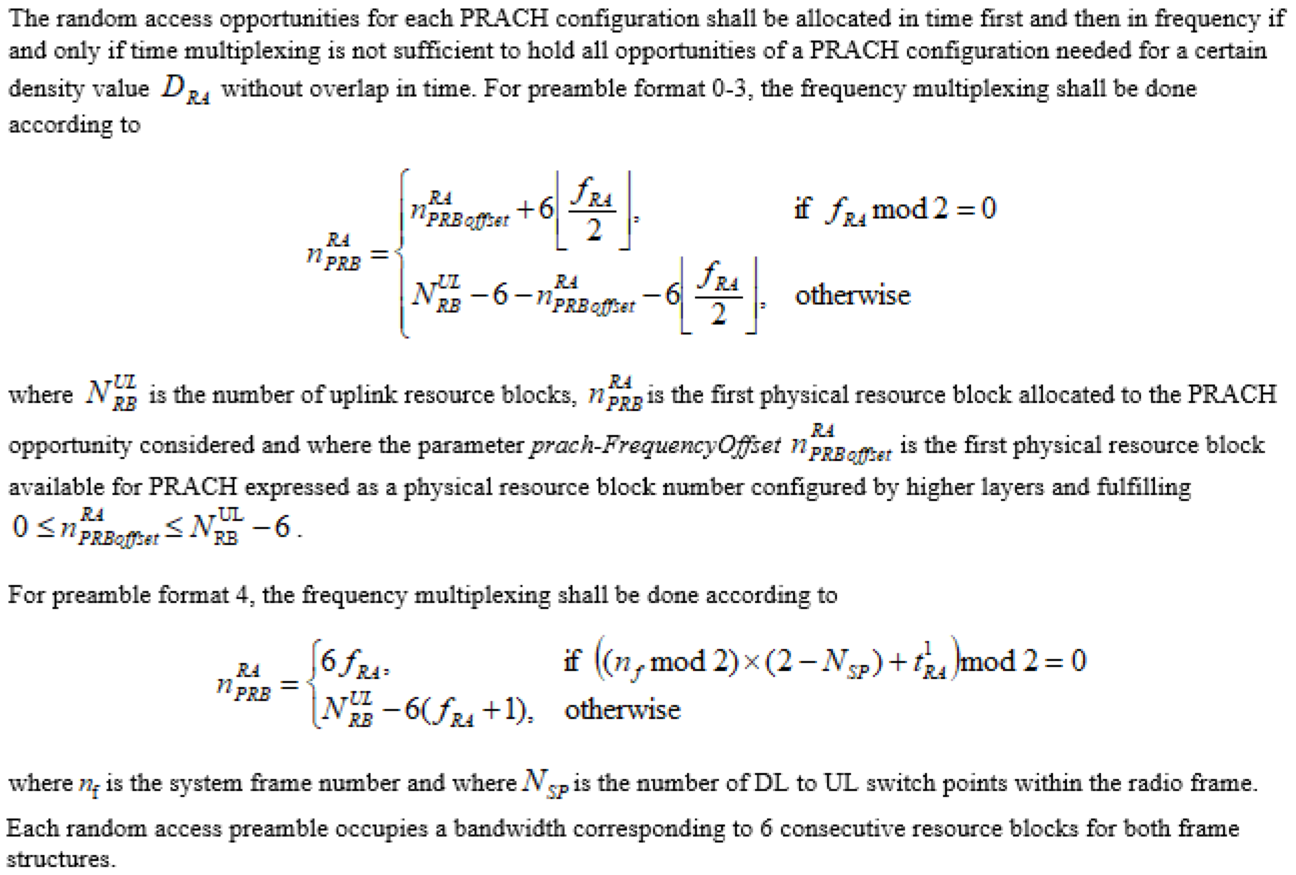
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	Mercedes's Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

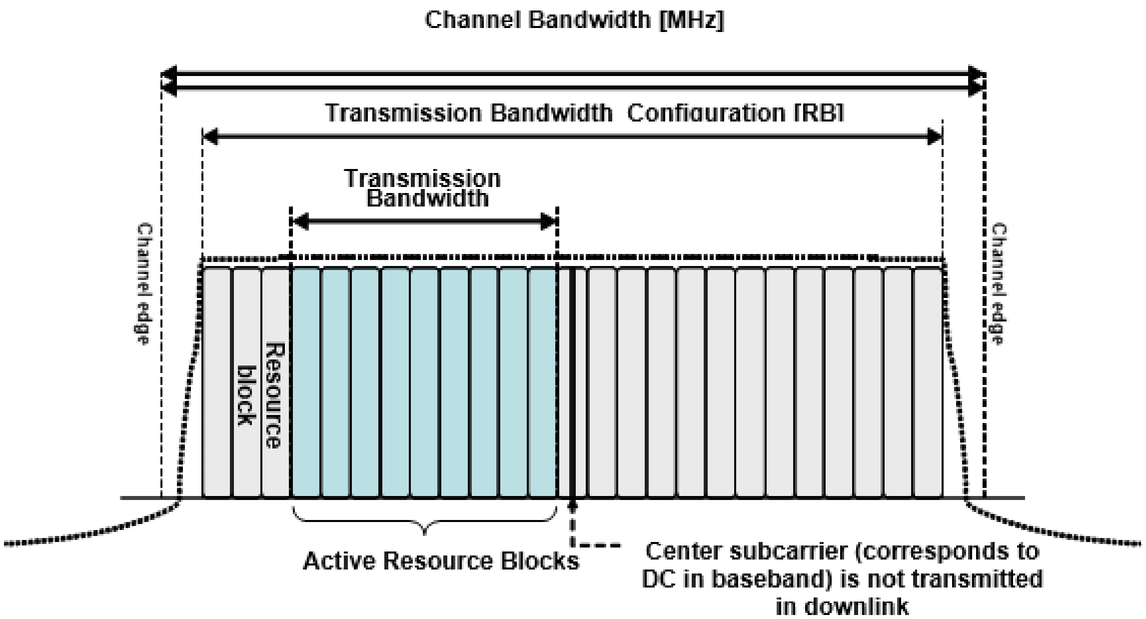
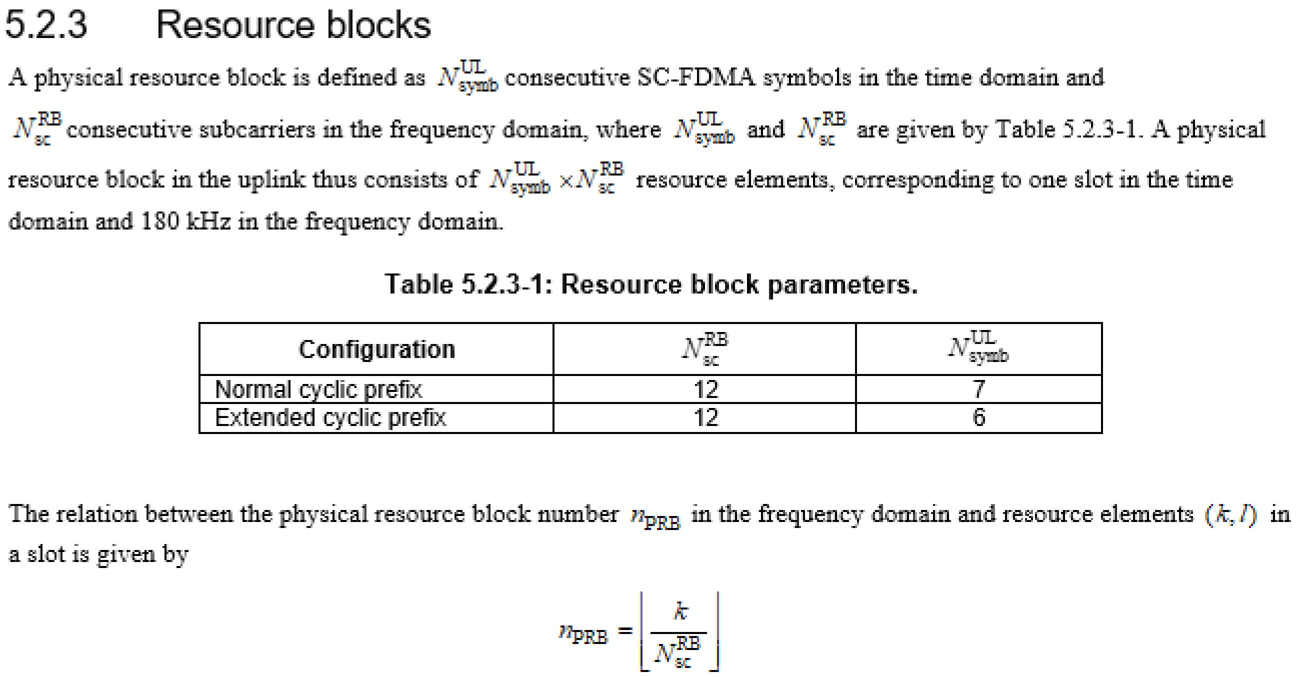


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

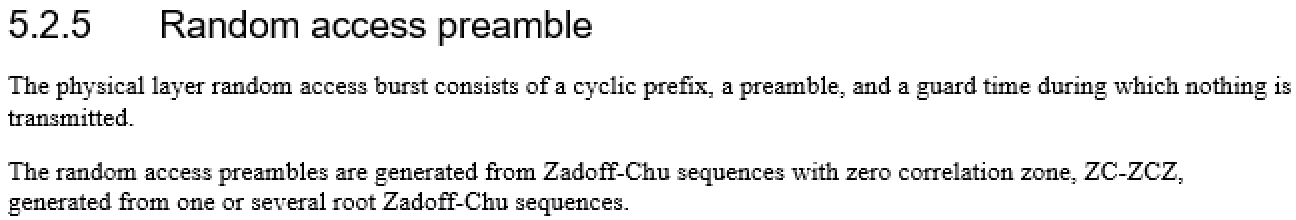
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

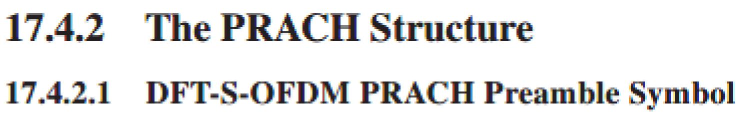


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

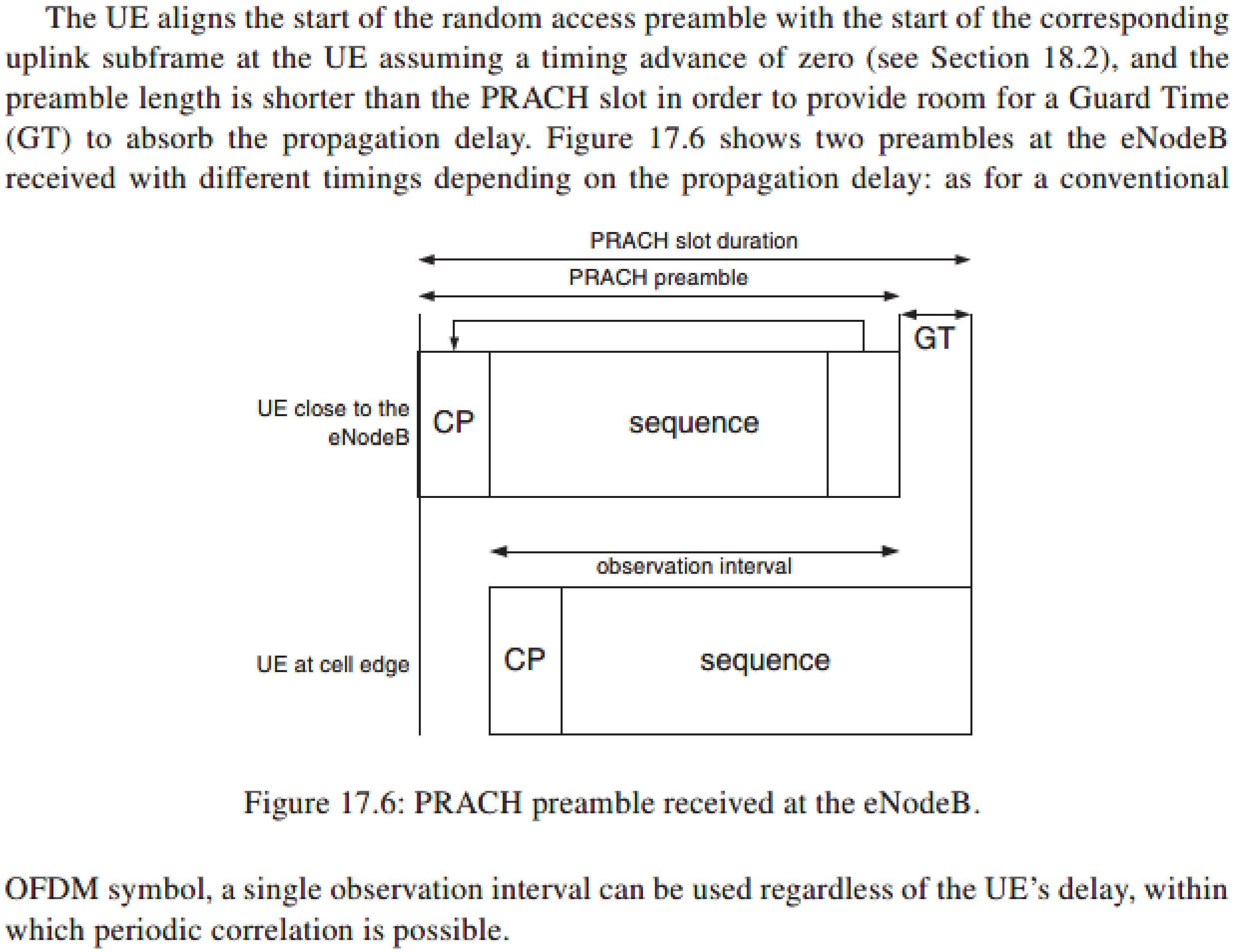


17.4.2 The PRACH Structure

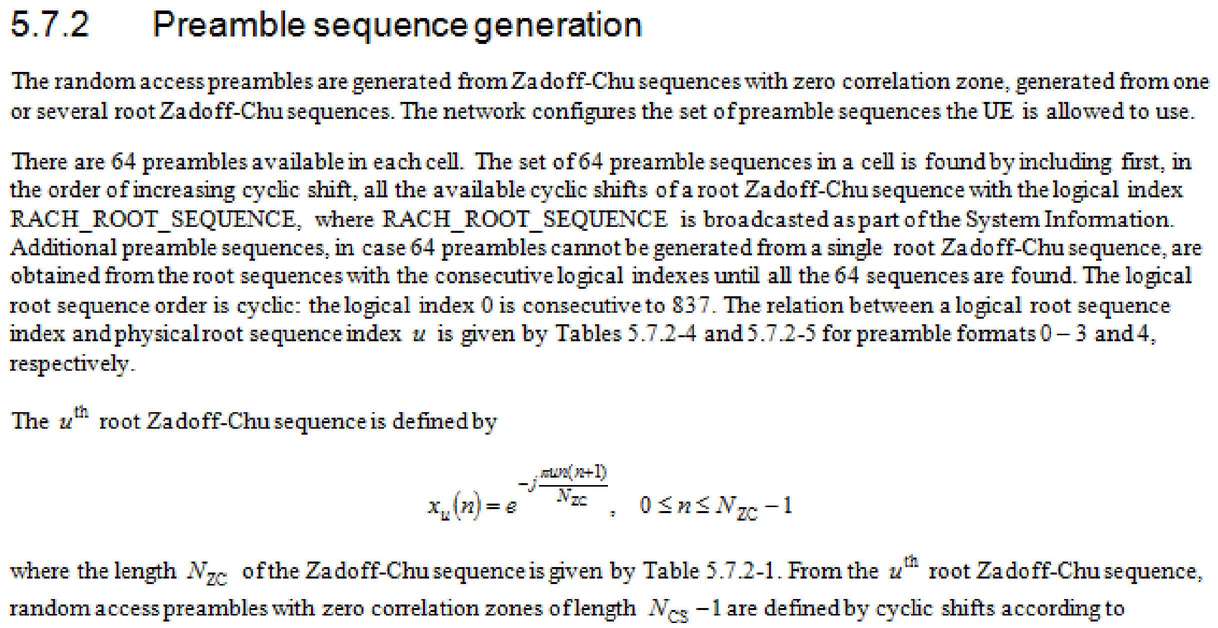
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

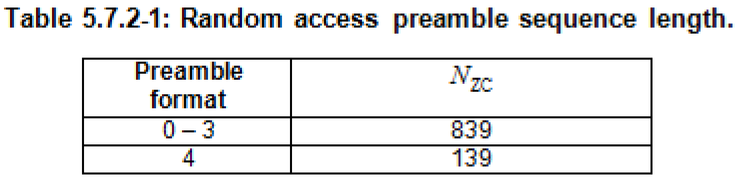
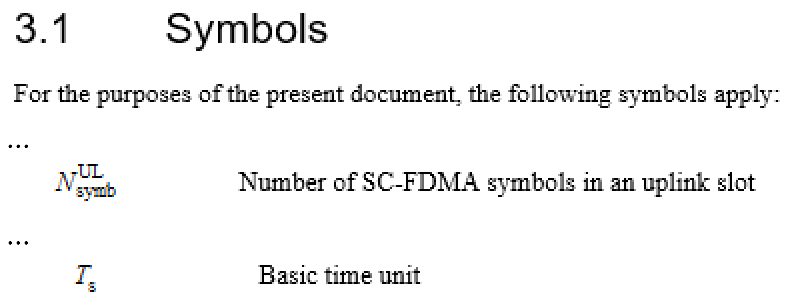
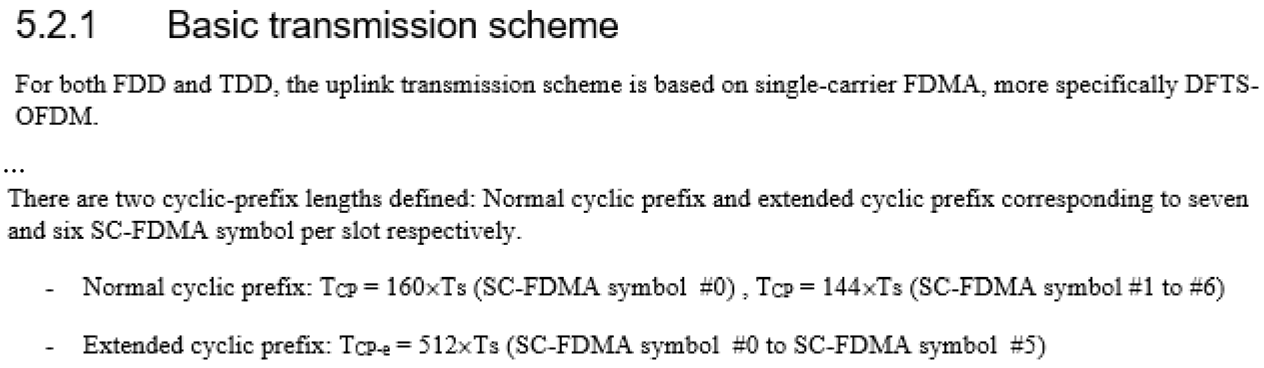


Table 5.7.2-1: Random access preamble sequence length.

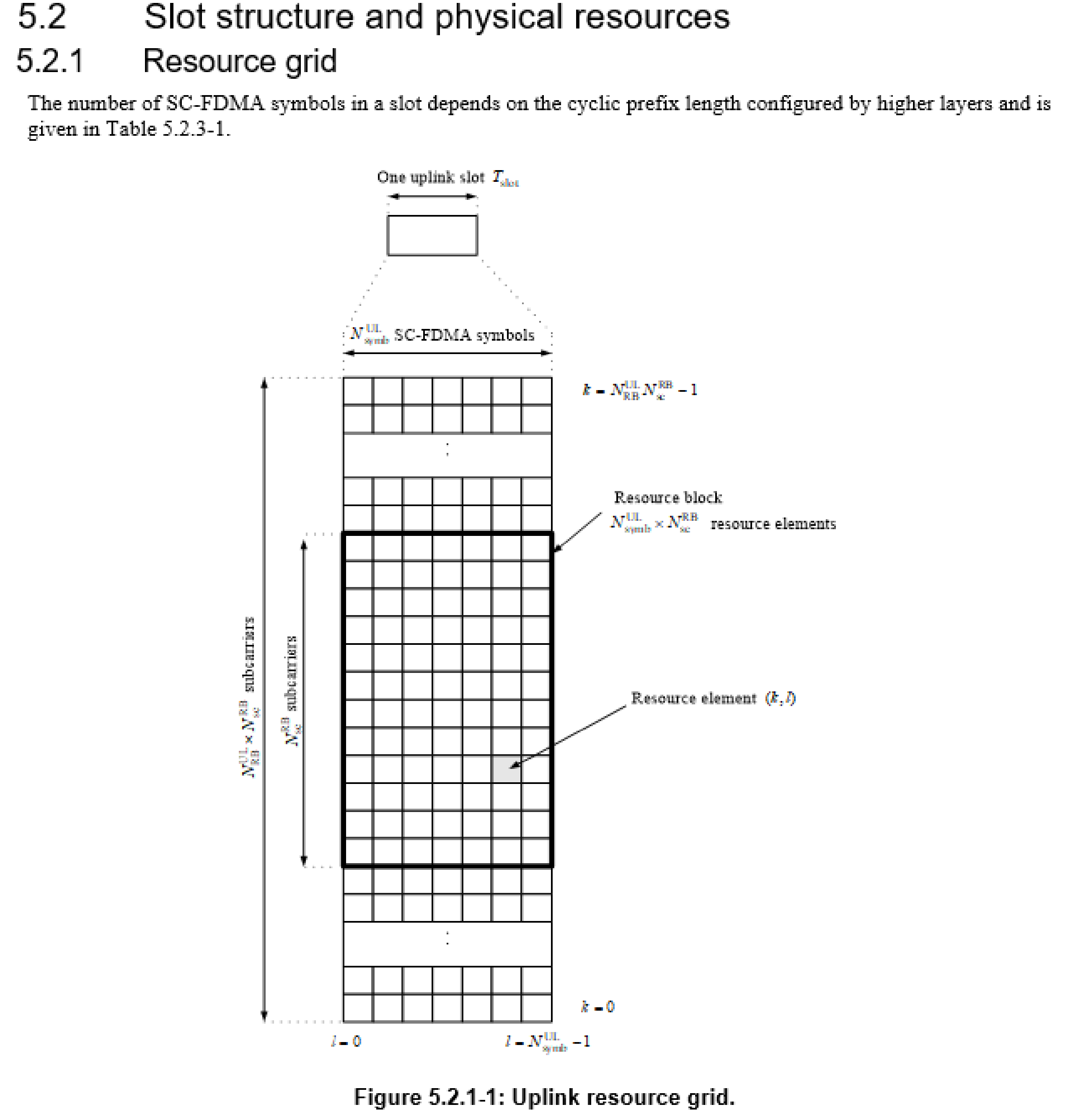
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Mercedes’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_{s} Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{\text{CP-e}}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



5.2 Slot structure and physical resources

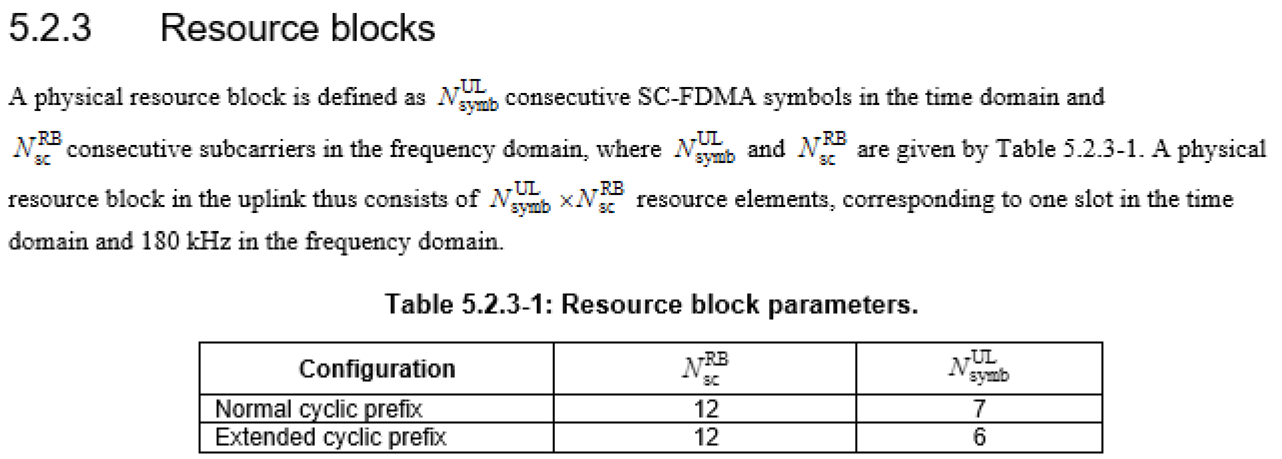
5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

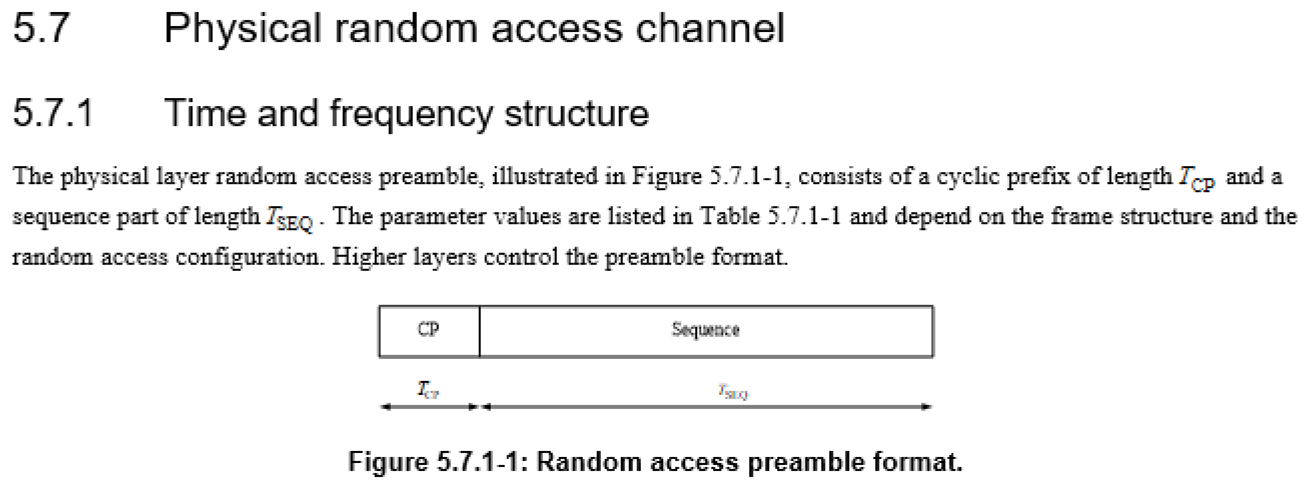
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

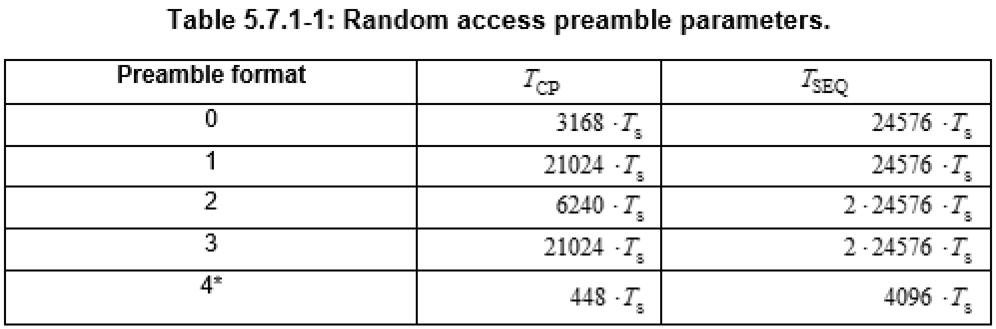
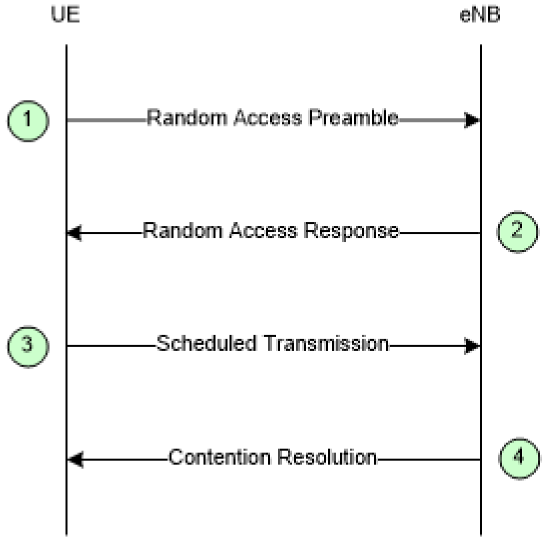


Table 5.7.1-1: Random access preamble parameters.

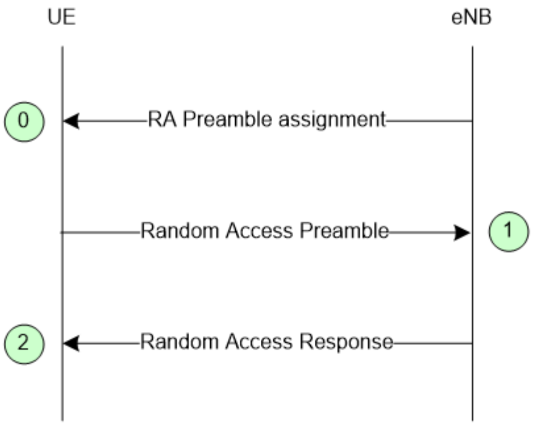
Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

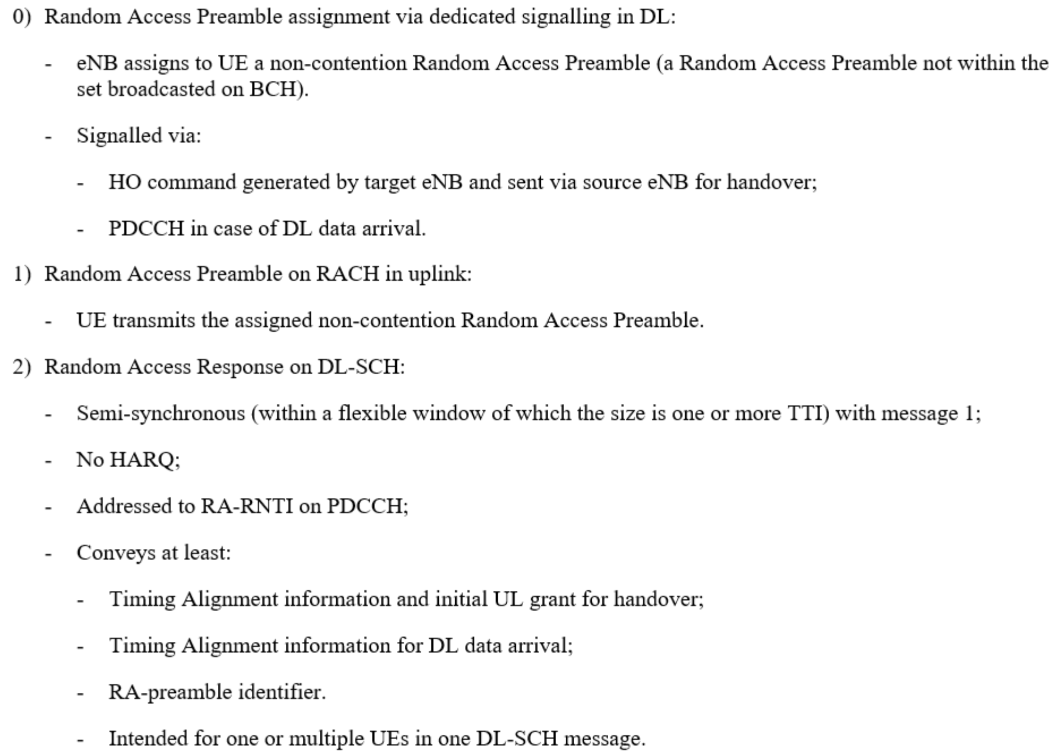
US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

receiving, from the base station, a response message. ;	Mercedes's Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:  **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”

	See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53. 10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
“receiving, from the base station, a response message.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

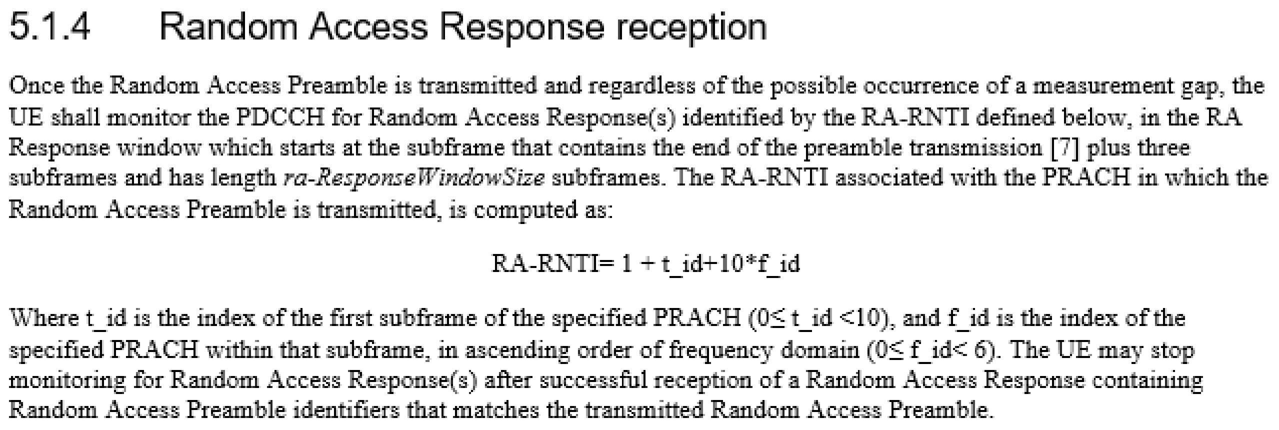
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

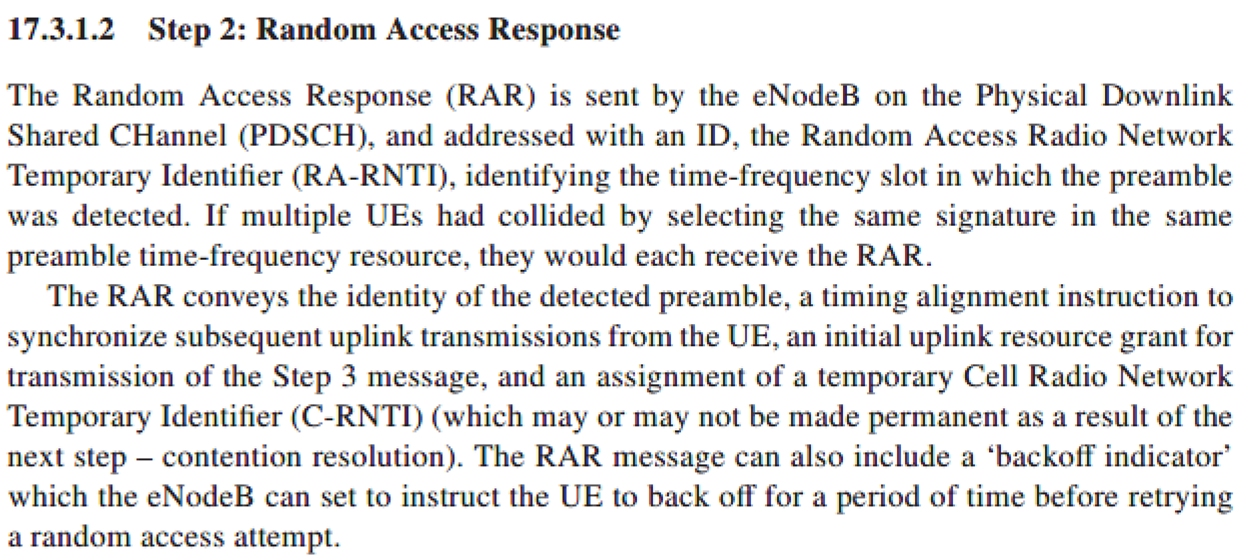
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

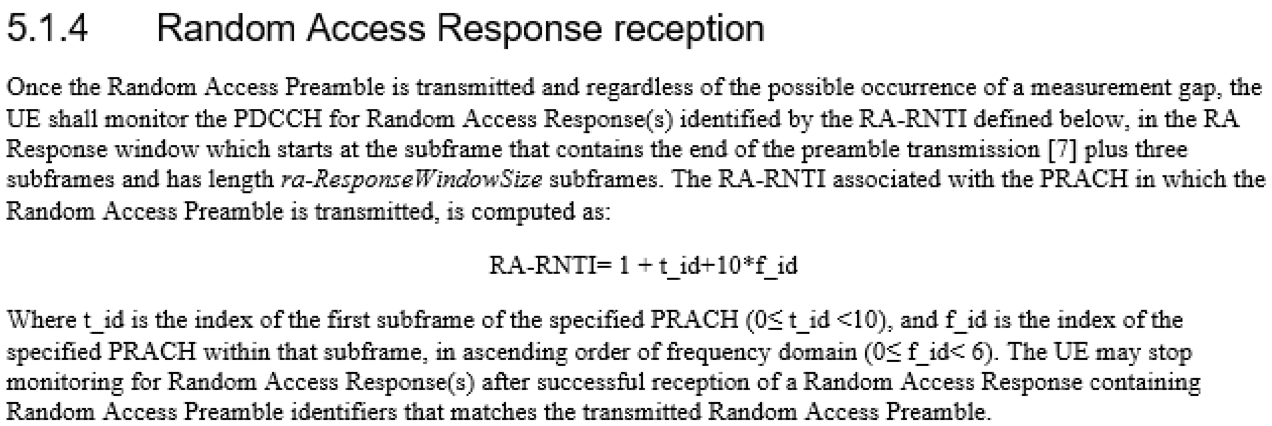
US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

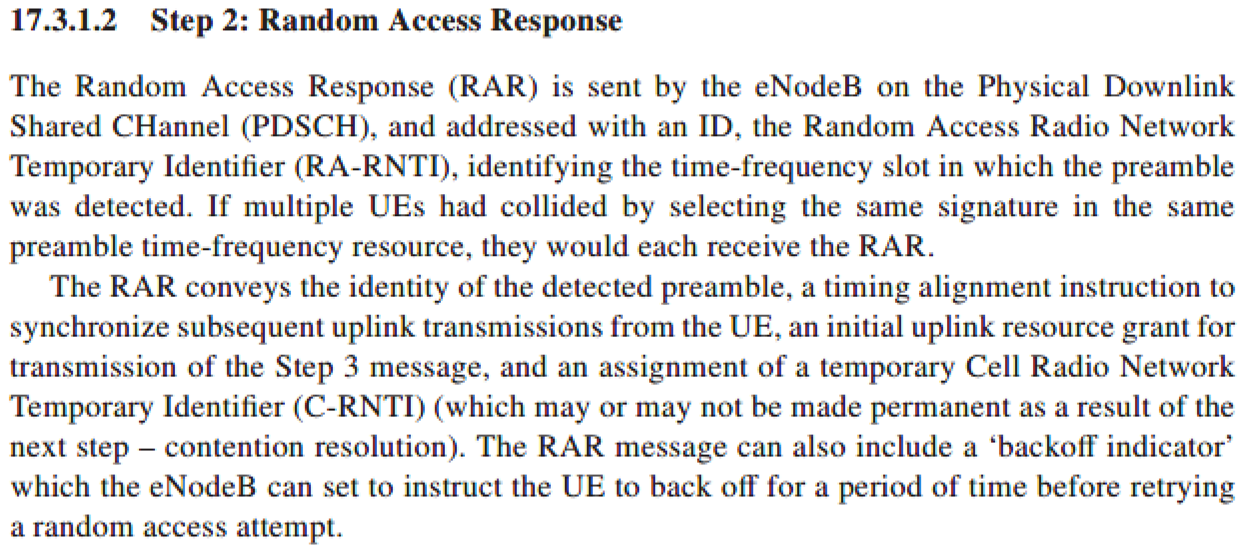
US Patent No. 10,833,908: Claim 12(a)
"The method claim 11, further comprising:"

12. The method claim 11, further comprising:	*See* Claim 11.

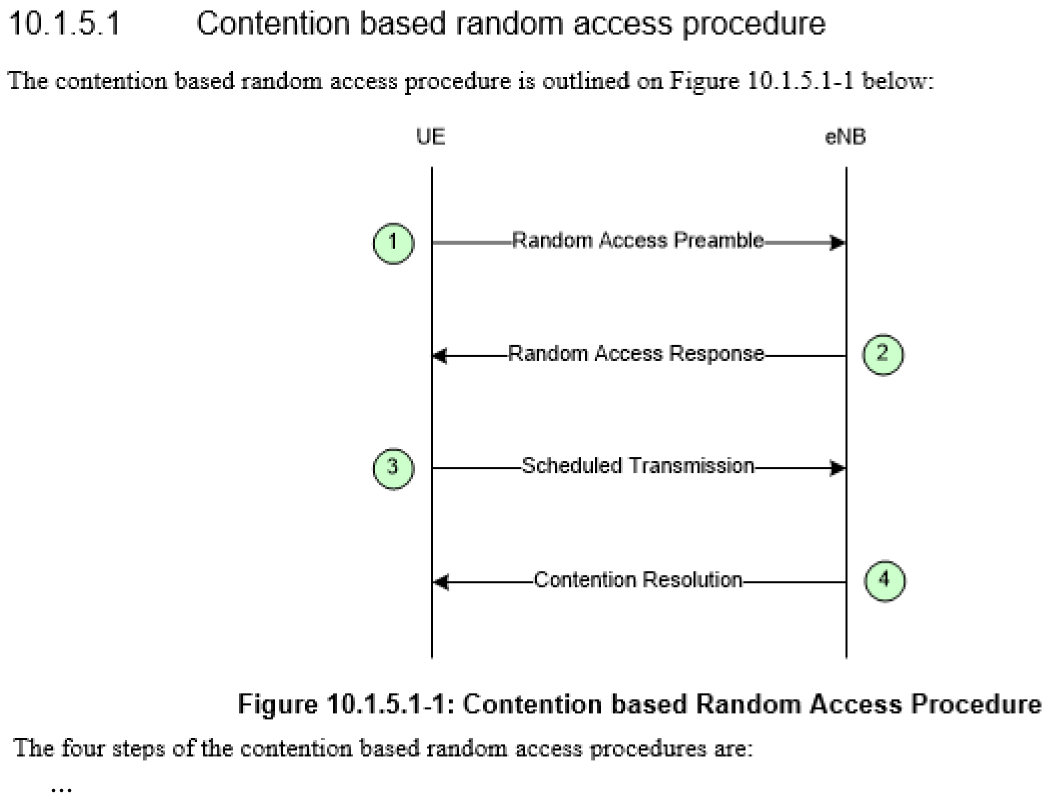
US Patent No. 10,833,908: Claim 12(b)
"determining if the response message identifies the sequence associated with the base station in the random access signal; and"

determining if the response message identifies the sequence associated with the base station in the random access signal; and	Mercedes's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI} = 1 + \text{t\_id} + 10 * \text{f\_id}$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le \text{t\_id} < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le \text{f\_id} < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Mercedes's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: ...

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

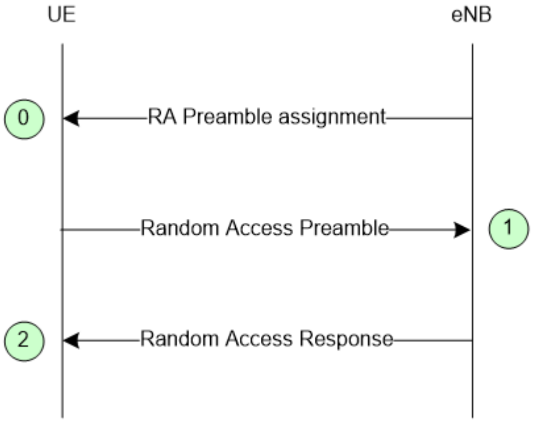
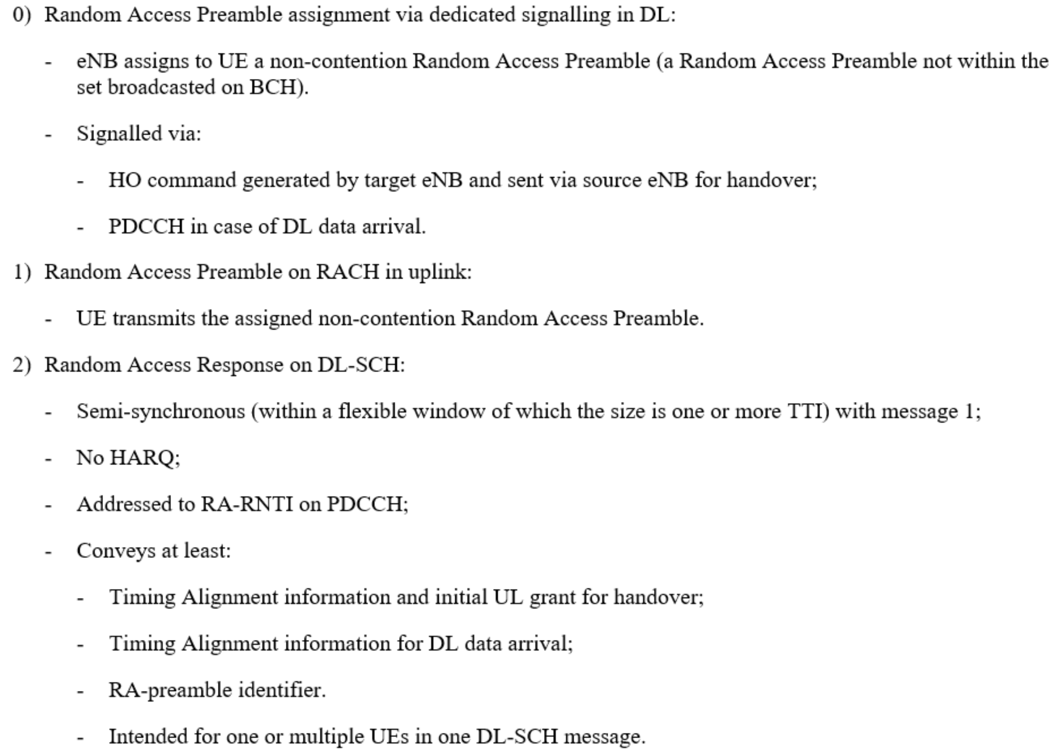


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

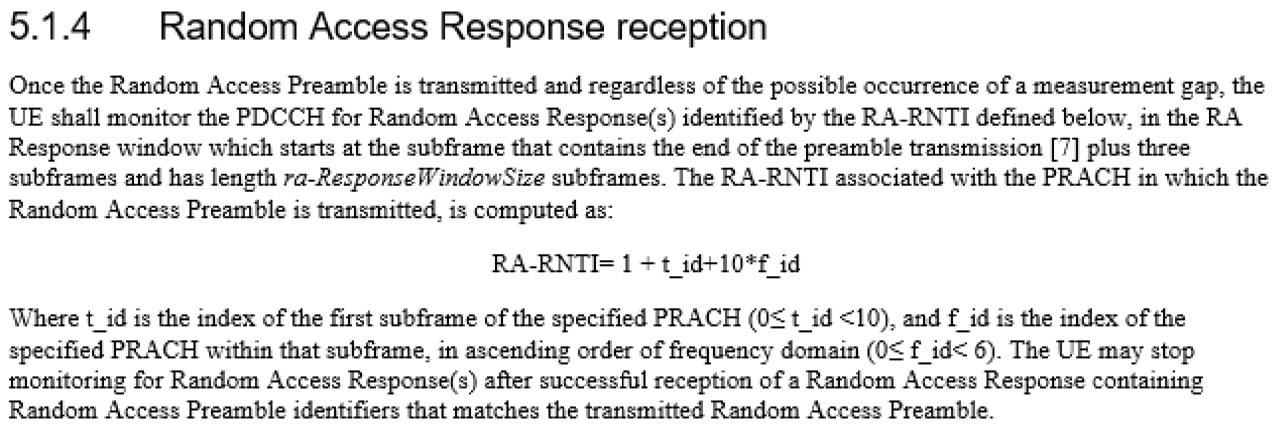
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

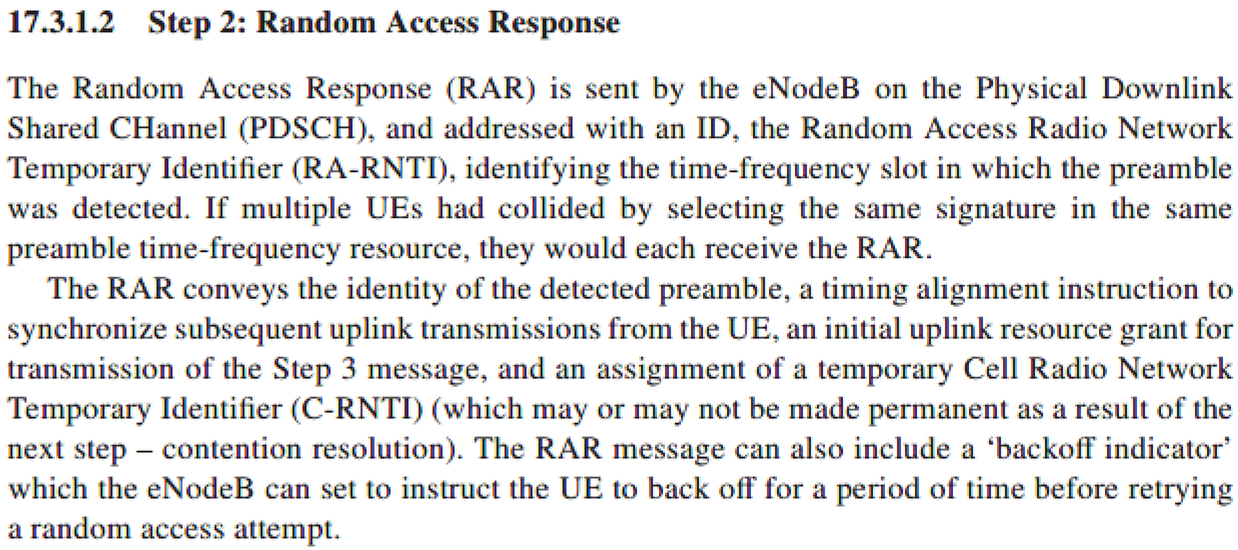
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10*f\_id$$

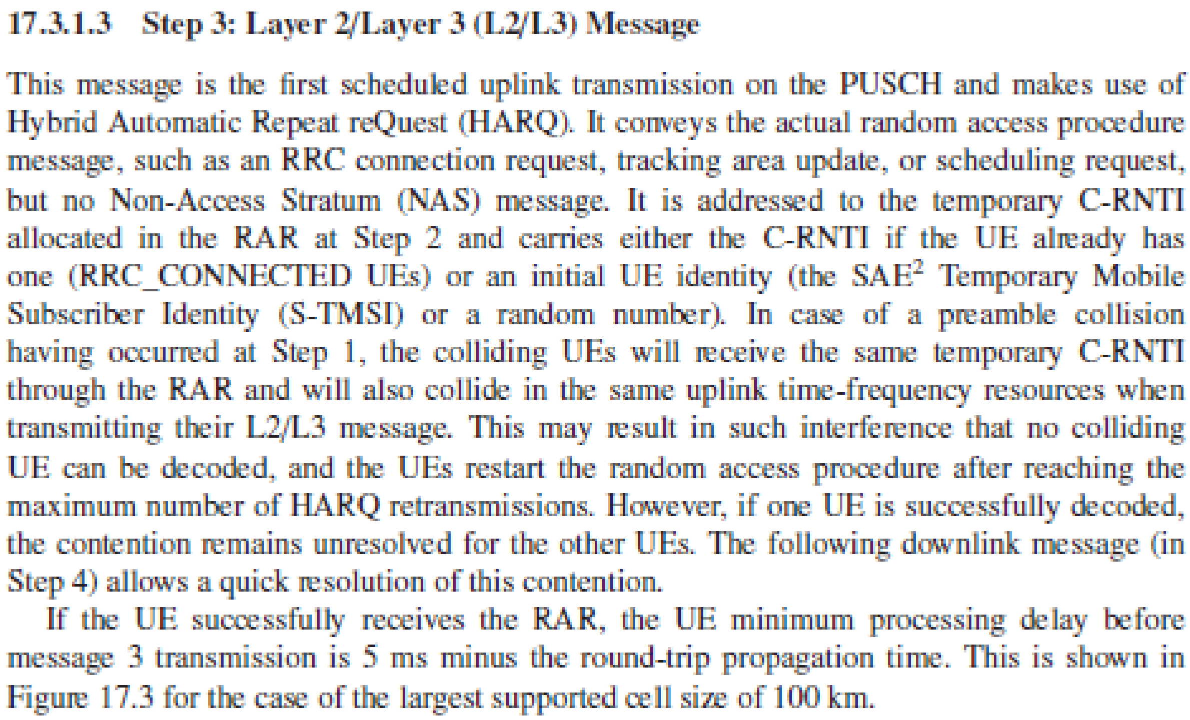
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message

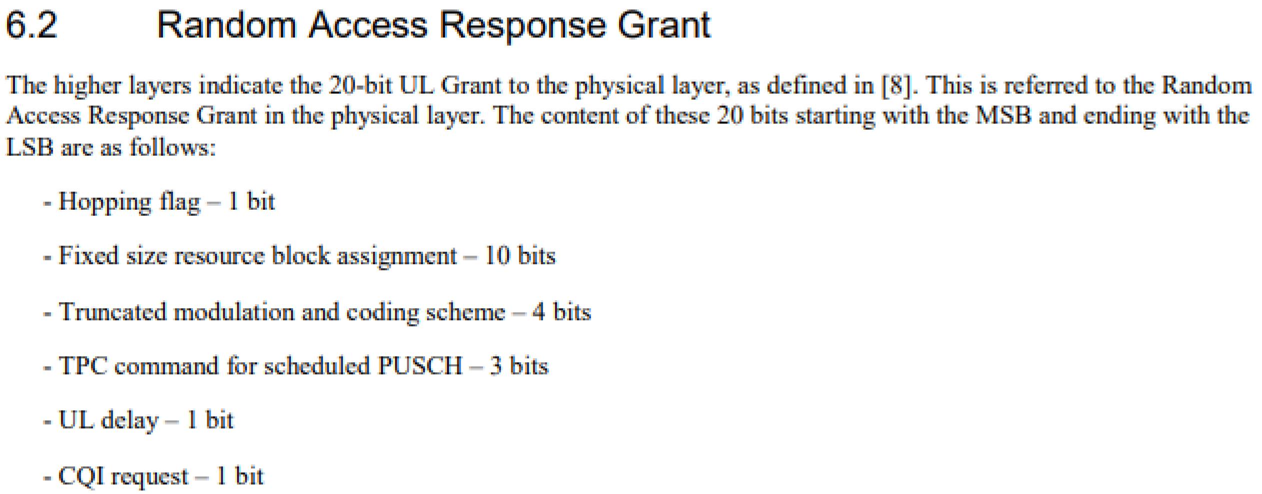
This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention.

If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km.

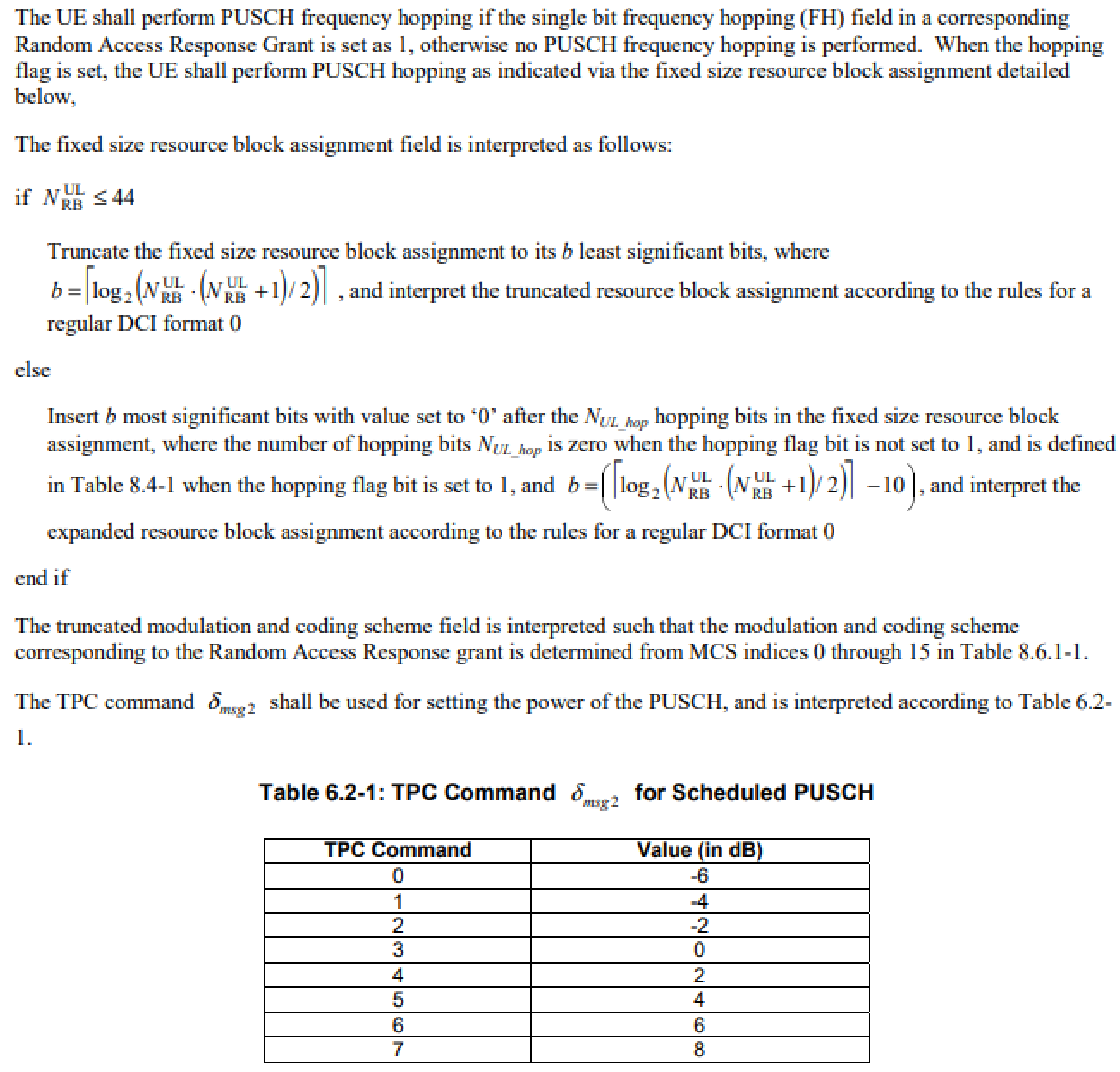
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

See also Claim 2.

US Patent No. 10,833,908: Claim 13(a)
"The method of claim 12, wherein the response message includes power adjustment information and"

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by Mercedes's Accused Instrumentalities includes power adjustment information. *E.g.,* The response message can include an uplink grant with power adjustment information, such as TPC:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)
“The method of claim 12, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

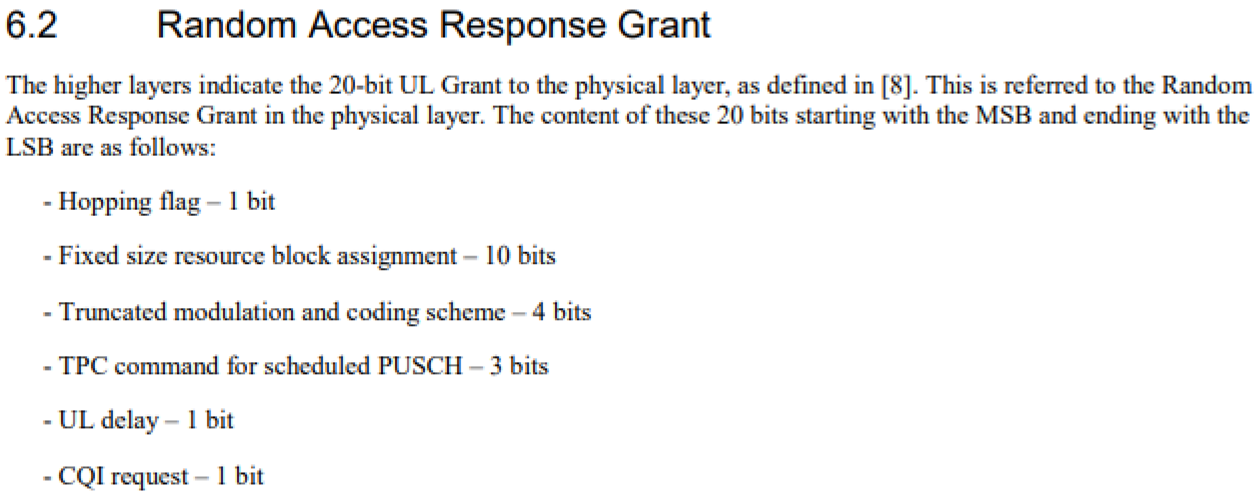
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

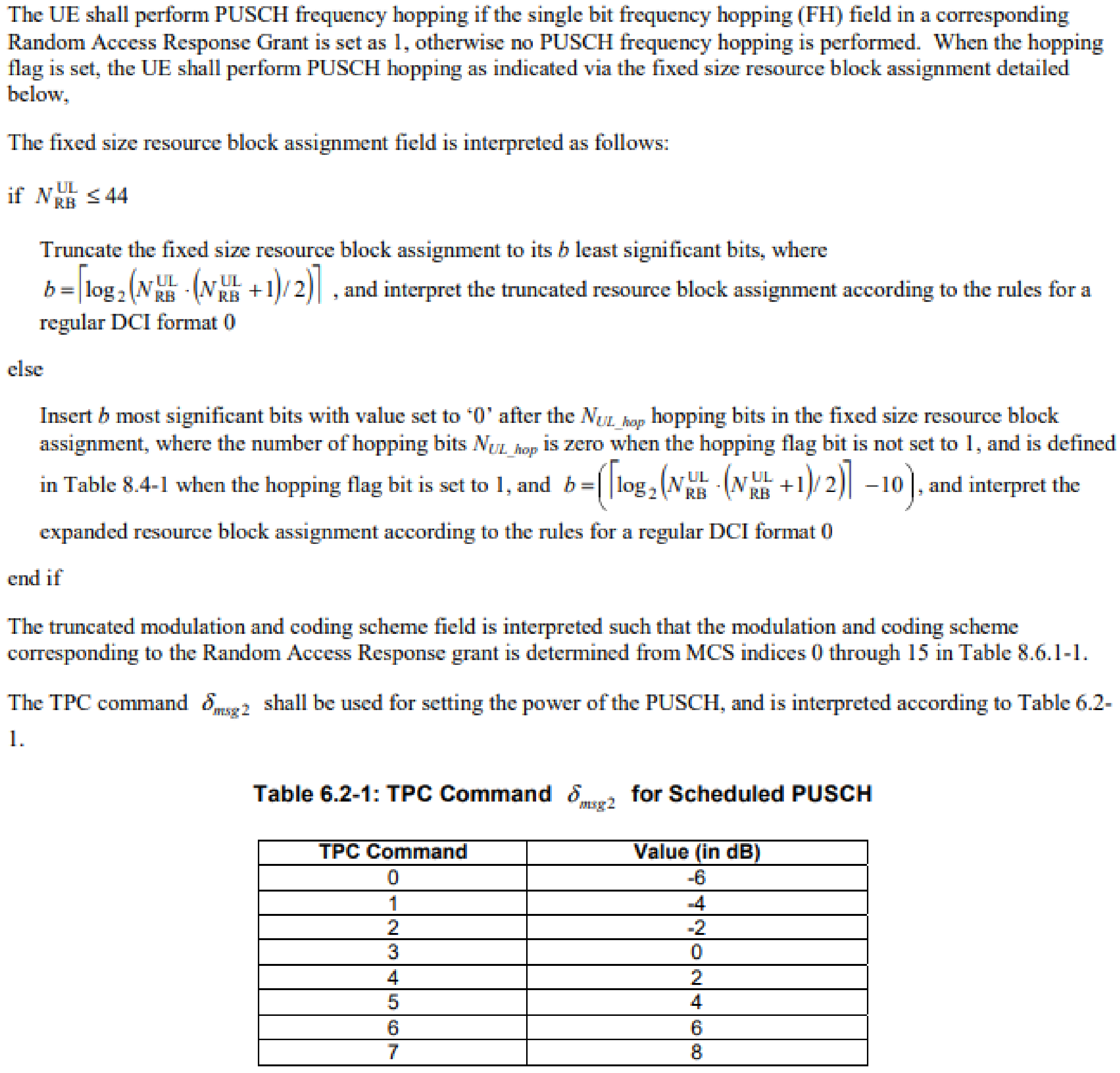
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 13(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”

wherein the second uplink signal is transmitted according to the power adjustment information.	Mercedes’s Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  **6.2 Random Access Response Grant** The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

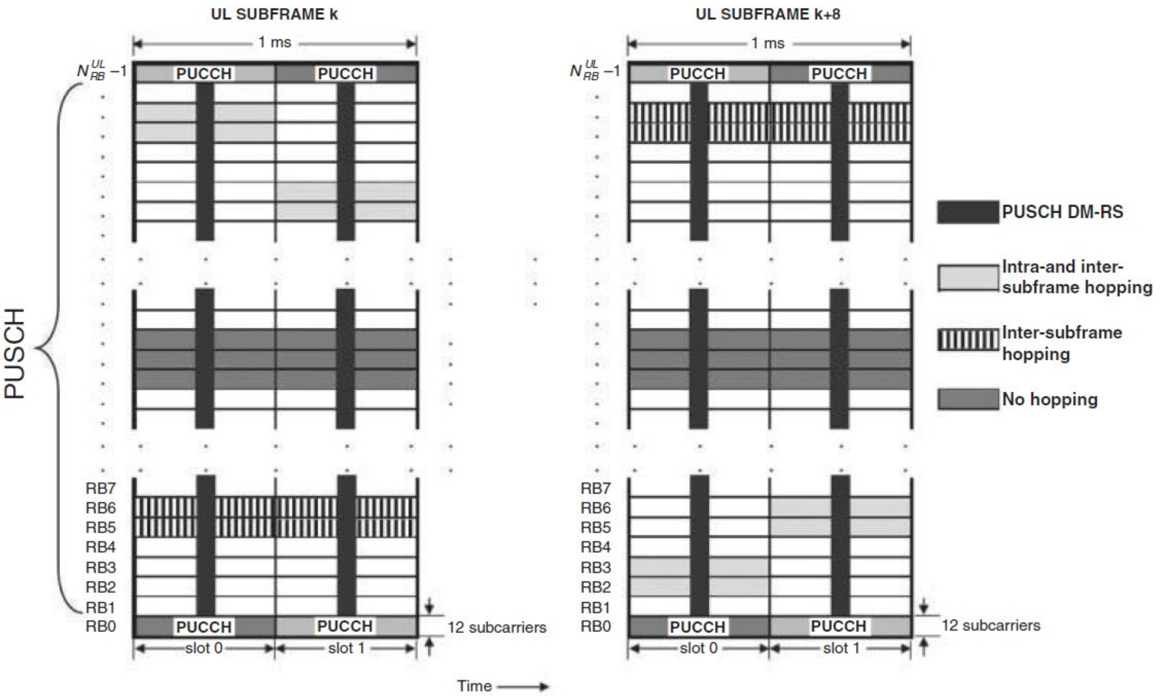
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 14

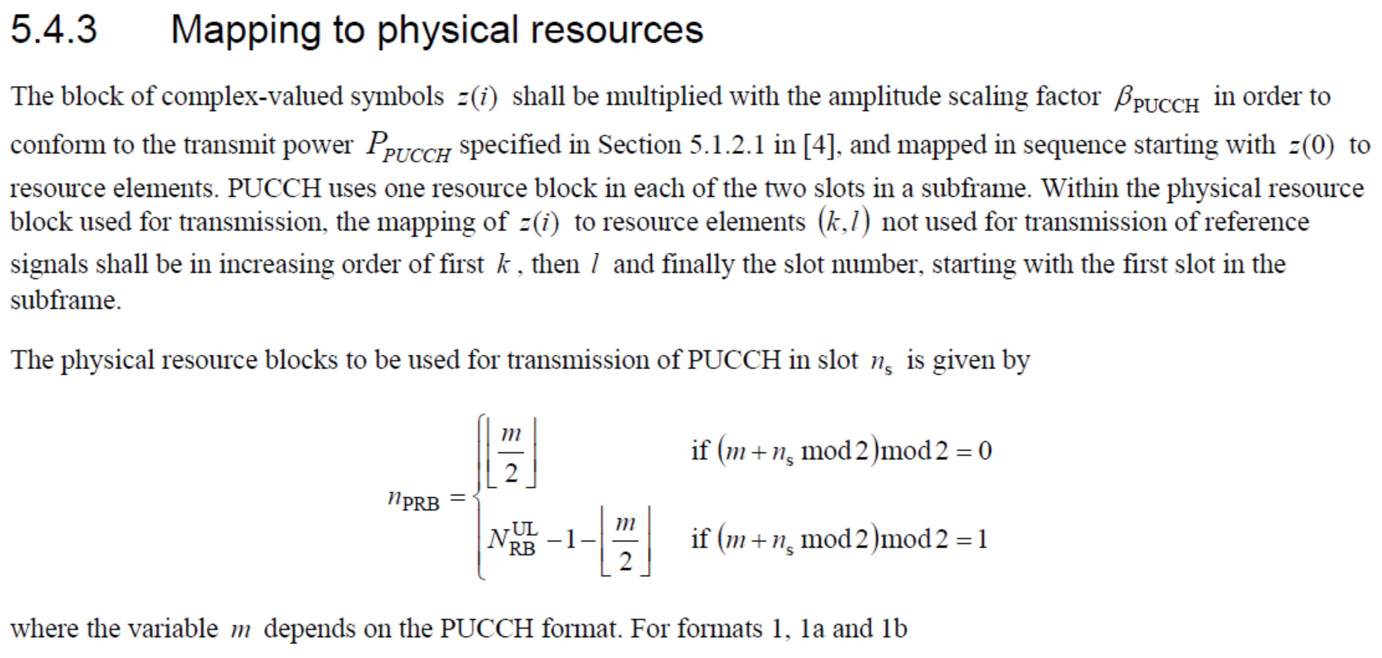
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Mercedes's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 11. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

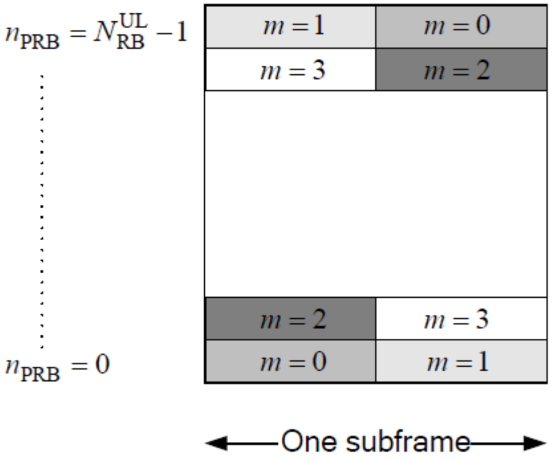


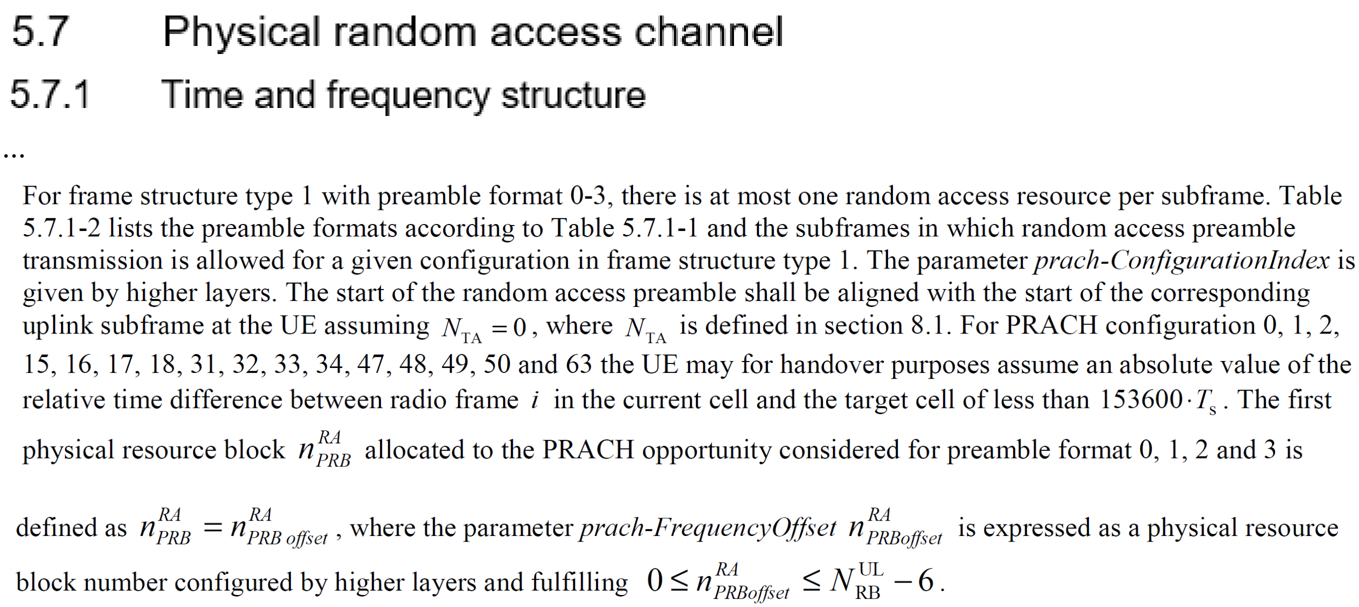
Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\mathrm{RA}}_{\mathrm{PRBoffset}}$. For FDD, the parameter directly determines

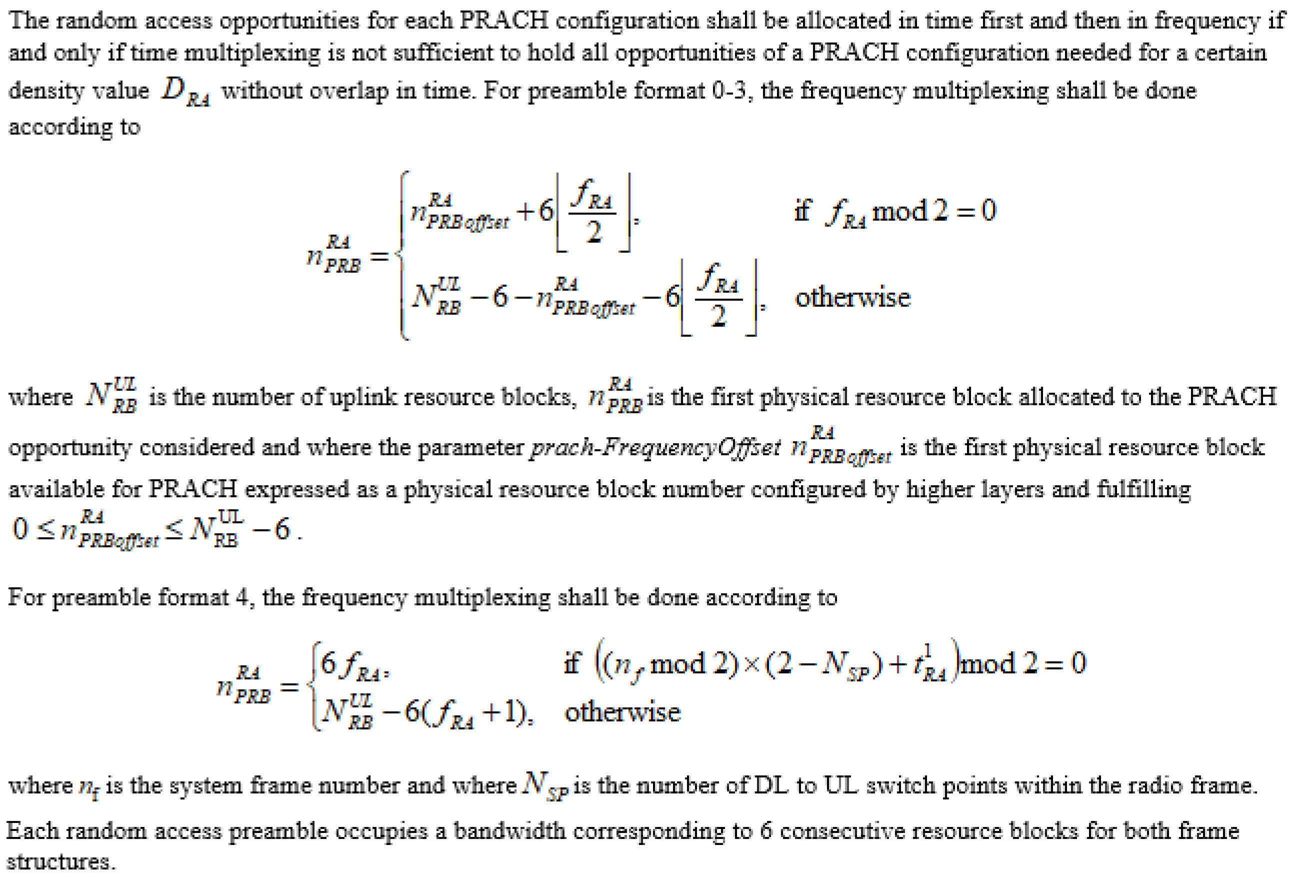
US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600\cdot T_{\mathrm{s}}$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA}=n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0\le n_{PRBoffset}^{RA}\le N_{\mathrm{RB}}^{\mathrm{UL}}-6$. …

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

<table>
<tr>
<td></td>
<td>


The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.
</td>
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US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

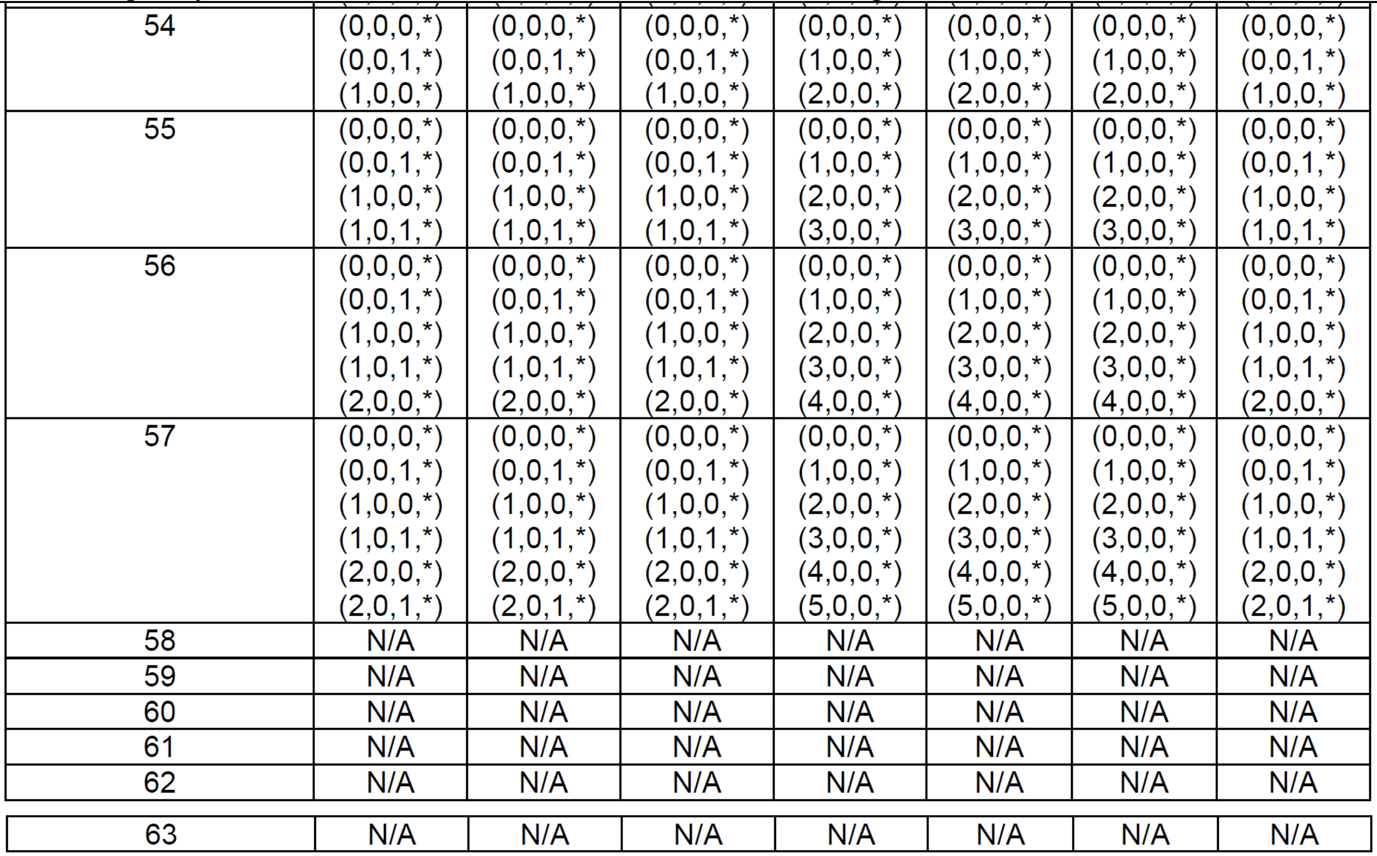
Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

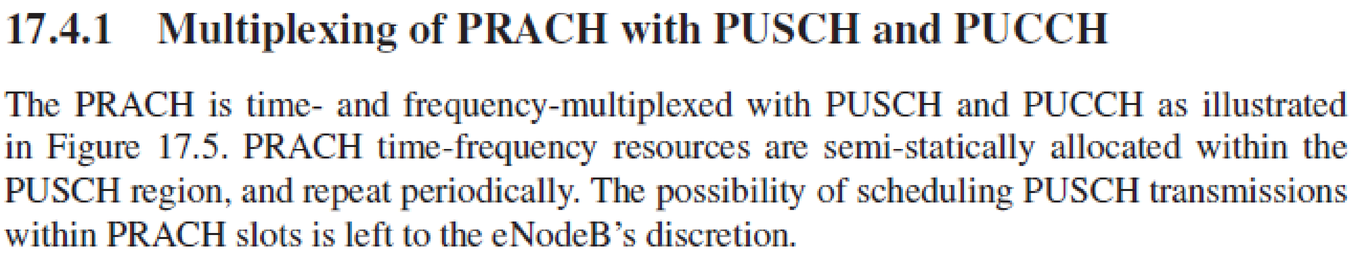
.
.
.

US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

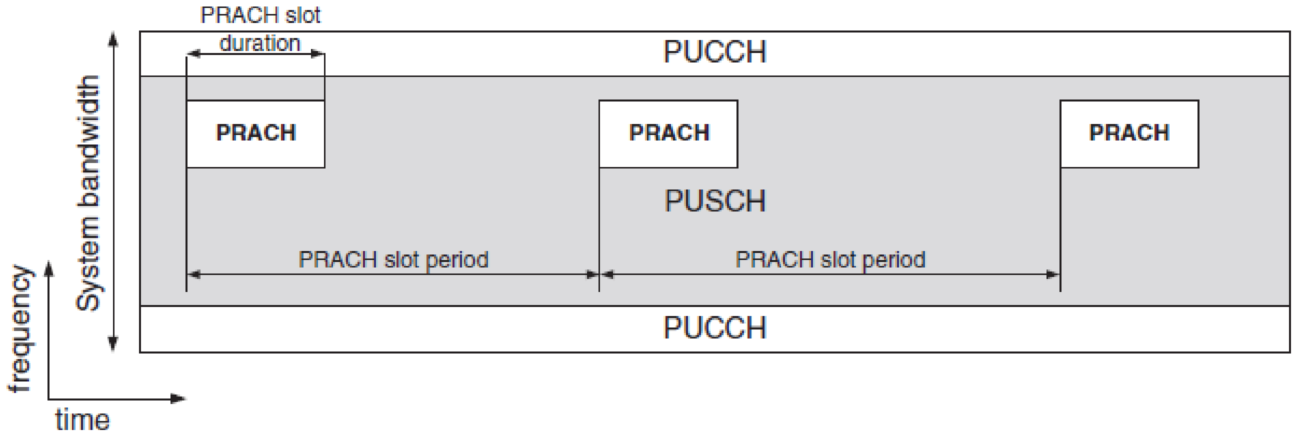
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

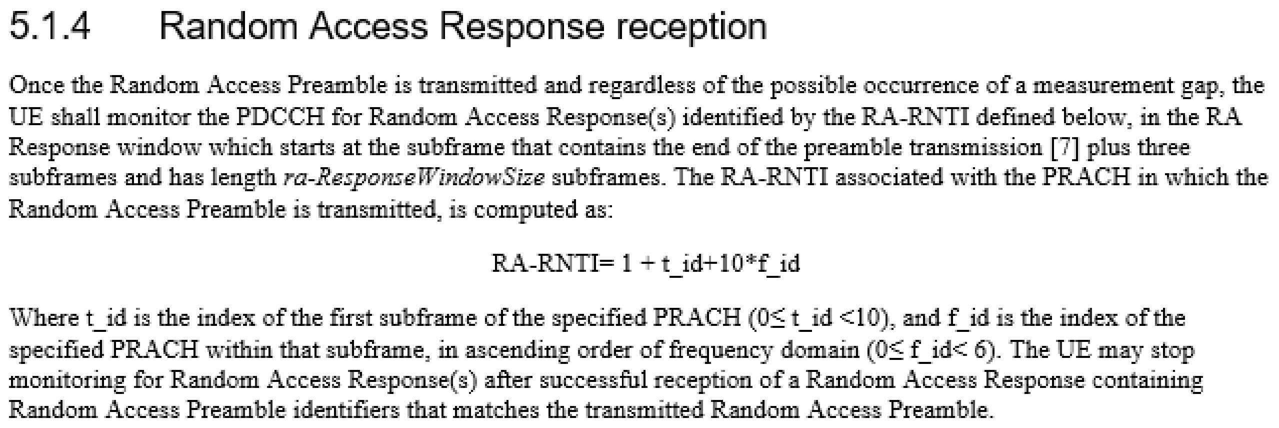
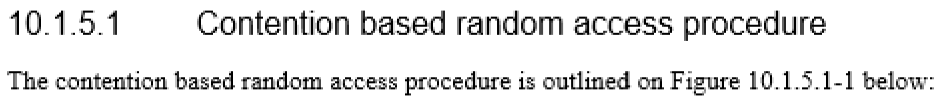
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 14
“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

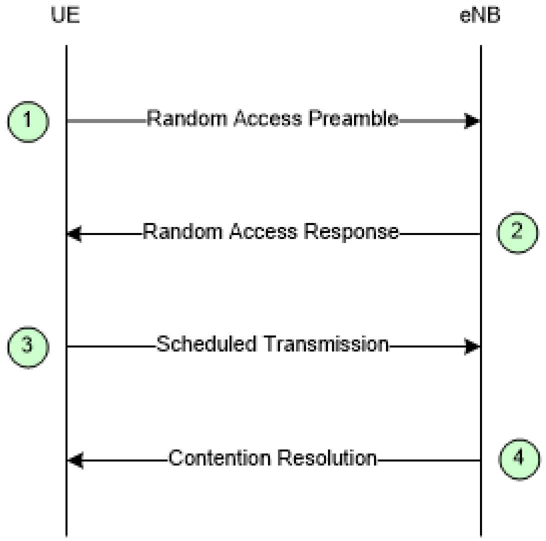
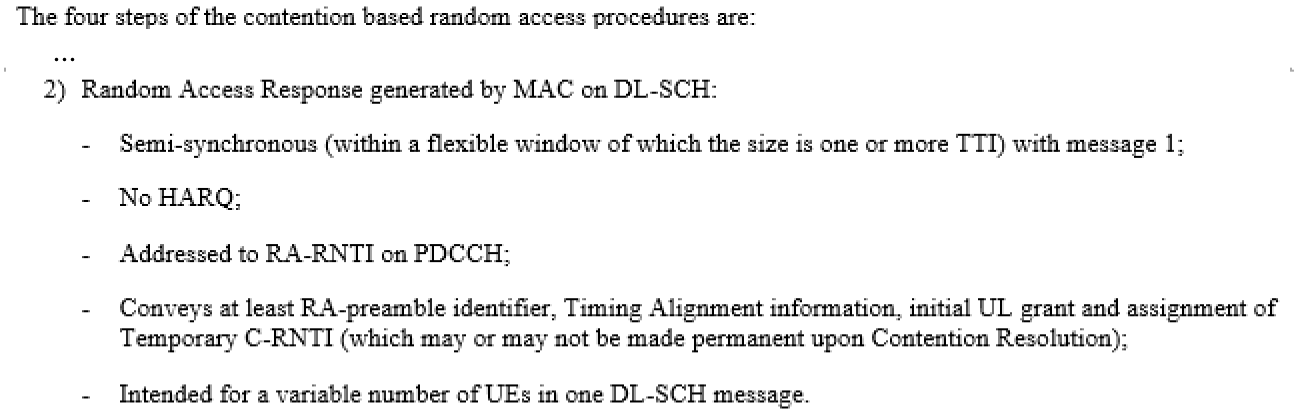
US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

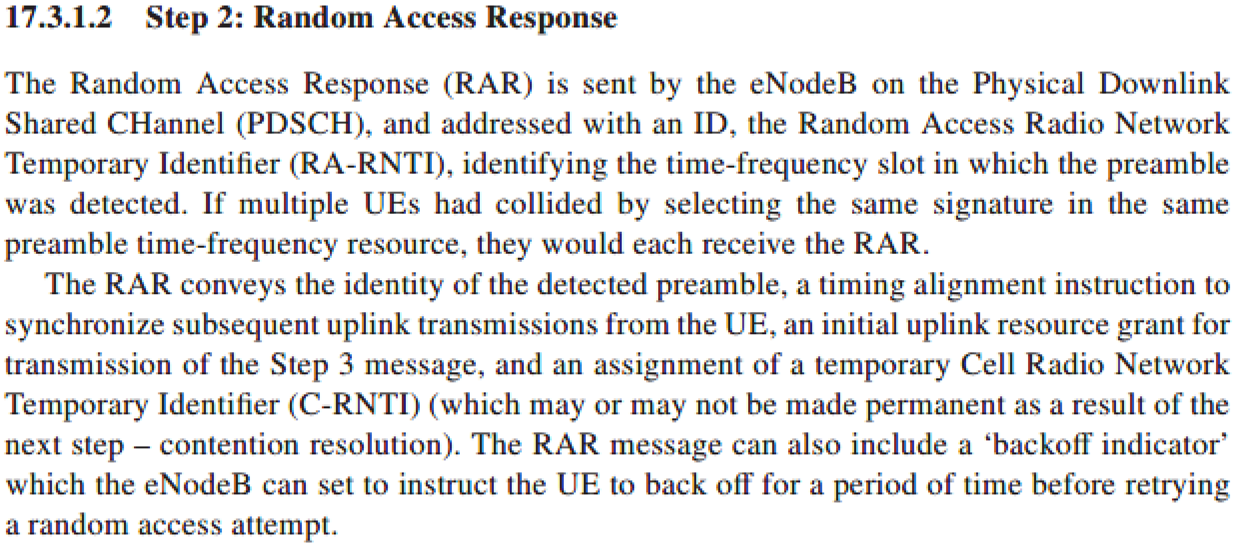
15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Mercedes's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI} = 1 + \text{t\_id} + 10*\text{f\_id}$ Where t_id is the index of the first subframe of the specified PRACH ($0 \leq \text{t\_id} < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq \text{f\_id} < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure**  The four steps of the contention based random access procedures are: ... 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15
“The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.”

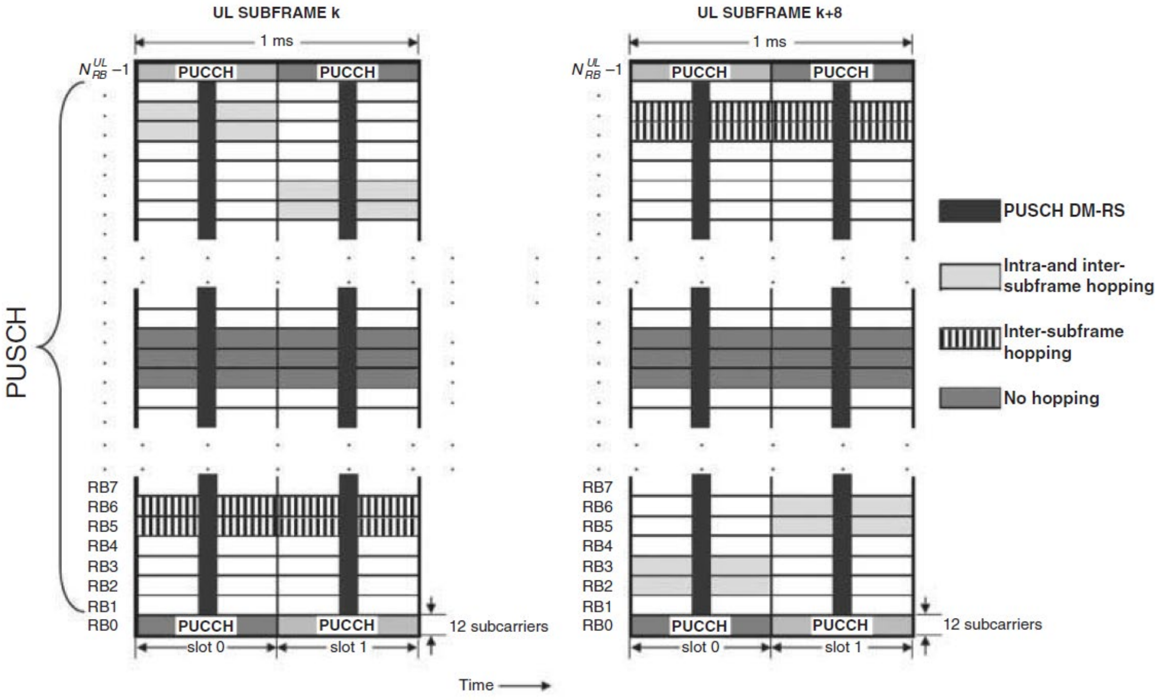
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 16
"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Mercedes's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 17

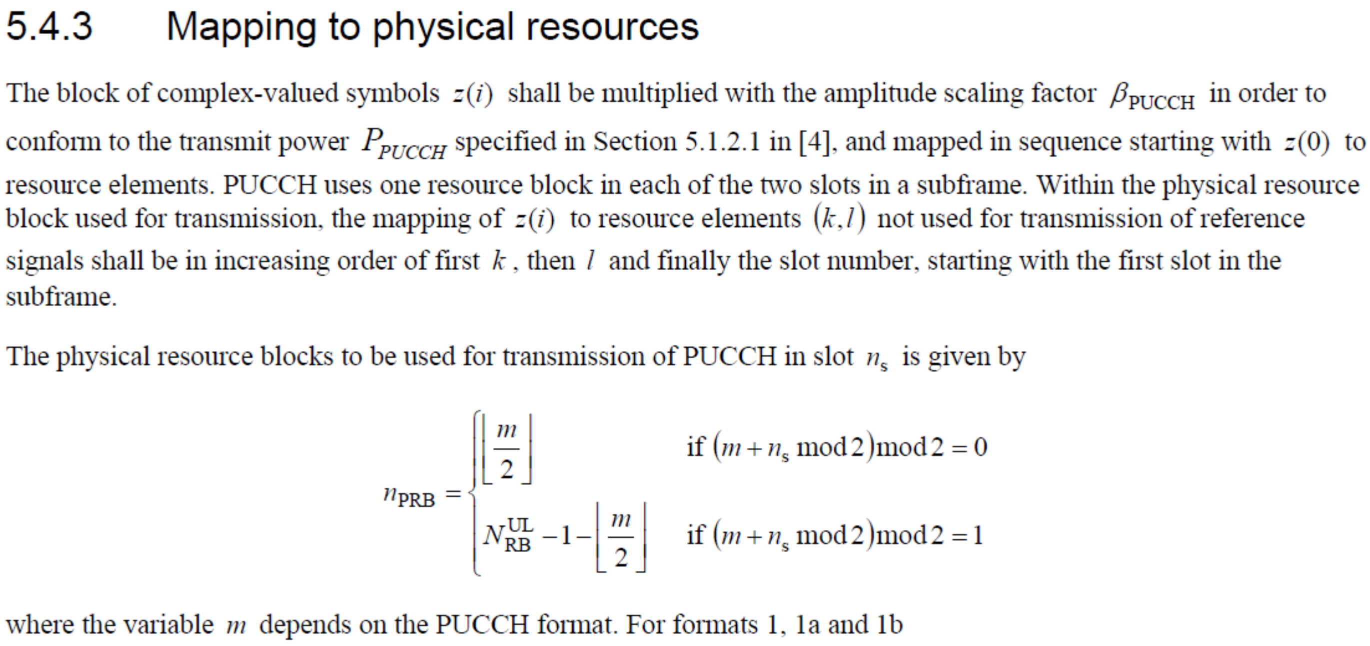
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Mercedes's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 17

“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

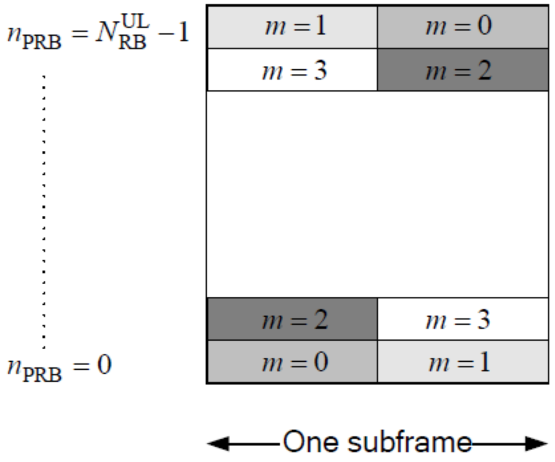


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

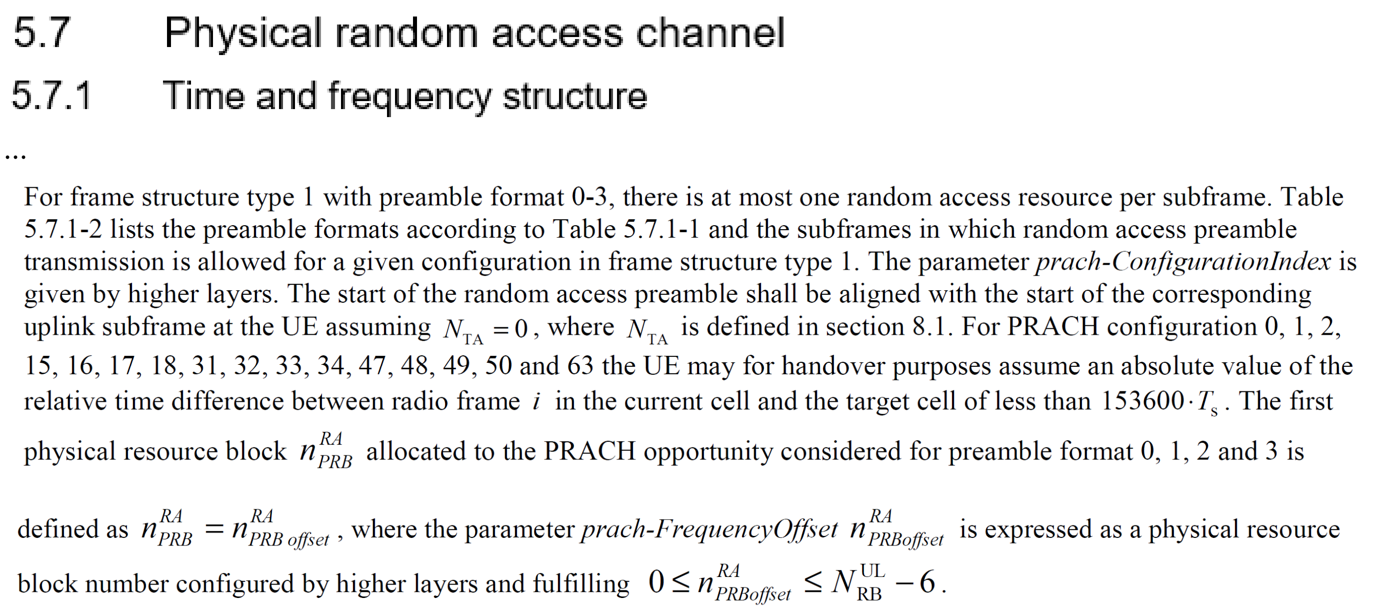
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

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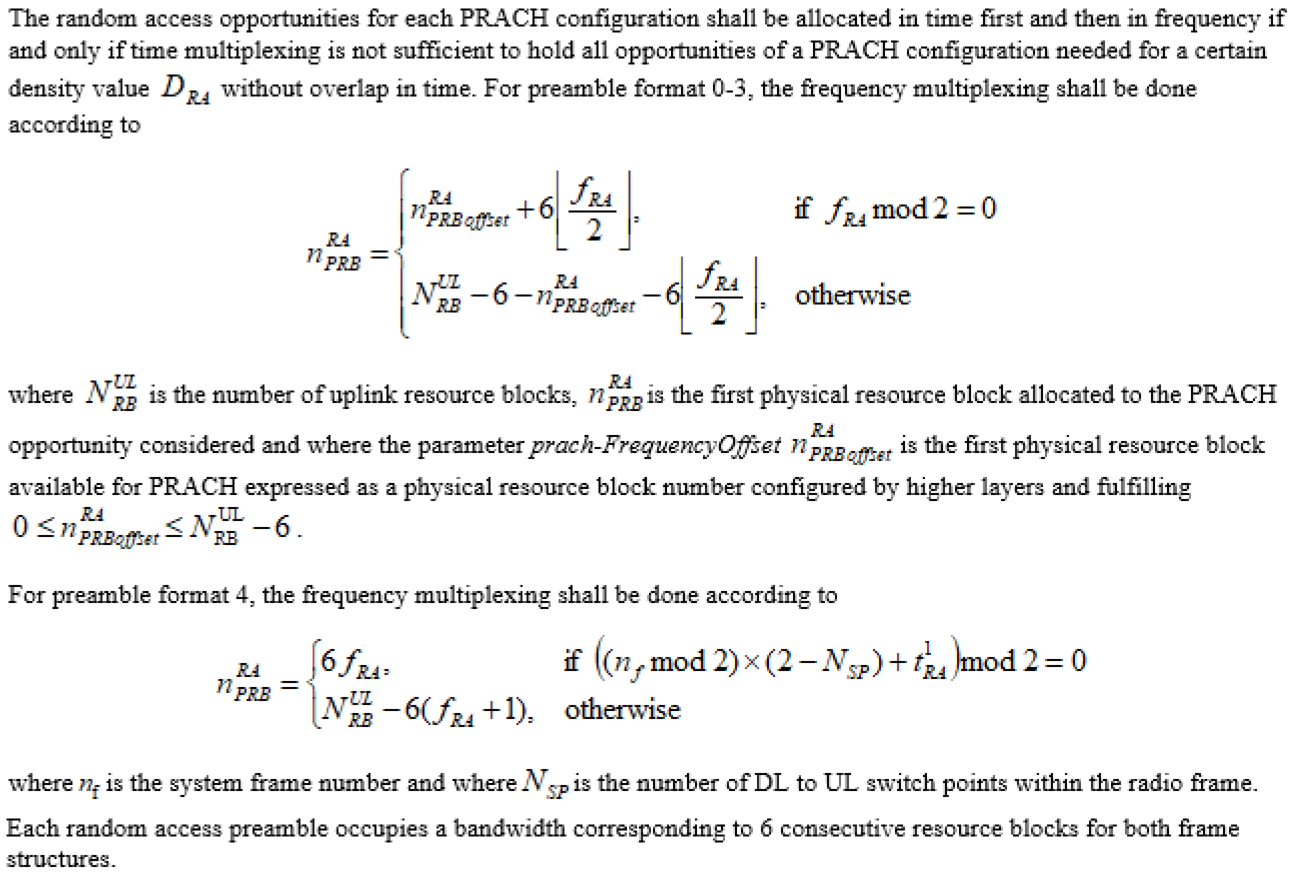
For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\ offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} n^{RA}_{PRBoffset} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N^{UL}_{RB} - 6 - n^{RA}_{PRBoffset} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N^{UL}_{RB} is the number of uplink resource blocks, n^{RA}_{PRB} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n^{RA}_{PRB} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t^{1}_{RA}\right) \bmod 2 = 0 \\ N^{UL}_{RB} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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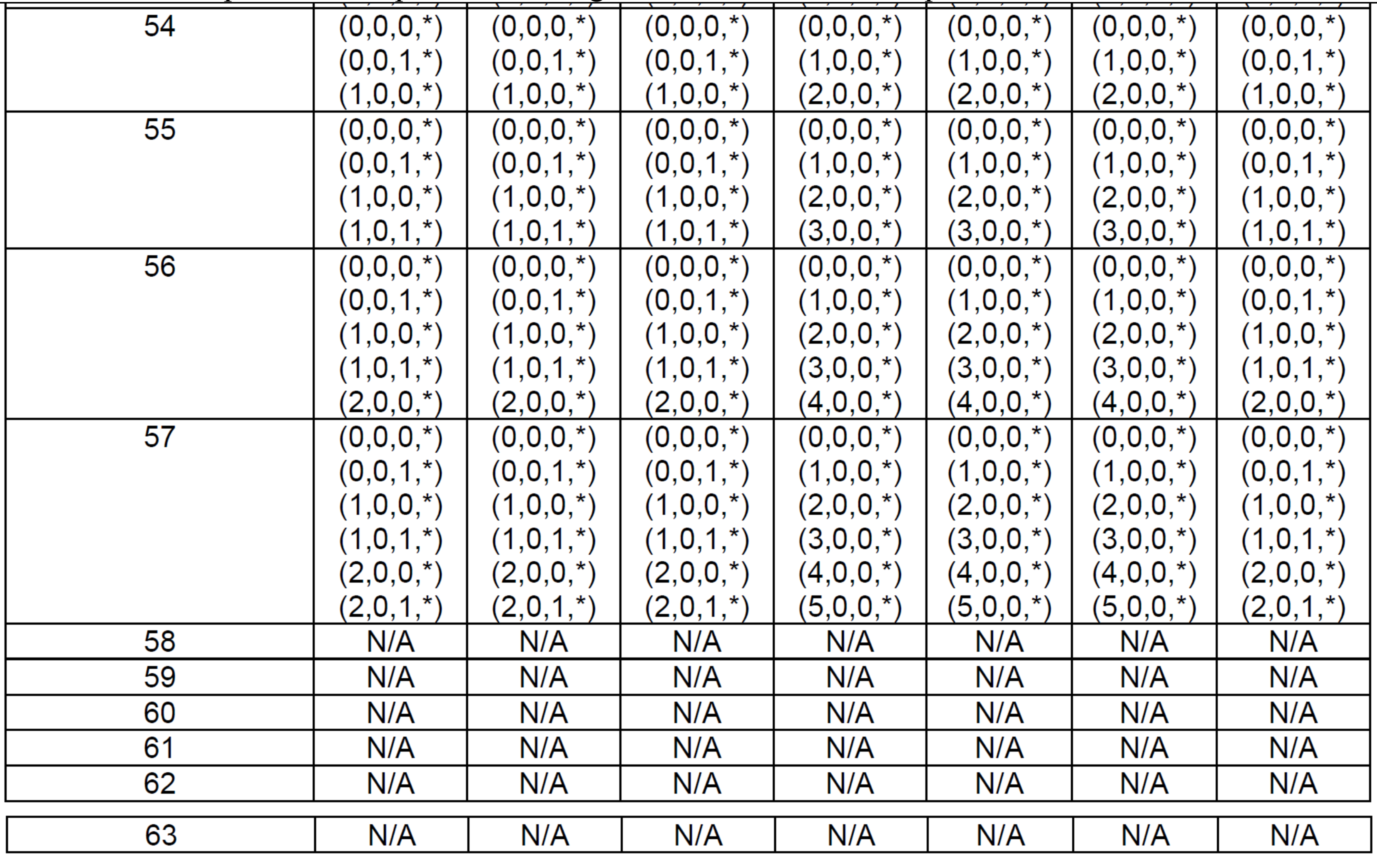
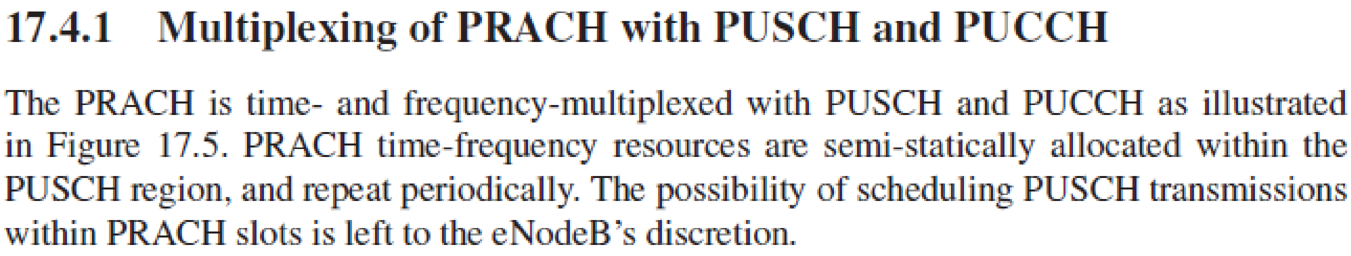
US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

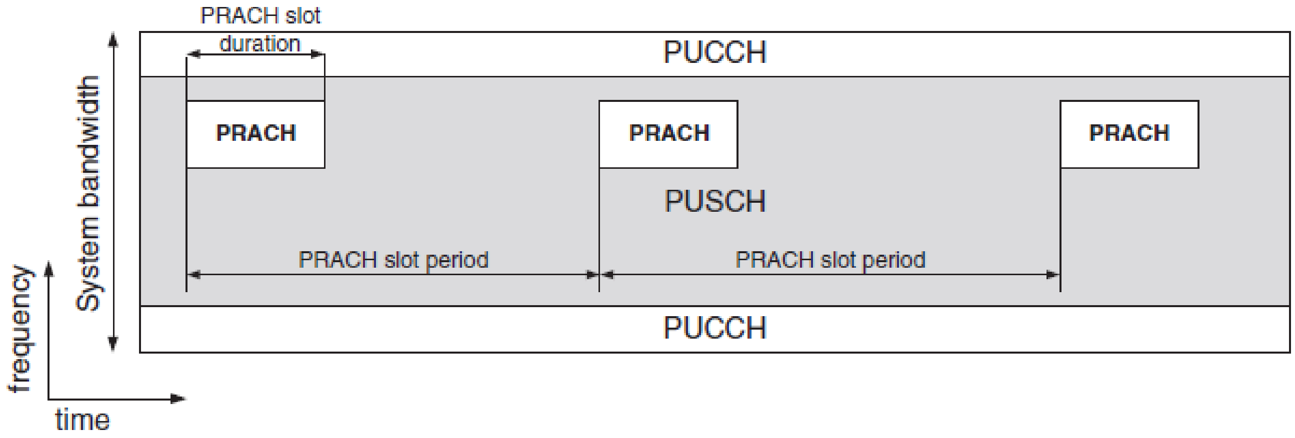
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



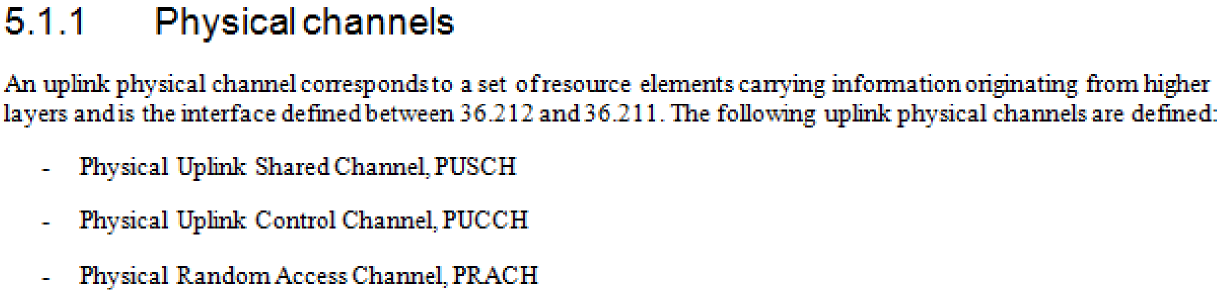
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

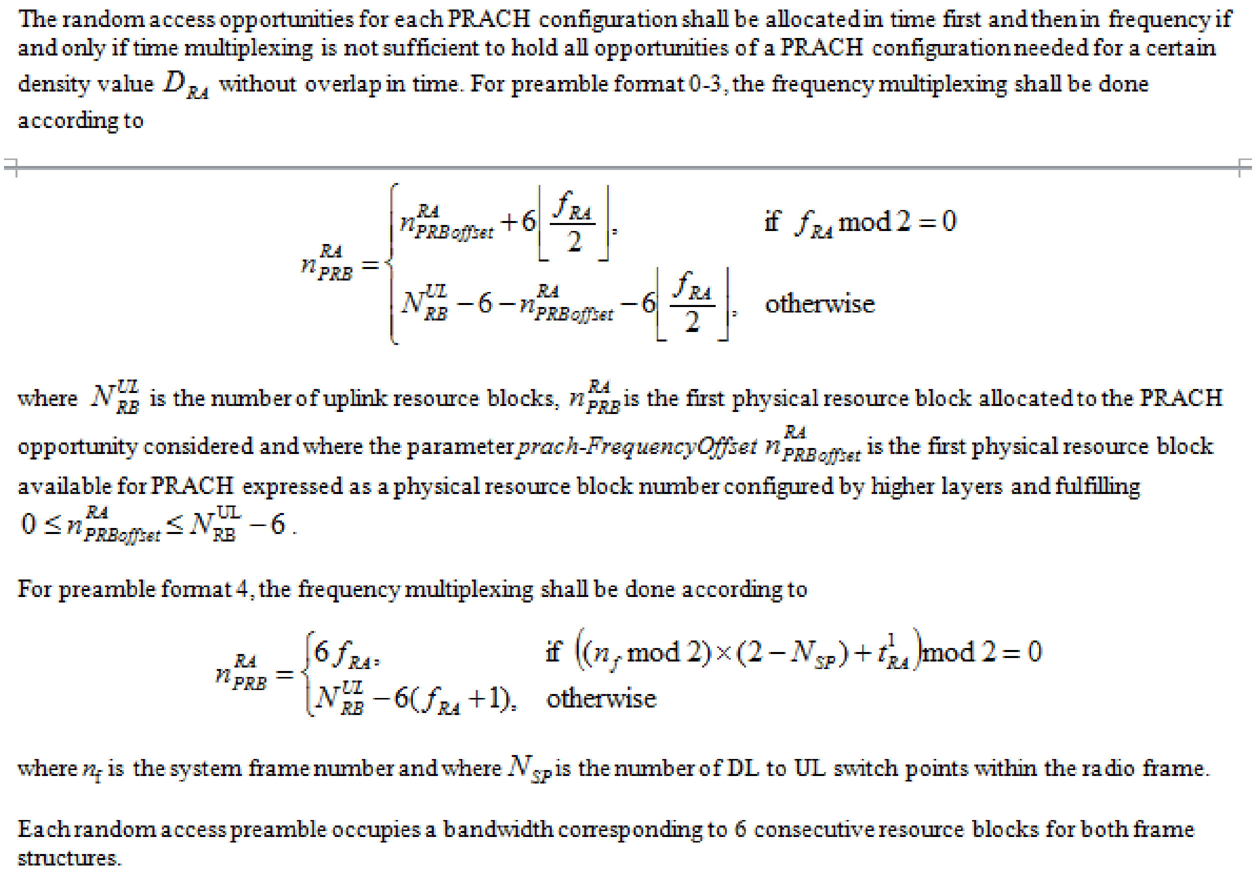
US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with Mercedes's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB. 5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

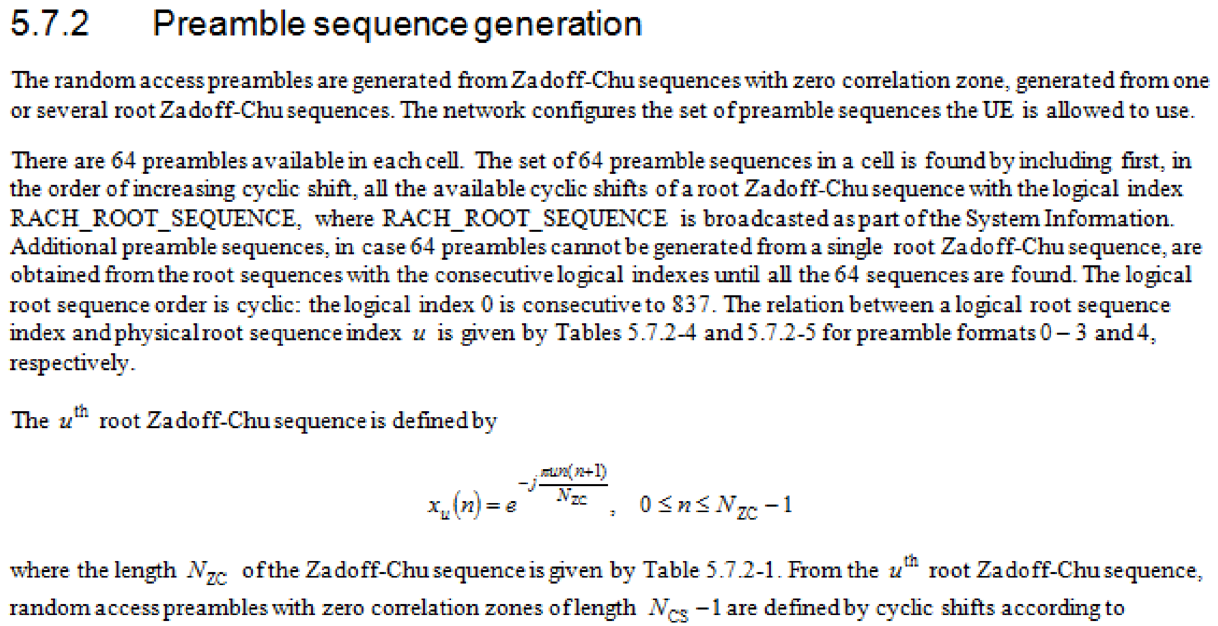
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

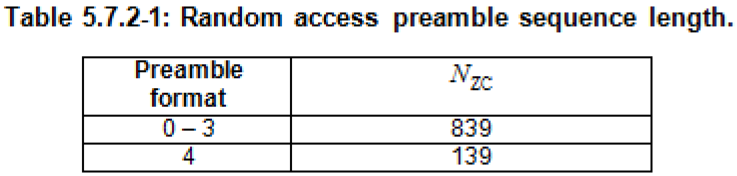
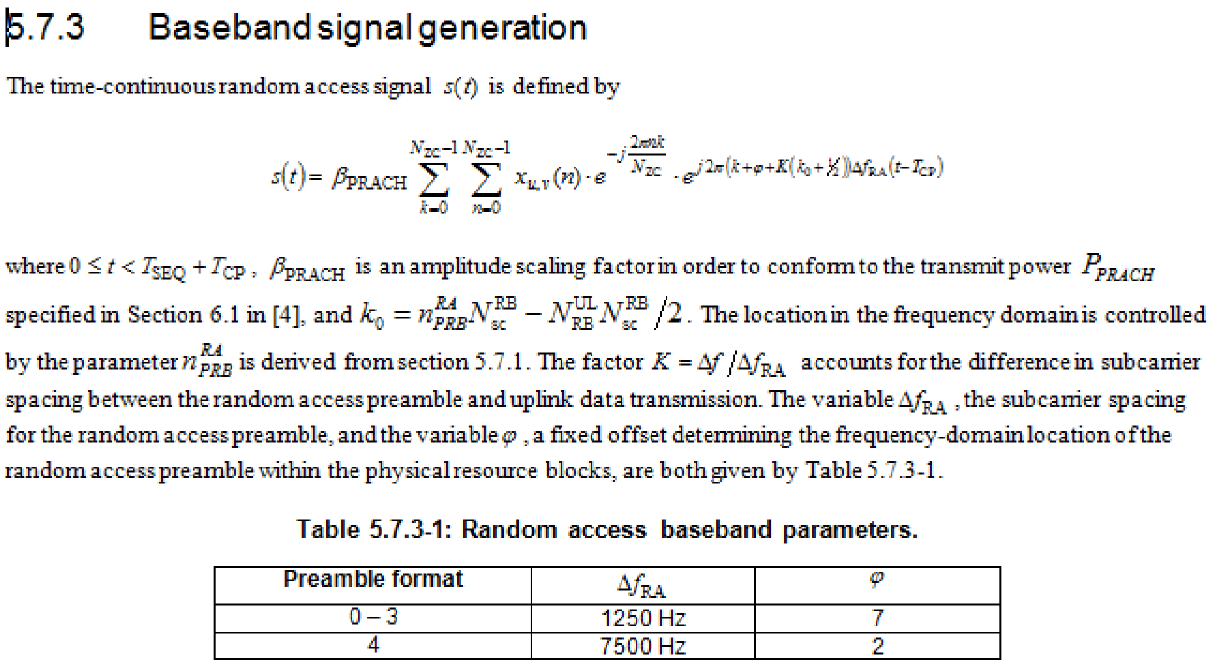


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

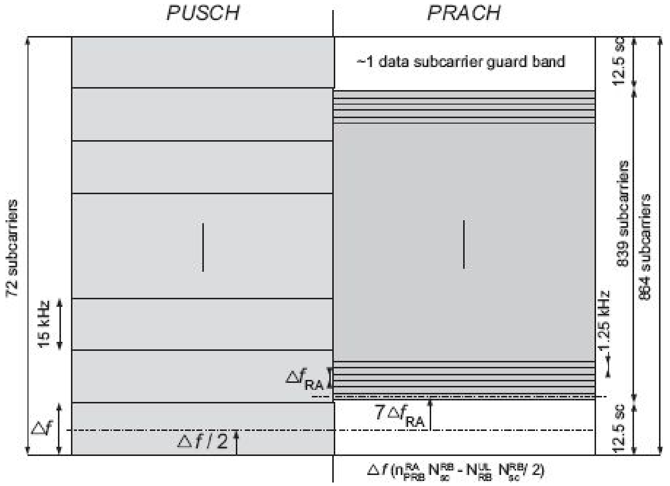
where $0\leq t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

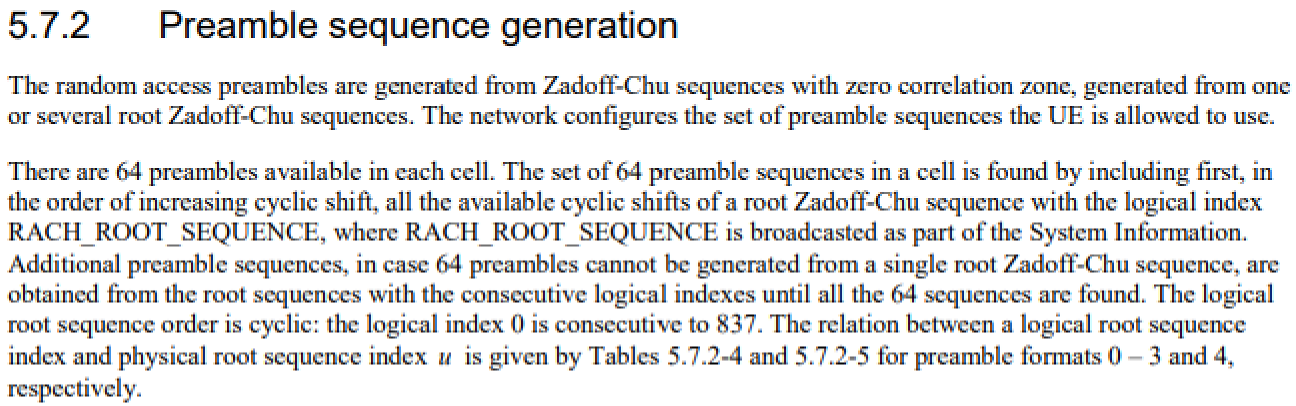
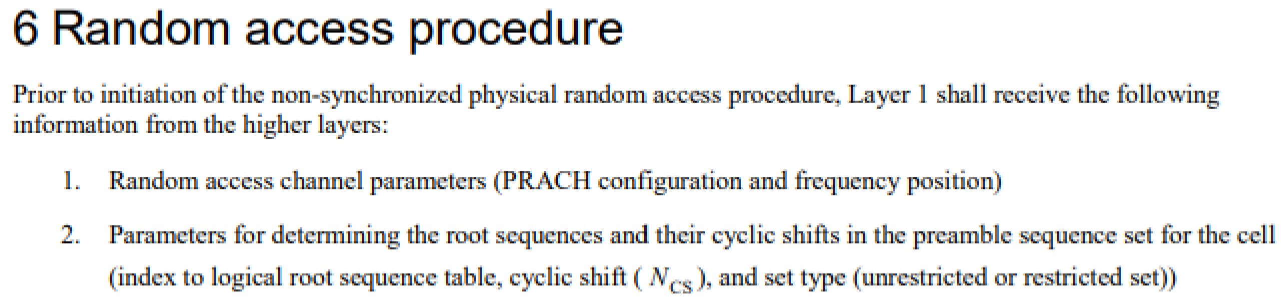
See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Mercedes's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                        -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

“The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

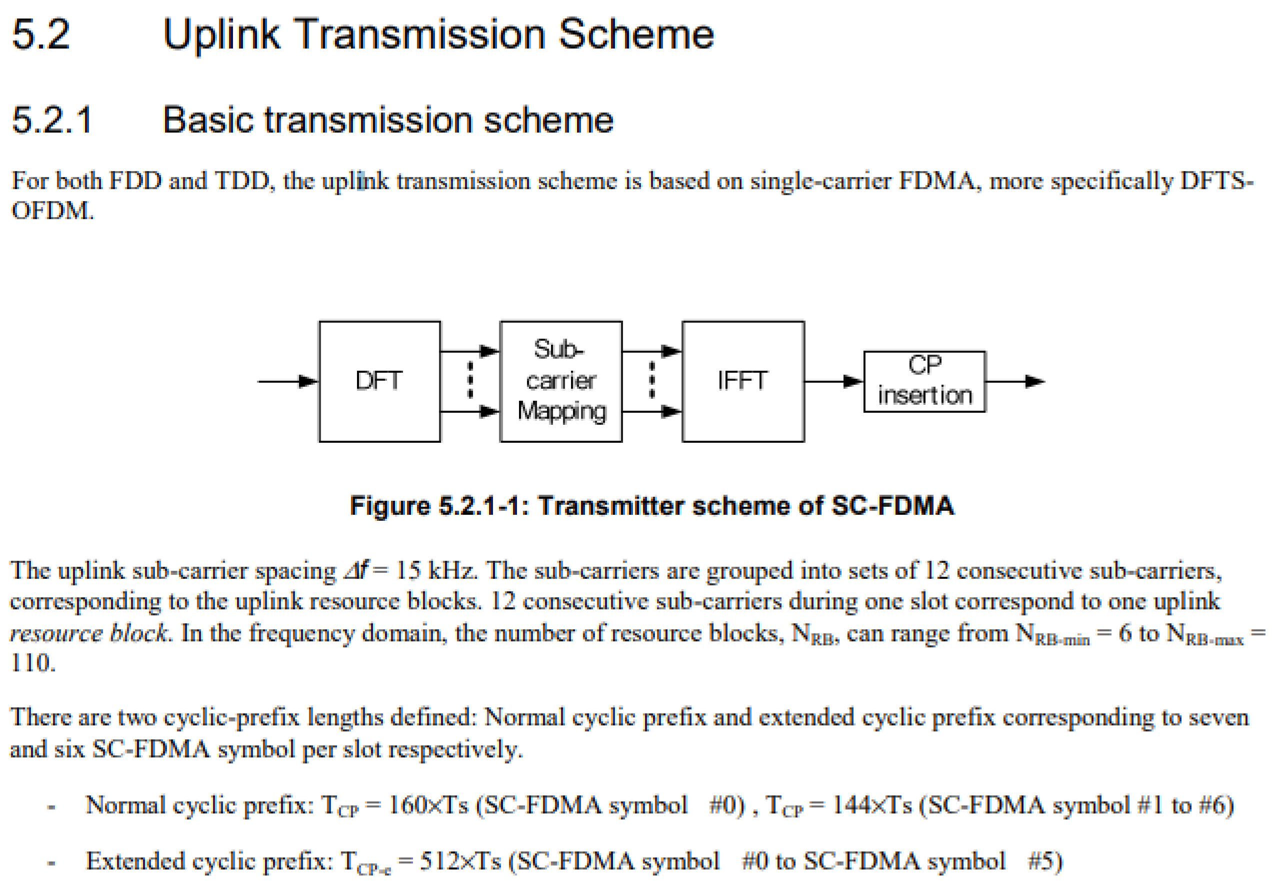
RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

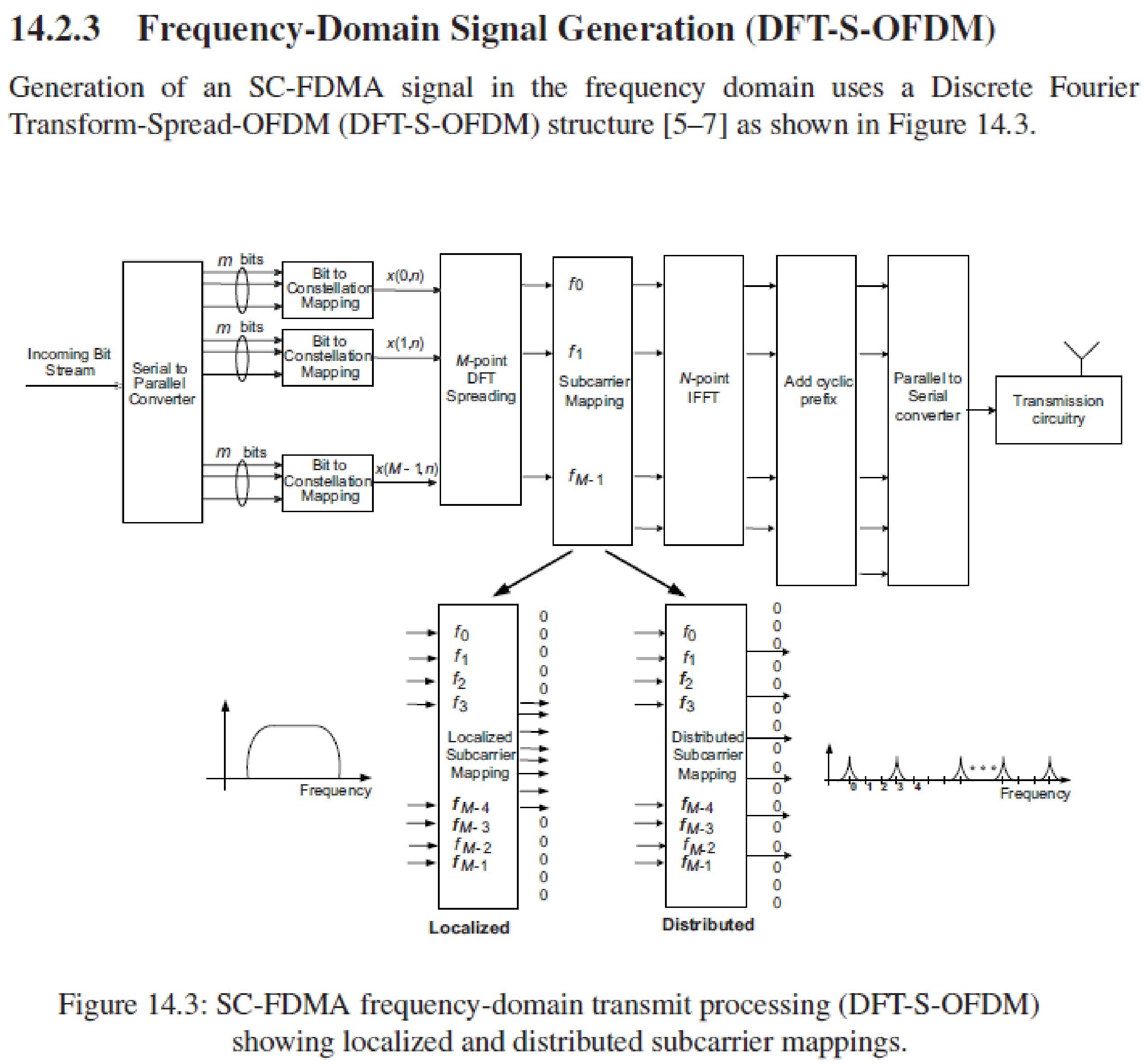
US Patent No. 10,833,908: Claim 20

"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. Mercedes's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,* Mercedes's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

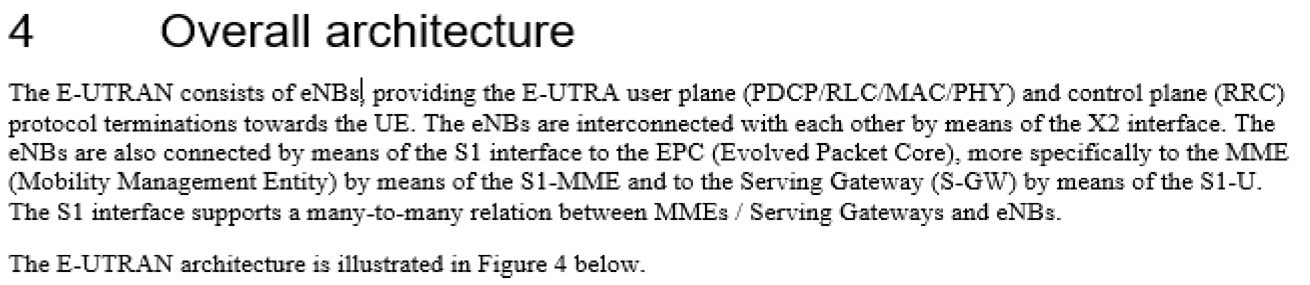
Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

21. A mobile station comprising:	To the extent the preamble is considered a limitation, Mercedes's Accused Instrumentalities meet the preamble of claim 21 of the '908 patent. *E.g.,* Mercedes's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, Mercedes offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

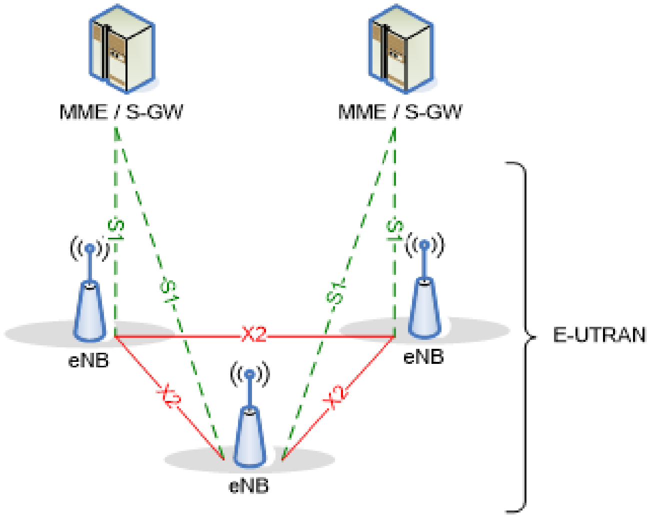


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

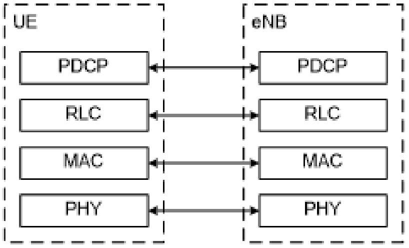


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	Mercedes's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The Mercedes Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

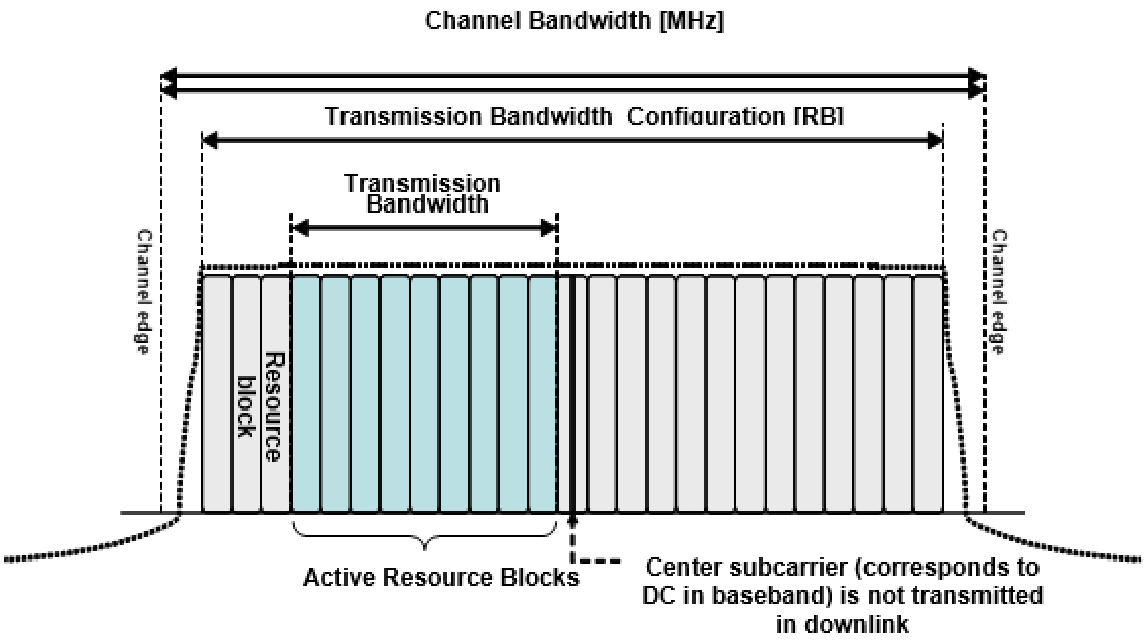
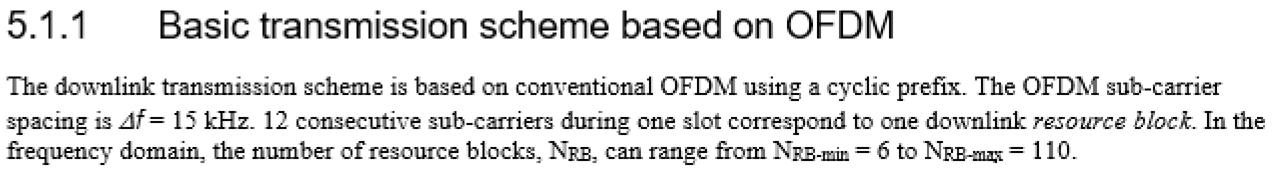


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

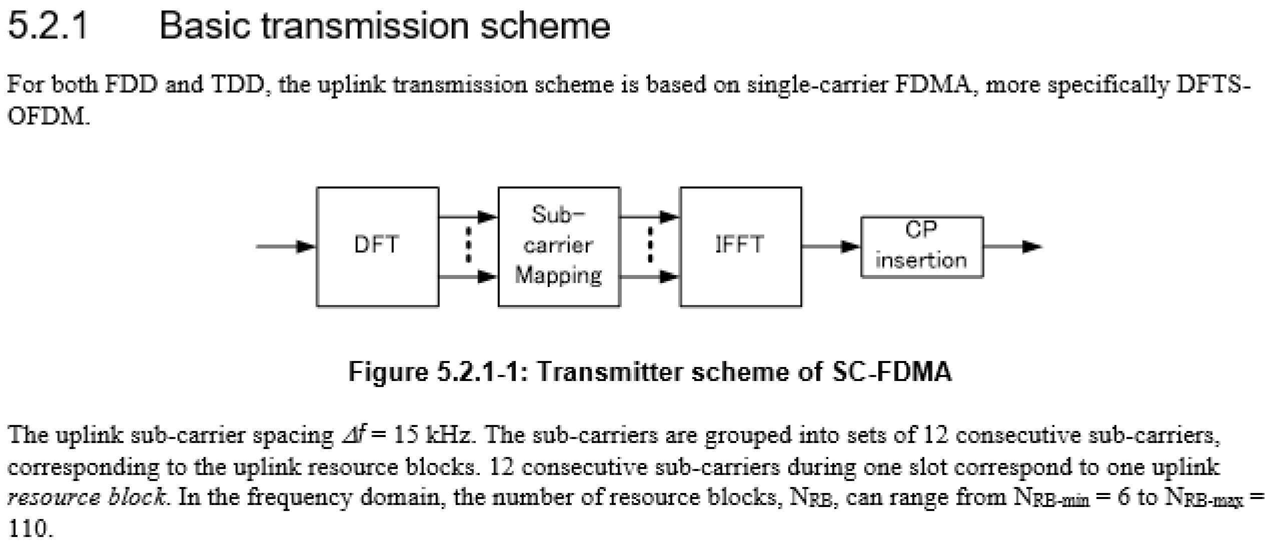
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

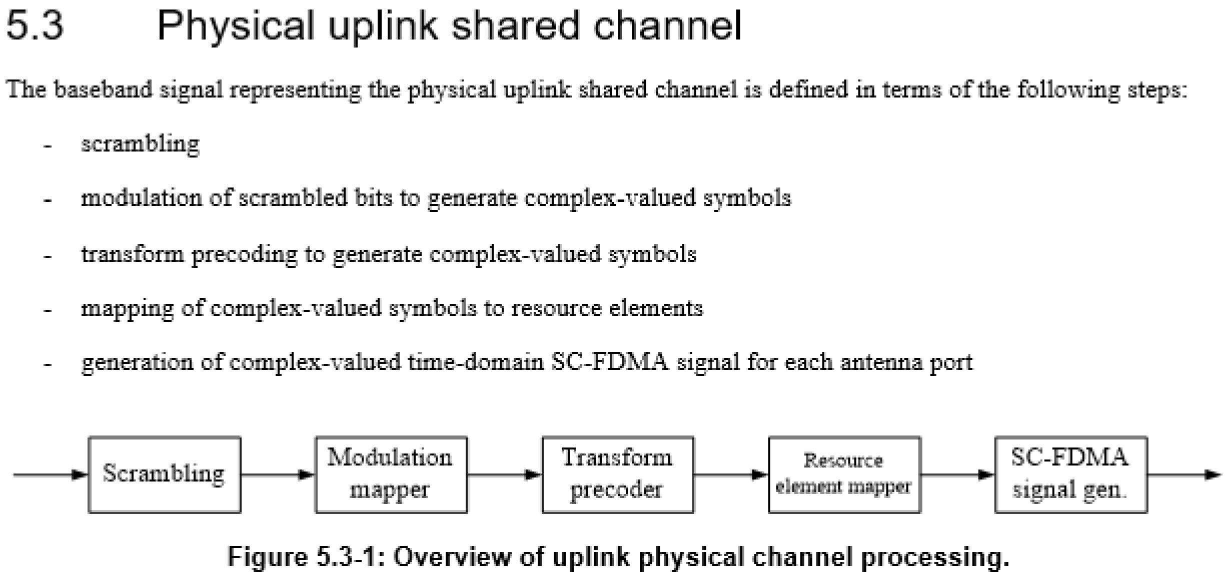
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

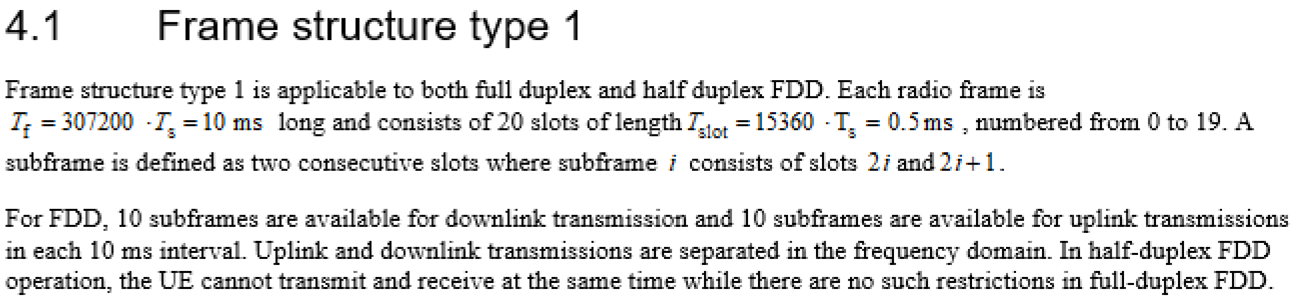
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

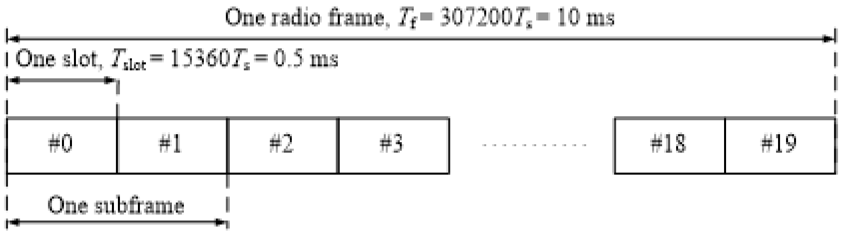
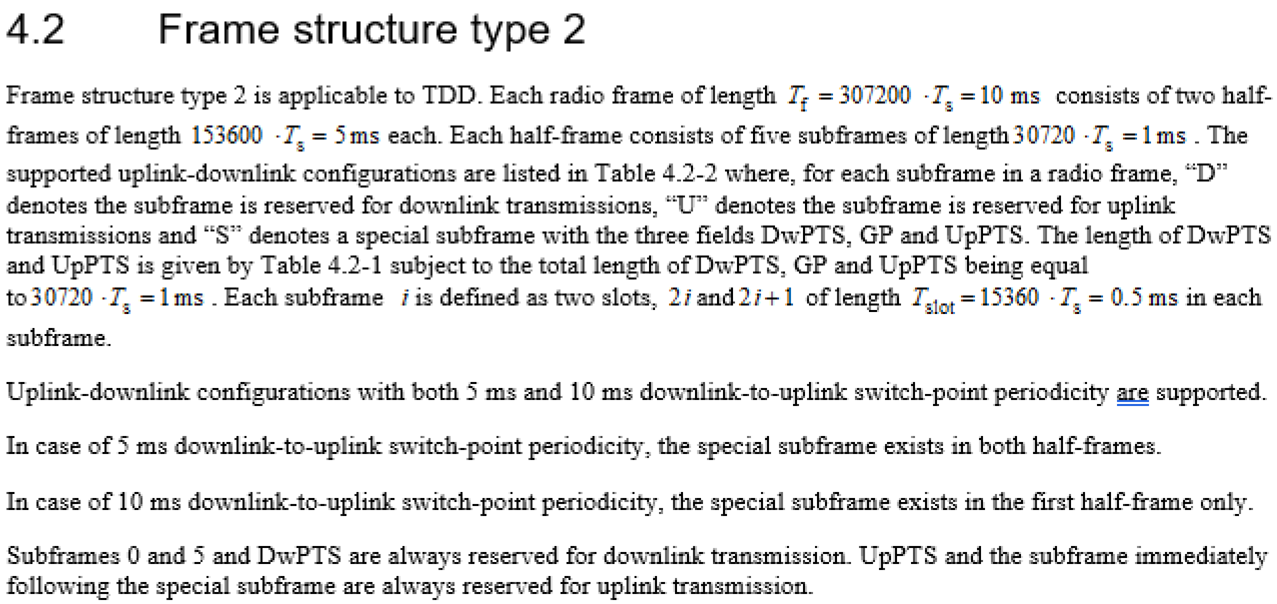


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

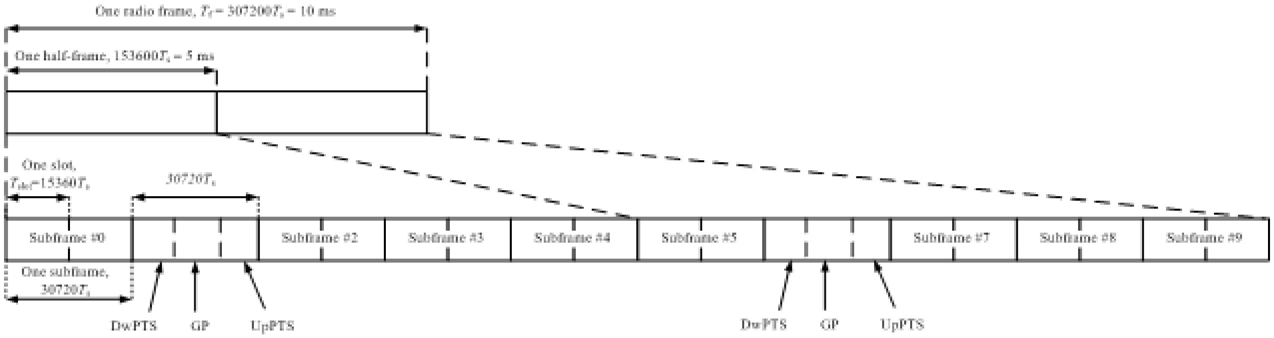
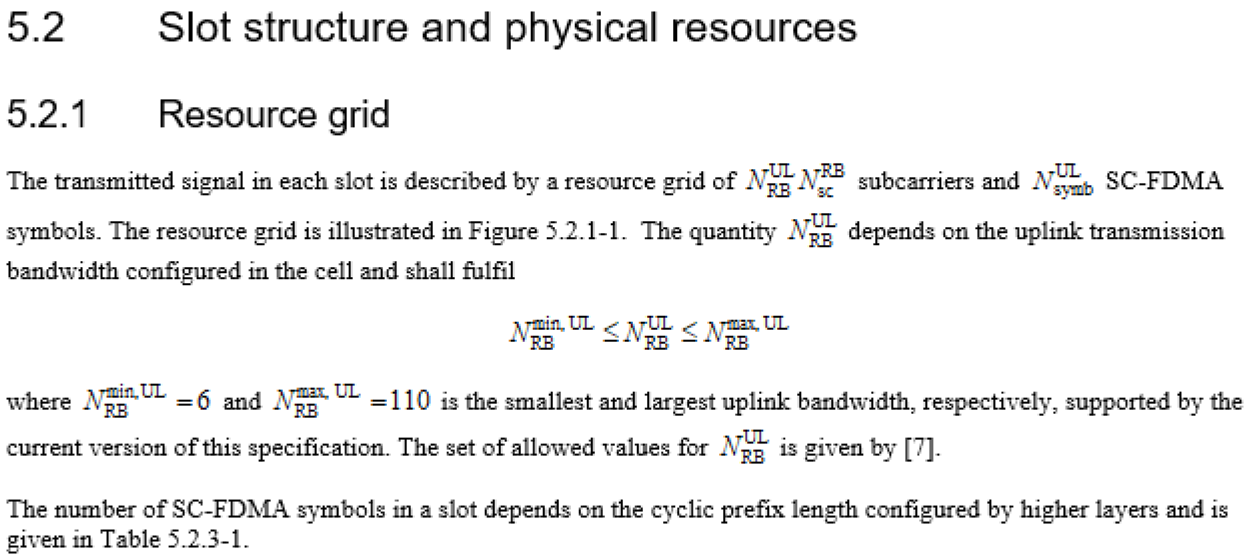


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{RB}^{UL} N_{sc}^{RB}$ subcarriers and N_{symb}^{UL} SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity N_{RB}^{UL} depends on the uplink transmission bandwidth configured in the cell and shall fulfil

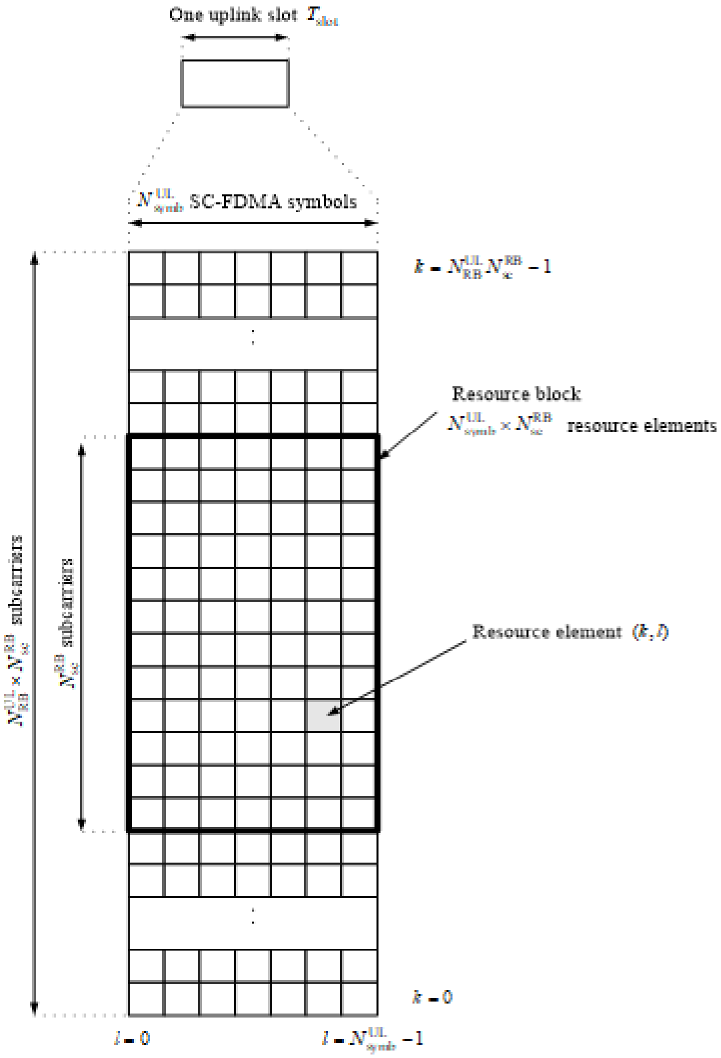
$$N_{RB}^{min,UL} \le N_{RB}^{UL} \le N_{RB}^{max,UL}$$

where $N_{RB}^{min,UL} = 6$ and $N_{RB}^{max,UL} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for N_{RB}^{UL} is given by [7].

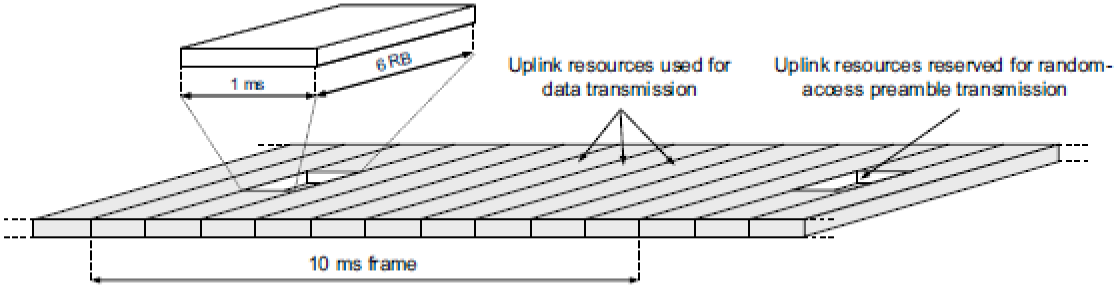
The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	Mercedes's Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

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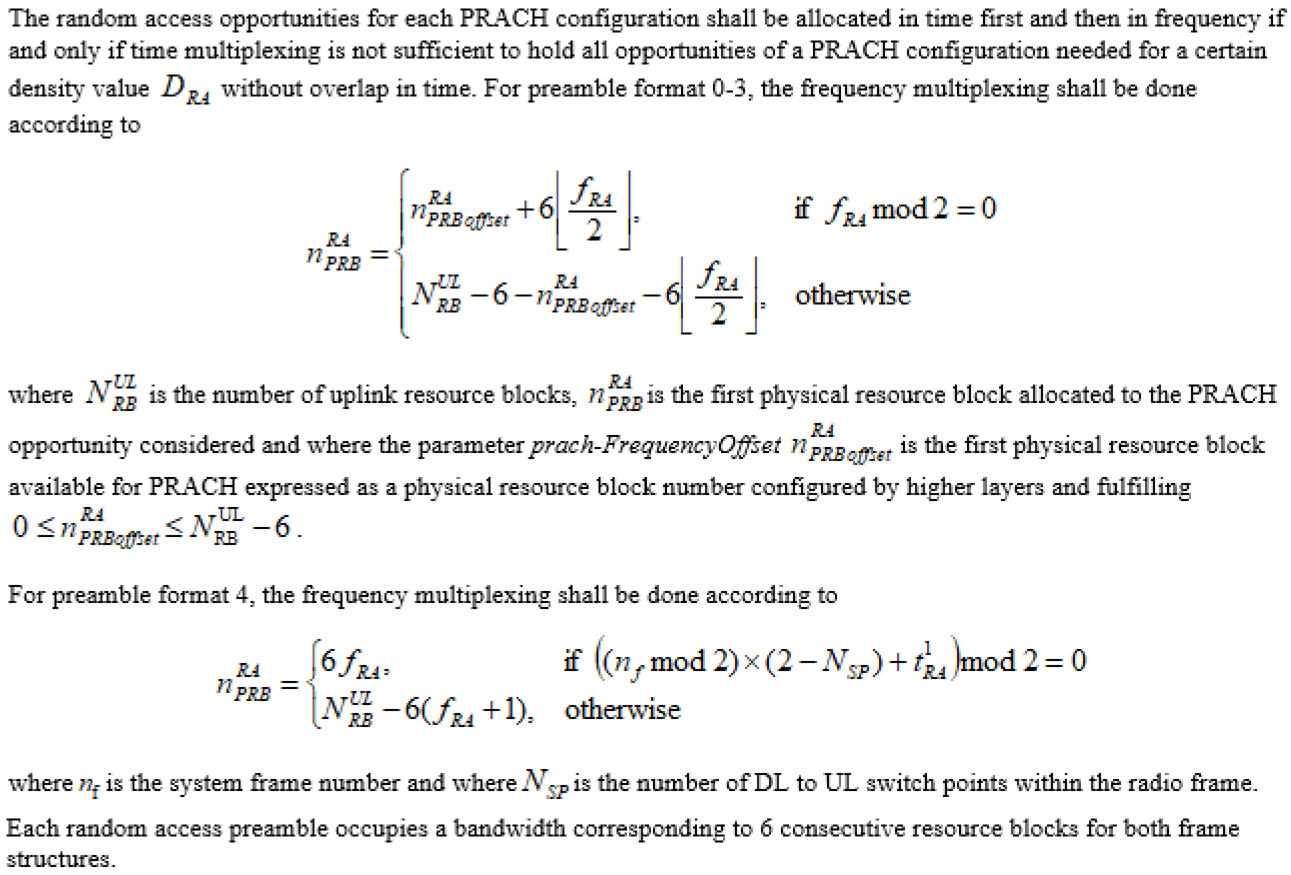

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

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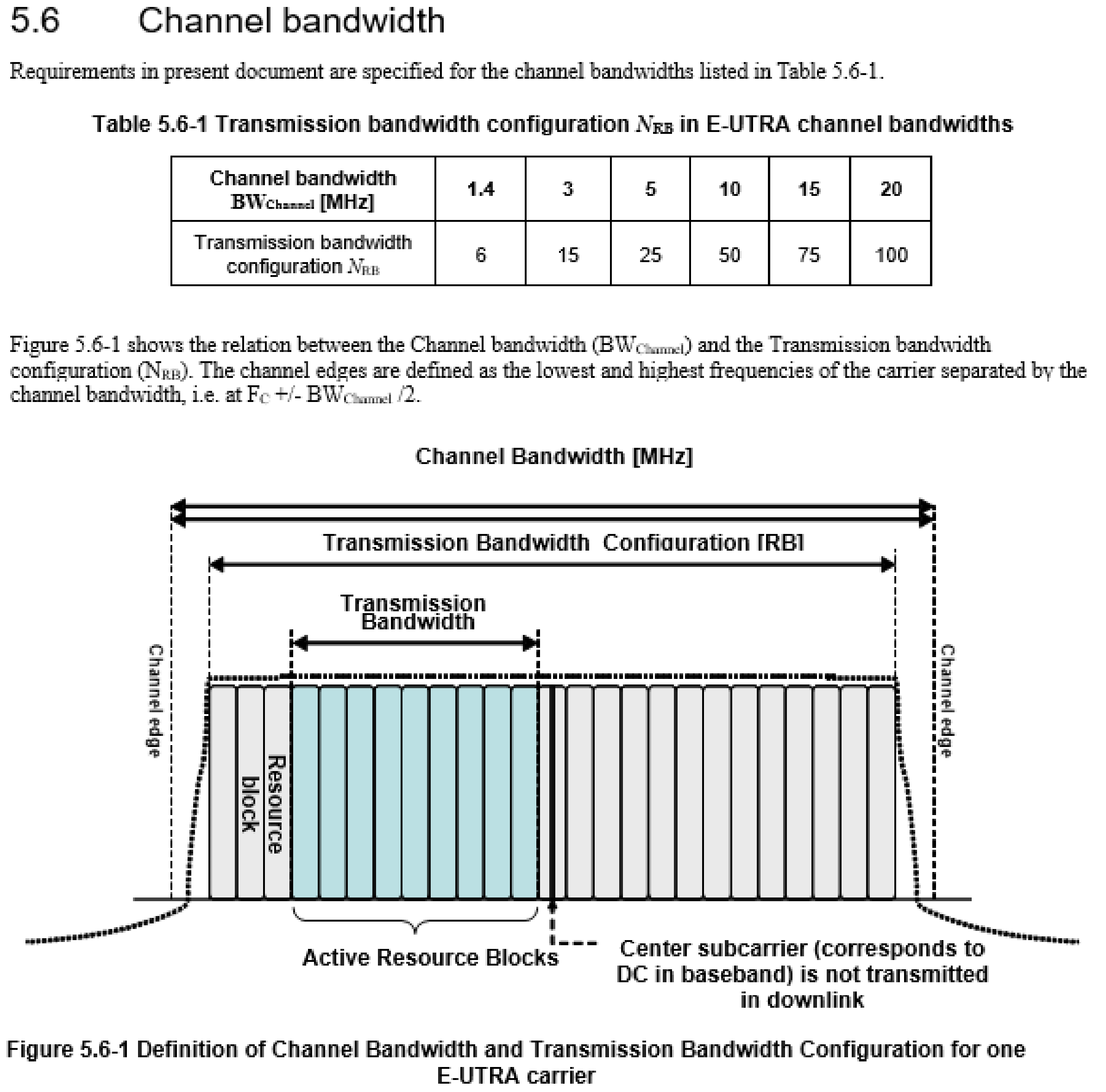
</table>



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

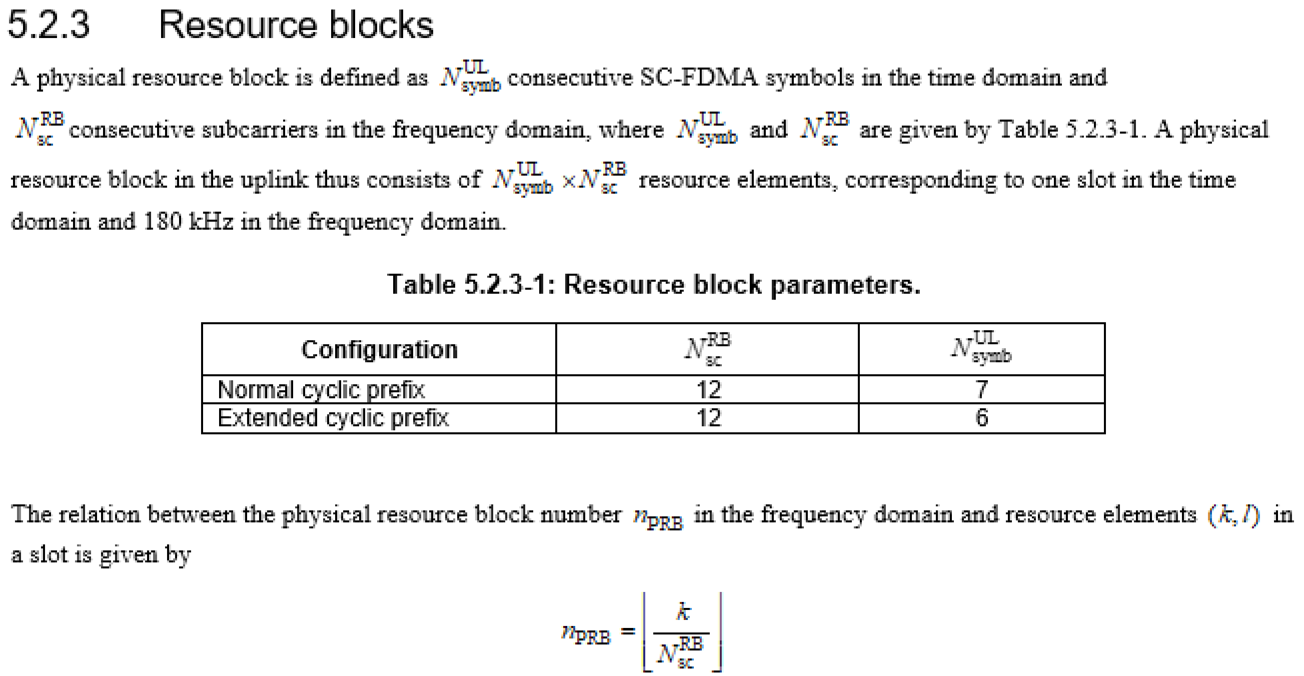
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

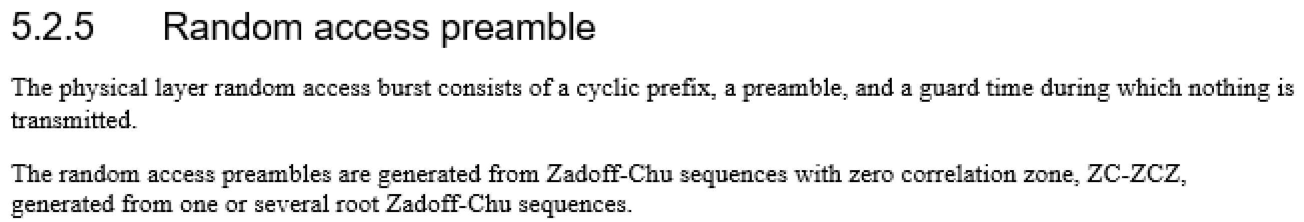
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

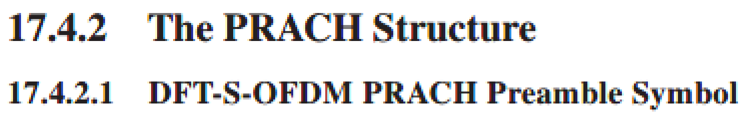


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

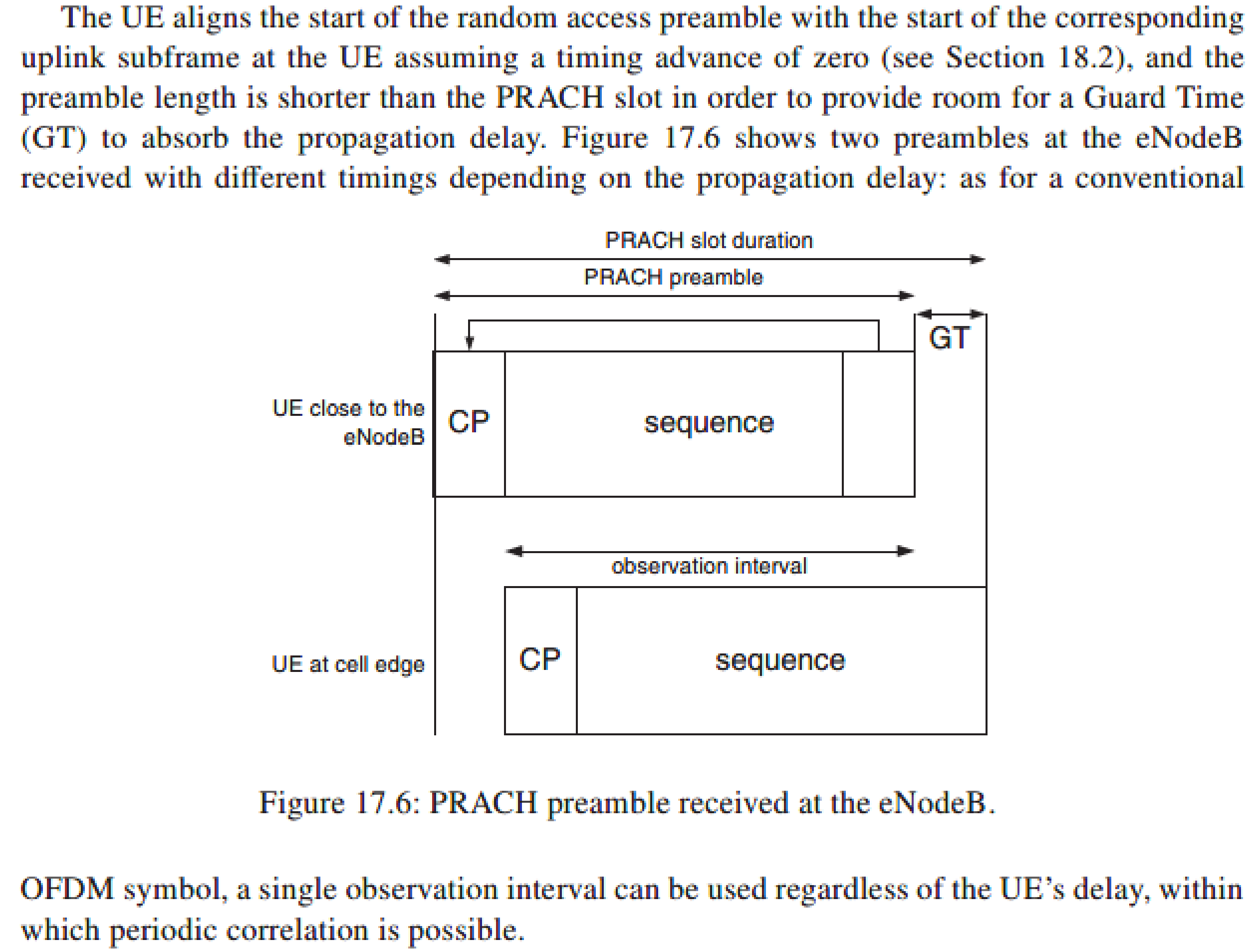


17.4.2 The PRACH Structure

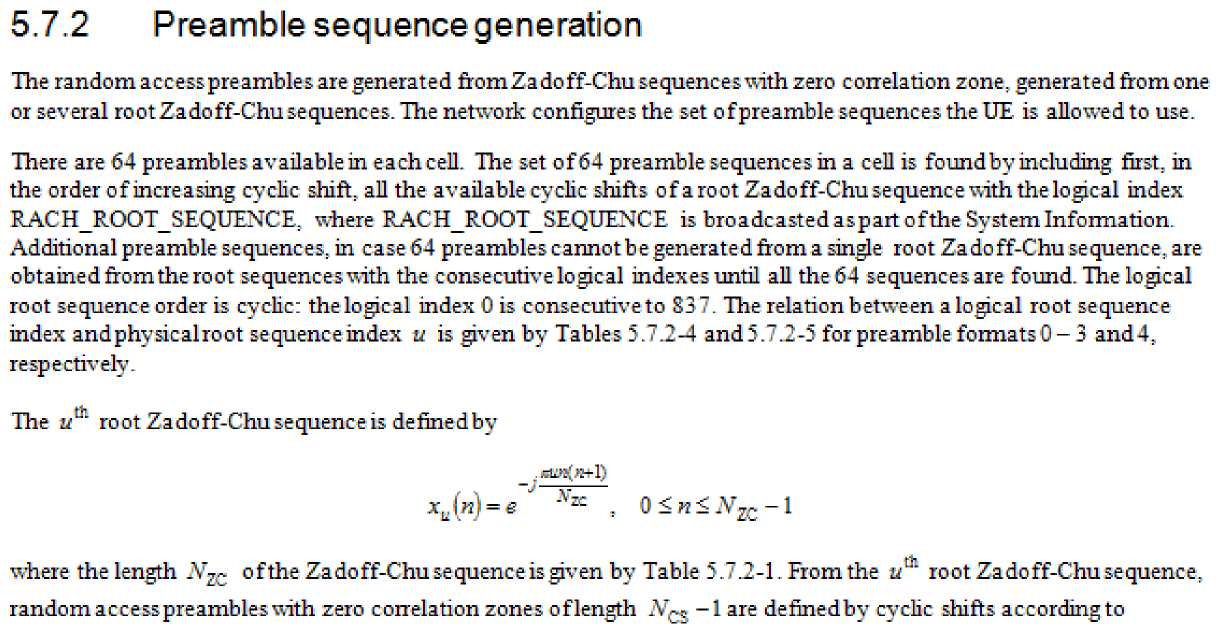
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

...

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

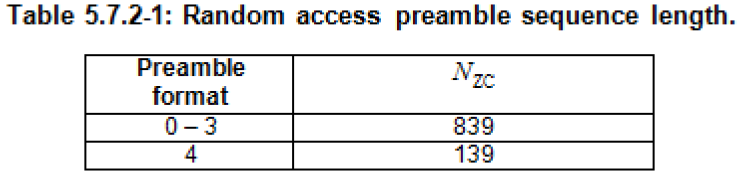
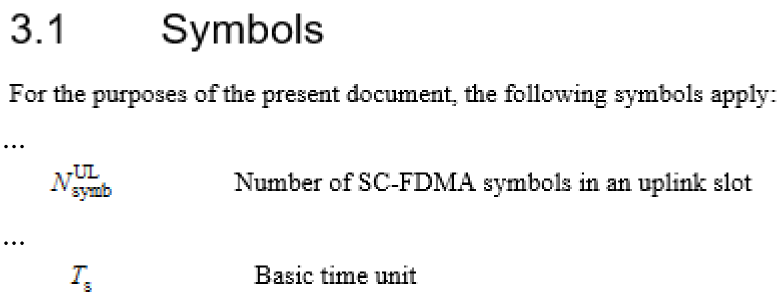
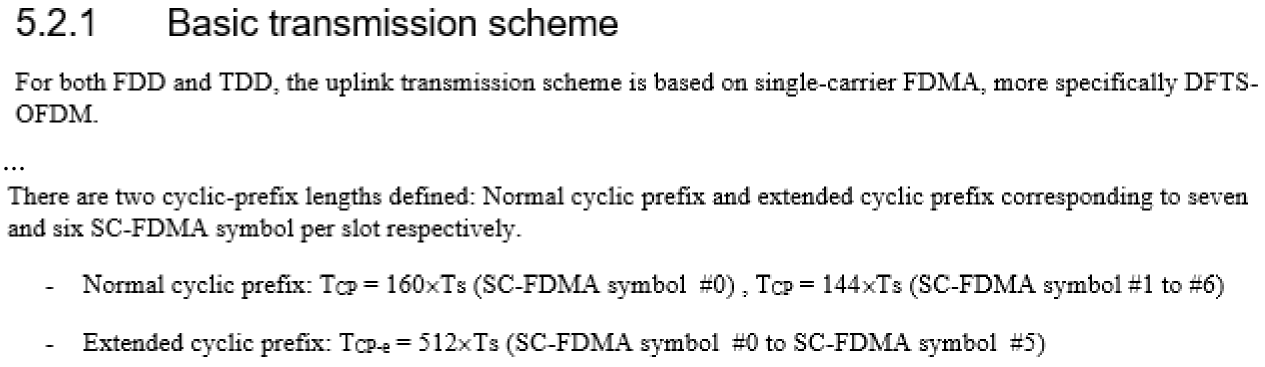


Table 5.7.2-1: Random access preamble sequence length.

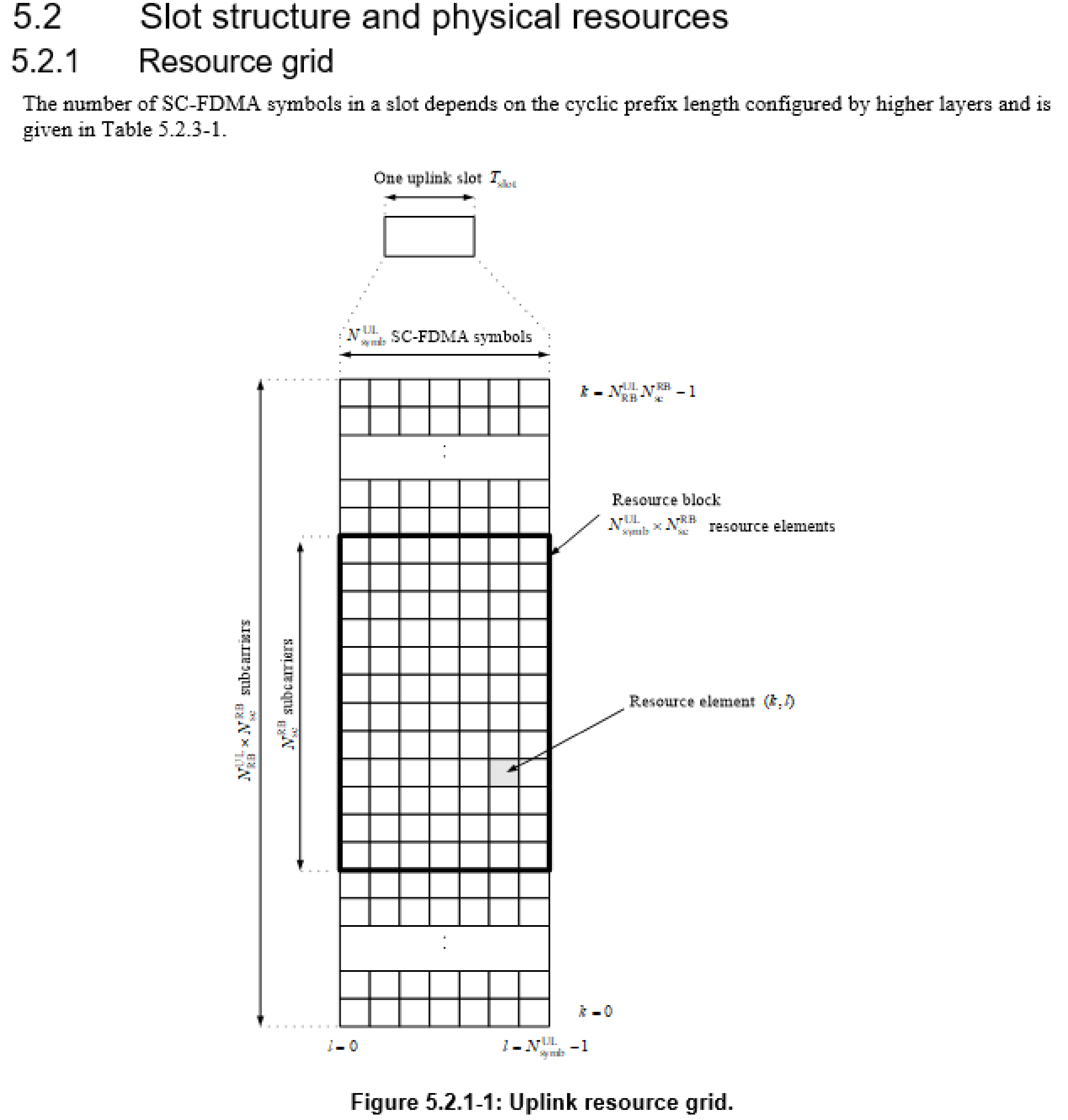
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using Mercedes's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (Ts) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 *Ts or 66.7 µs.  **3.1 Symbols** For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160\times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144\times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512\times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”



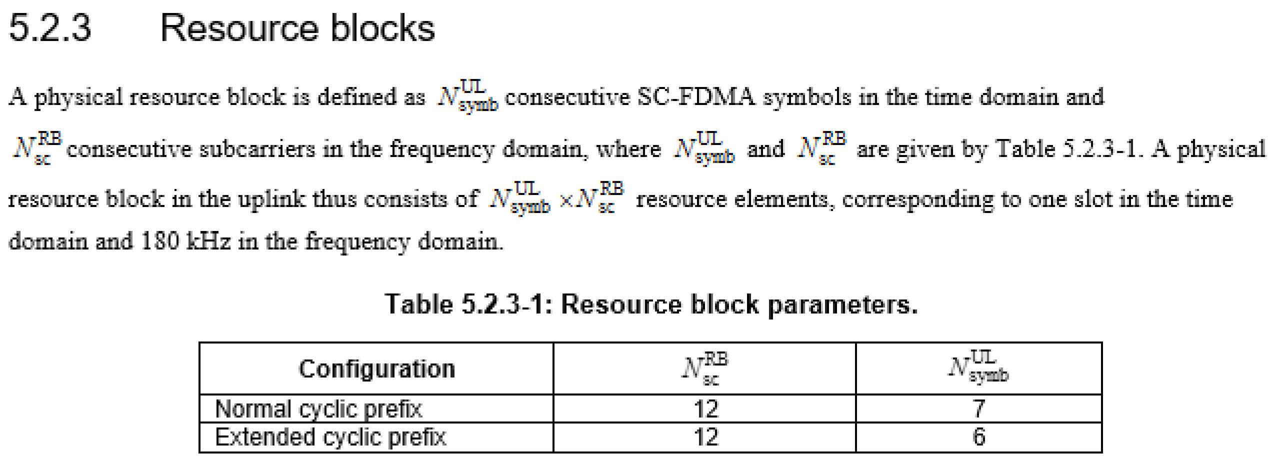
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

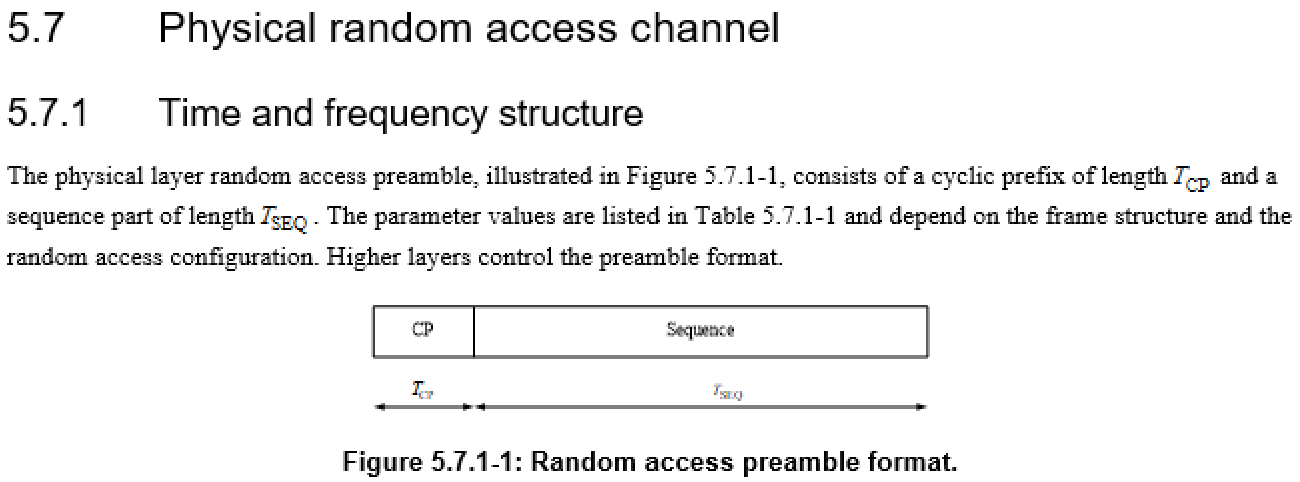
A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ} . The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

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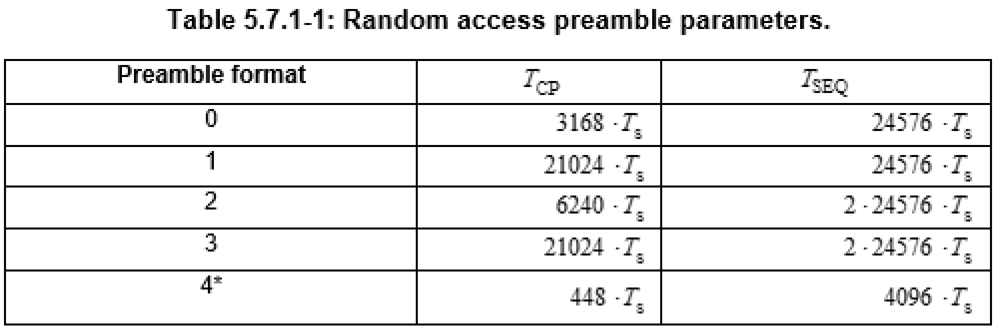
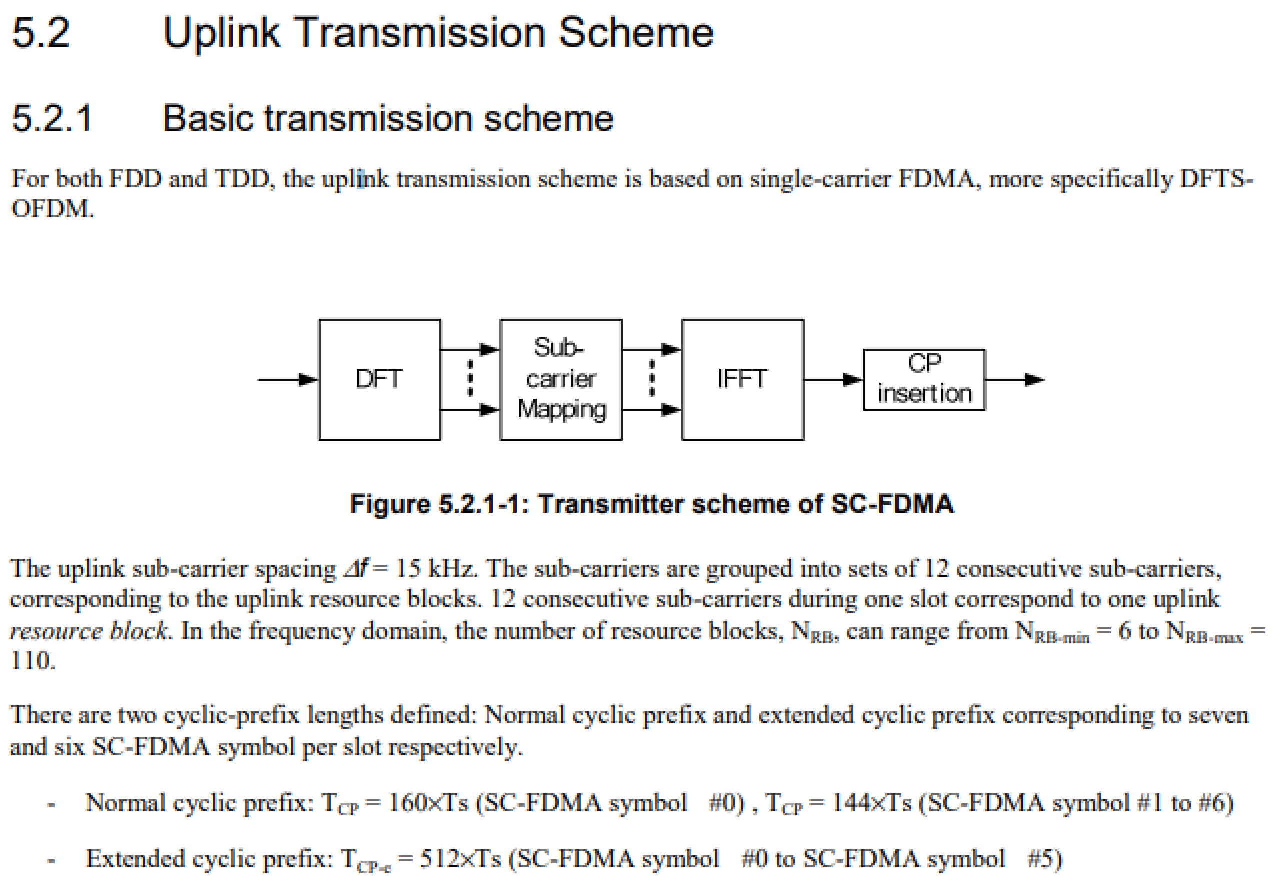


Table 5.7.1-1: Random access preamble parameters.

<table>
<tr><th>Preamble format</th><th>T_{CP}</th><th>T_{SEQ}</th></tr>
<tr><td>0</td><td>$3168 \cdot T_s$</td><td>$24576 \cdot T_s$</td></tr>
<tr><td>1</td><td>$21024 \cdot T_s$</td><td>$24576 \cdot T_s$</td></tr>
<tr><td>2</td><td>$6240 \cdot T_s$</td><td>$2 \cdot 24576 \cdot T_s$</td></tr>
<tr><td>3</td><td>$21024 \cdot T_s$</td><td>$2 \cdot 24576 \cdot T_s$</td></tr>
<tr><td>4*</td><td>$448 \cdot T_s$</td><td>$4096 \cdot T_s$</td></tr>
</table>

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.
</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 21(e)
"a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;"

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	Mercedes's Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, Mercedes's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

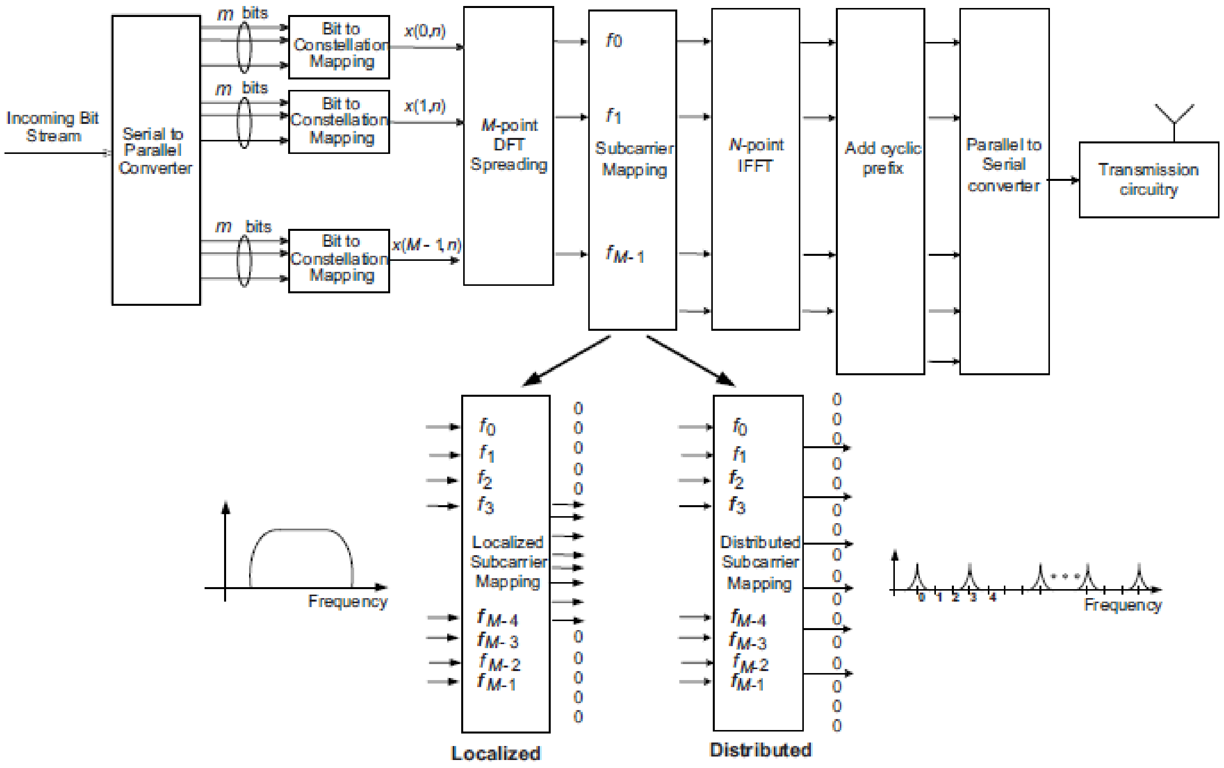


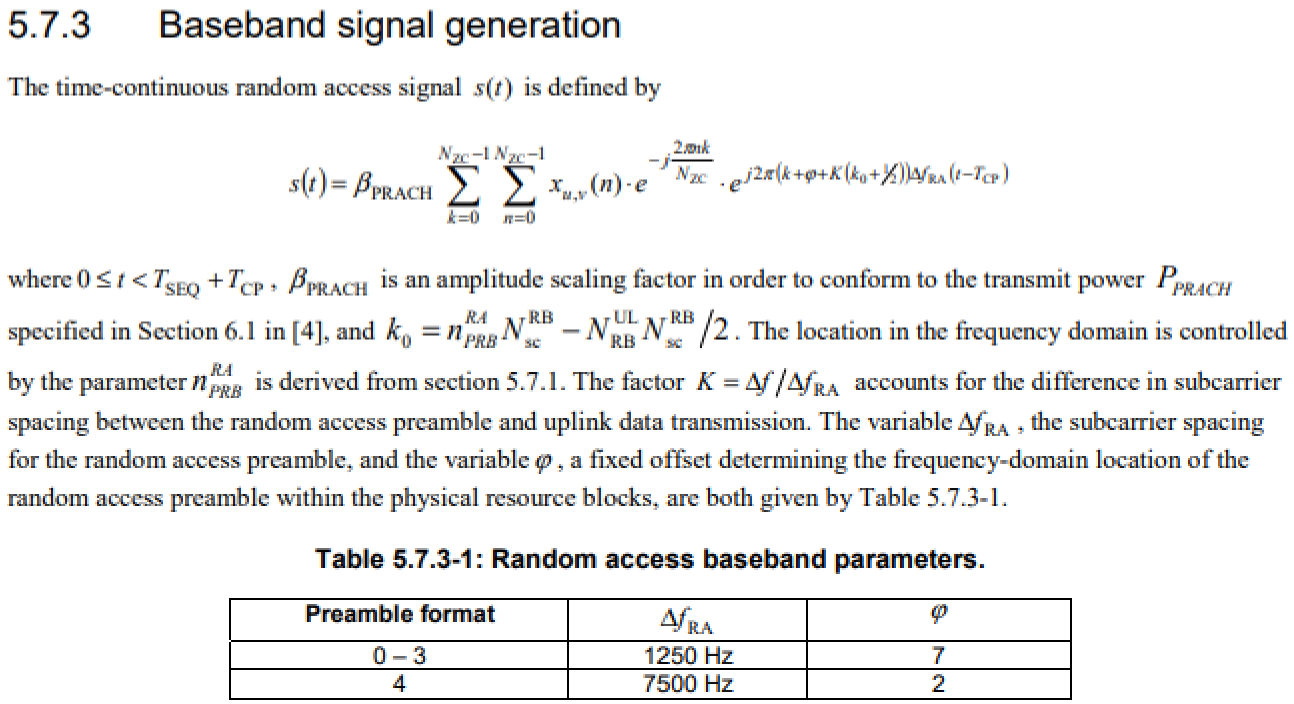
Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

US Patent No. 10,833,908: Claim 21(f)
"wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band"

<table>
<tr>
<td>wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;</td>
<td>
Mercedes's Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}} \sum_{k=0}^{N_{ZC}-1} \sum_{n=0}^{N_{ZC}-1} x_{u,v}(n) \cdot e^{-j\frac{2\pi nk}{N_{ZC}}} \cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

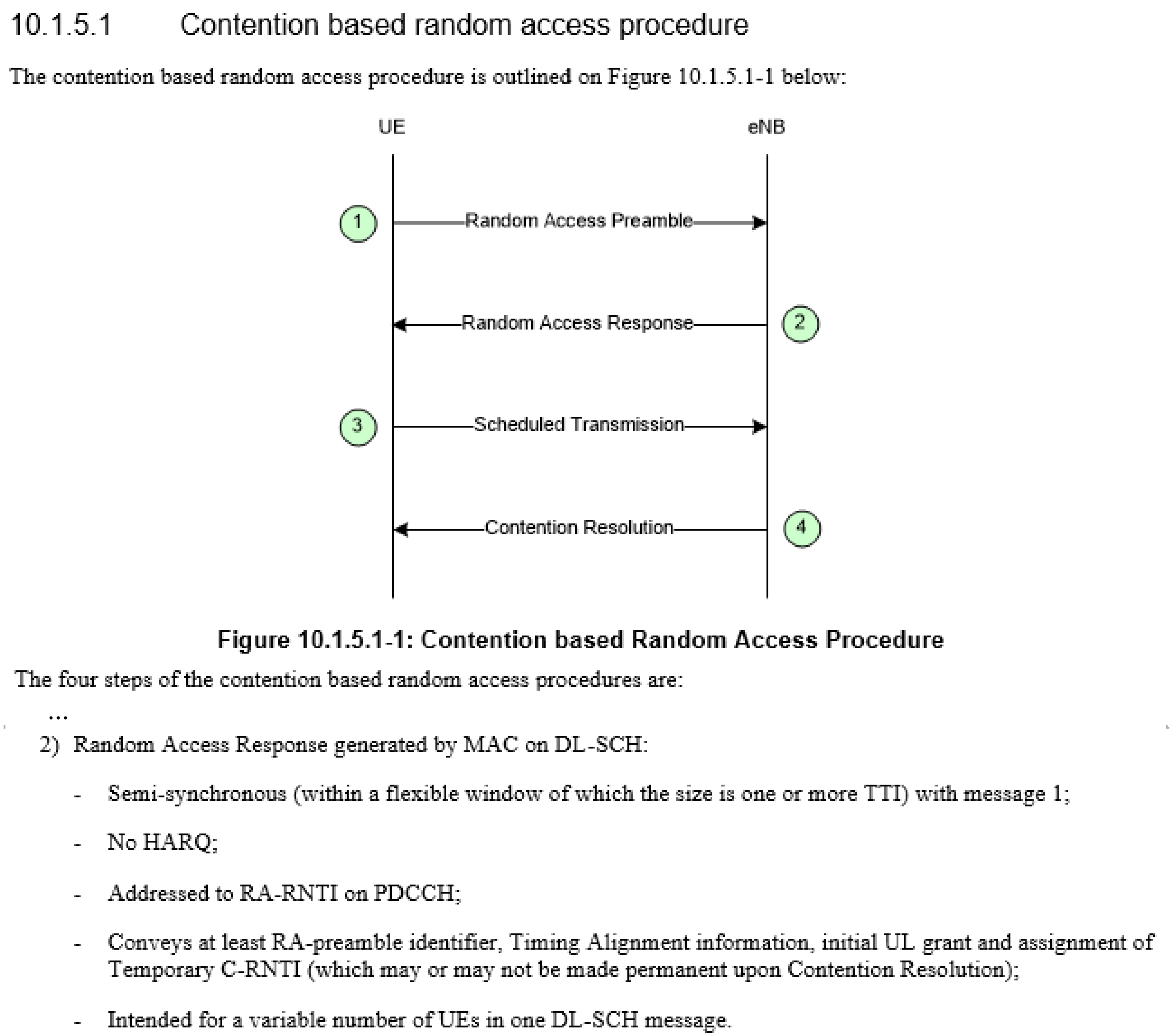
where $0 \leq t < T_{\text{SEQ}} + T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0 = n_{PRB}^{RA} N_{\text{sc}}^{\text{RB}} - N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}} / 2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K = \Delta f / \Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

<table>
<tr><th>Preamble format</th><th>Δf_{RA}</th><th>φ</th></tr>
<tr><td>0 – 3</td><td>1250 Hz</td><td>7</td></tr>
<tr><td>4</td><td>7500 Hz</td><td>2</td></tr>
</table>

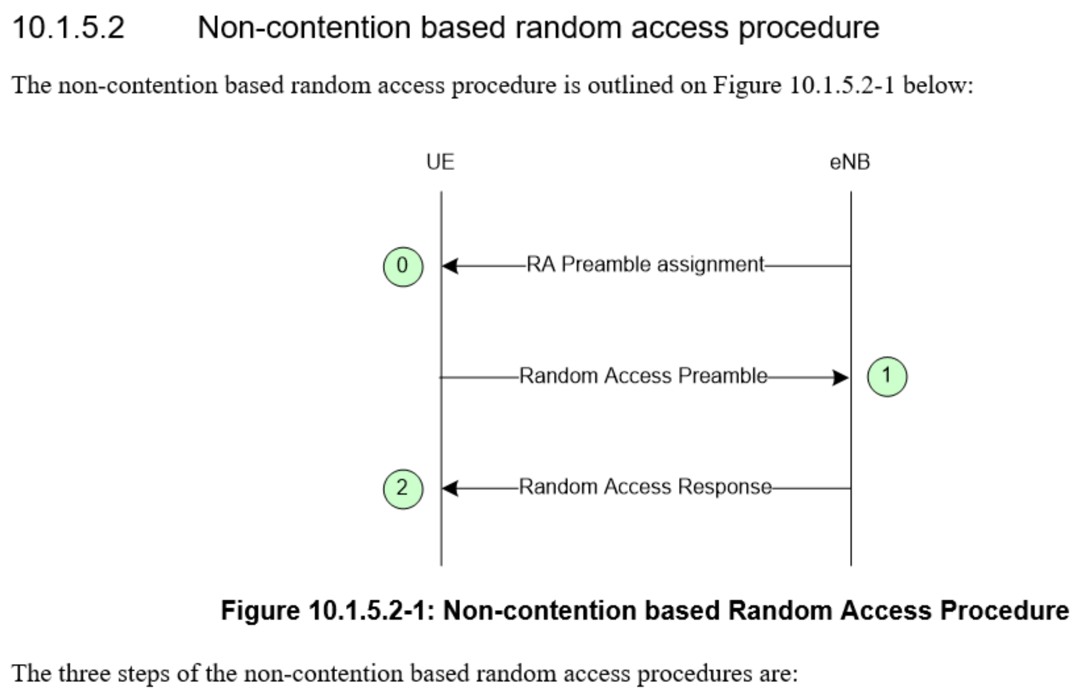
See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.
</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

wherein the mobile station is further configured to receive, from the base station, a second analog signal	Mercedes’s Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



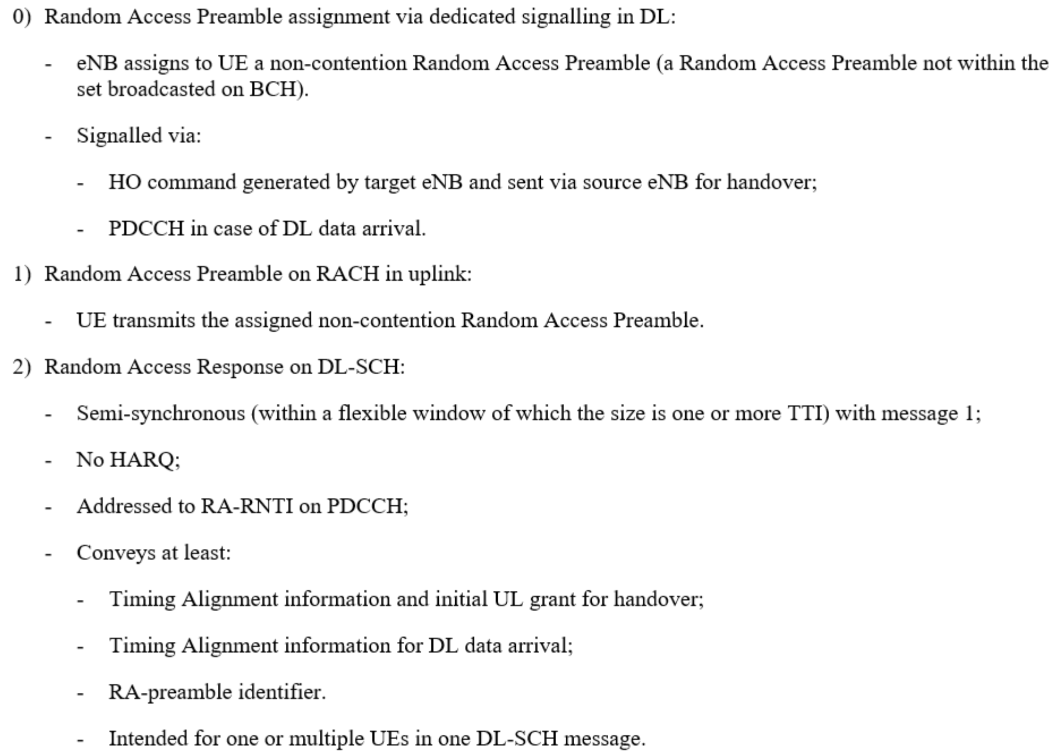
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

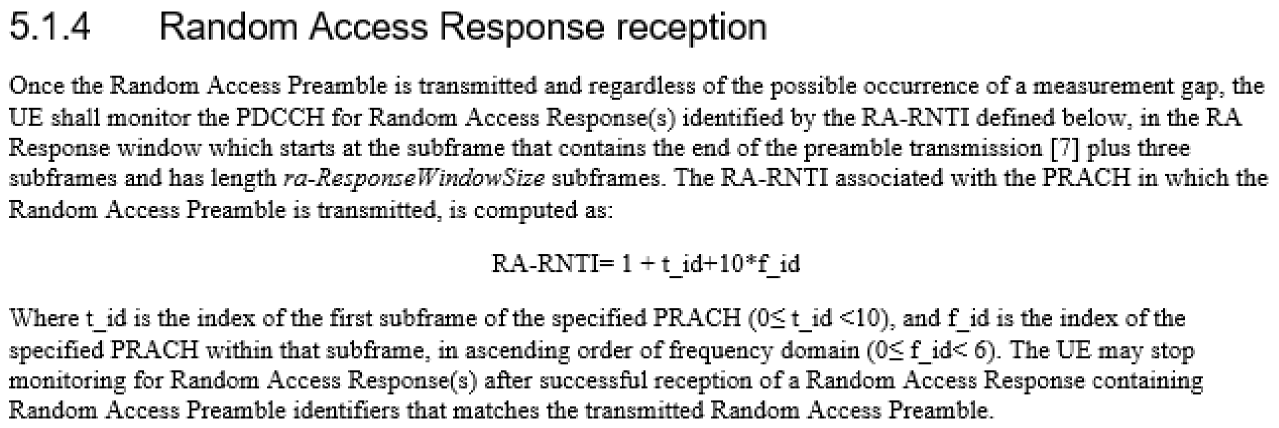
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

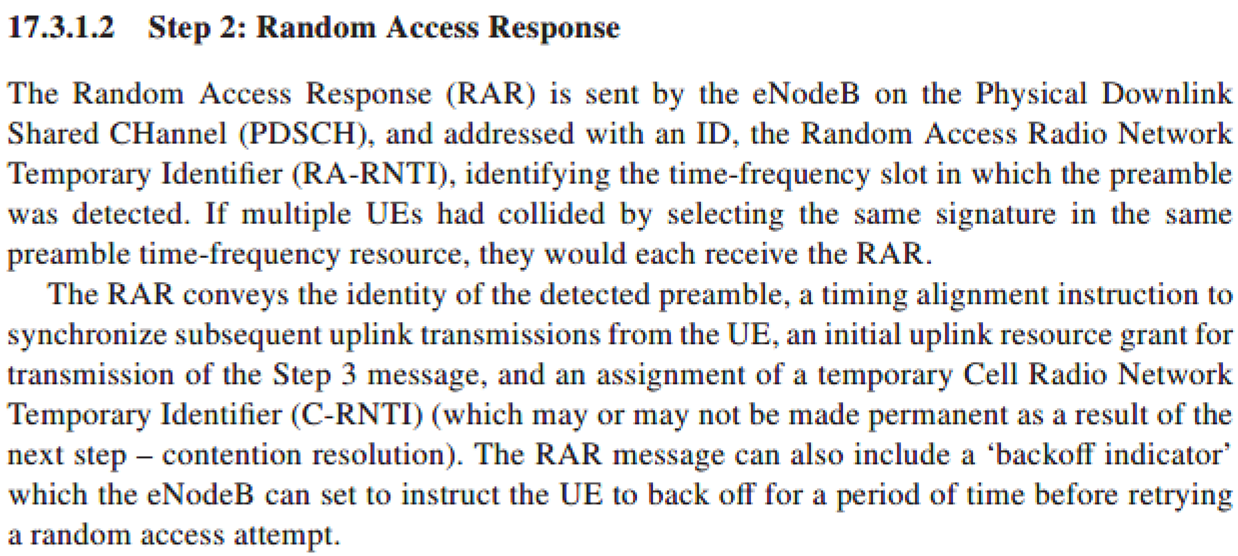
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + \text{t\_id}+10*\text{f\_id}$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq \text{t\_id} <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq \text{f\_id}< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

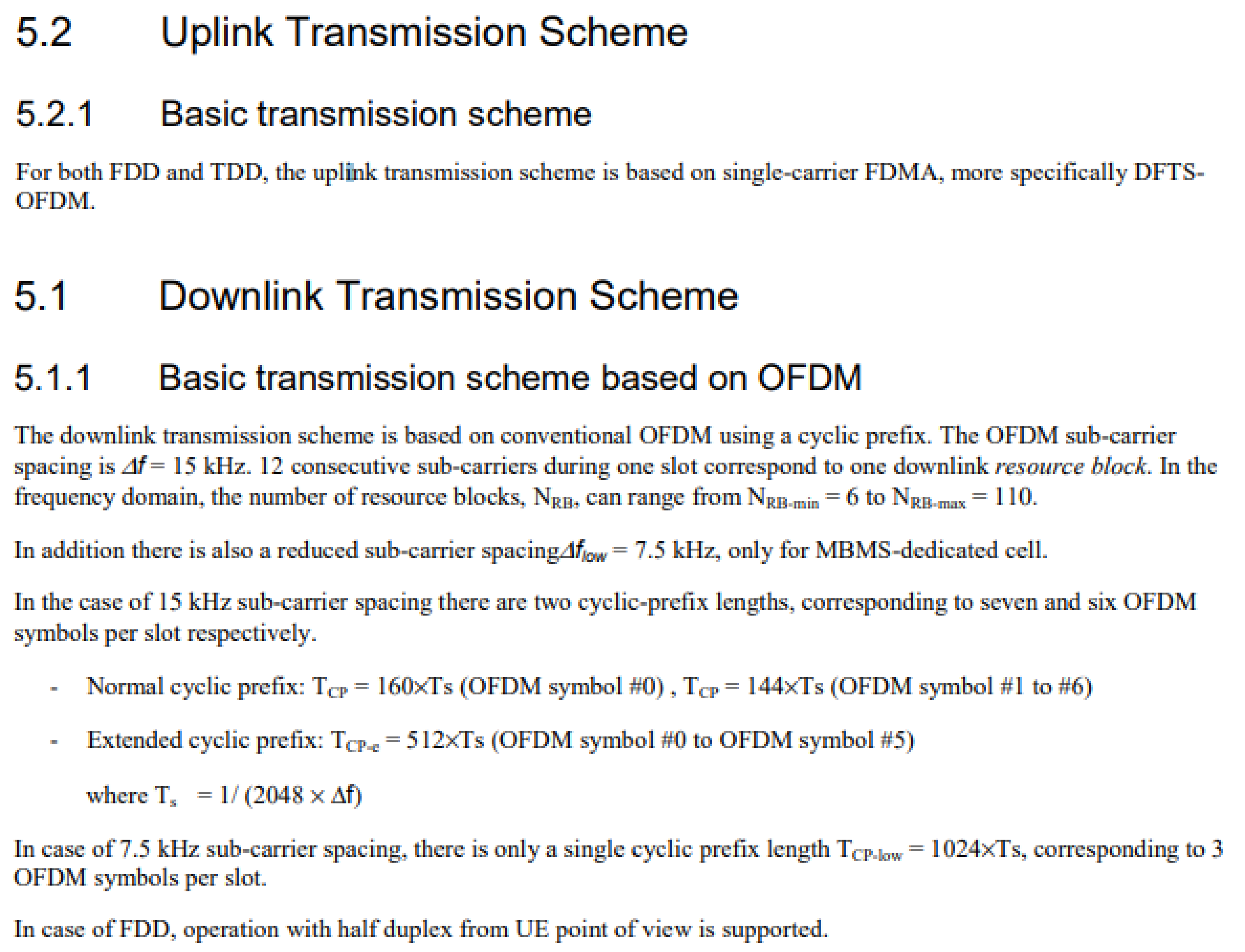


17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	Mercedes's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, Mercedes's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. 5.1 Downlink Transmission Scheme 5.1.1 Basic transmission scheme based on OFDM The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. In addition there is also a reduced sub-carrier spacing $\Delta f_{low} = 7.5$ kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

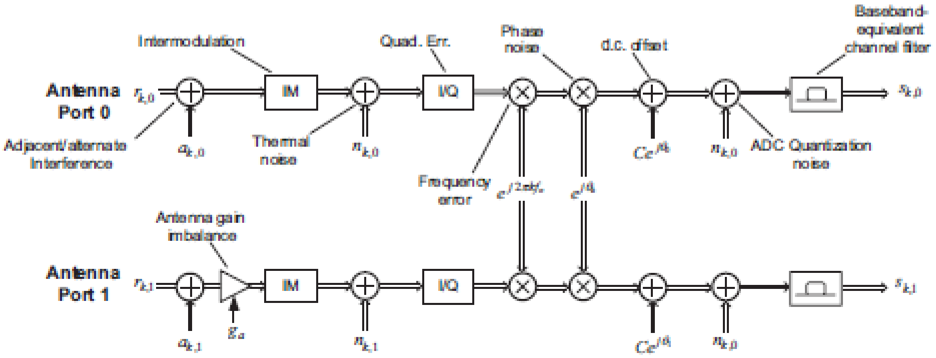
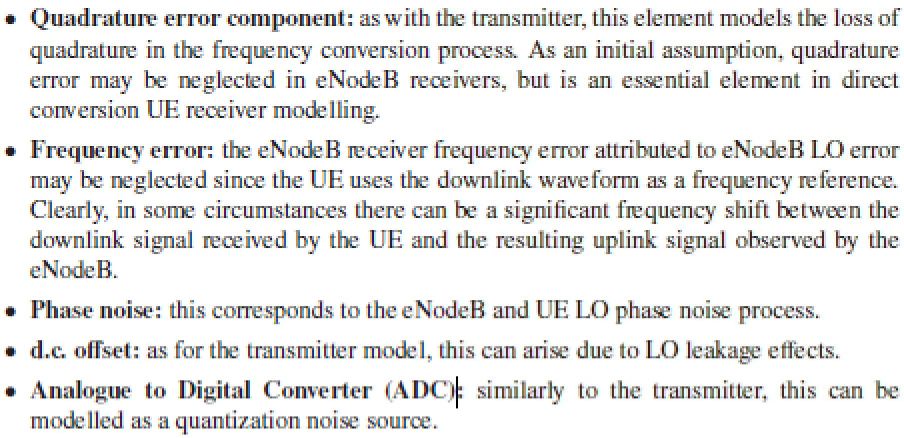


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.



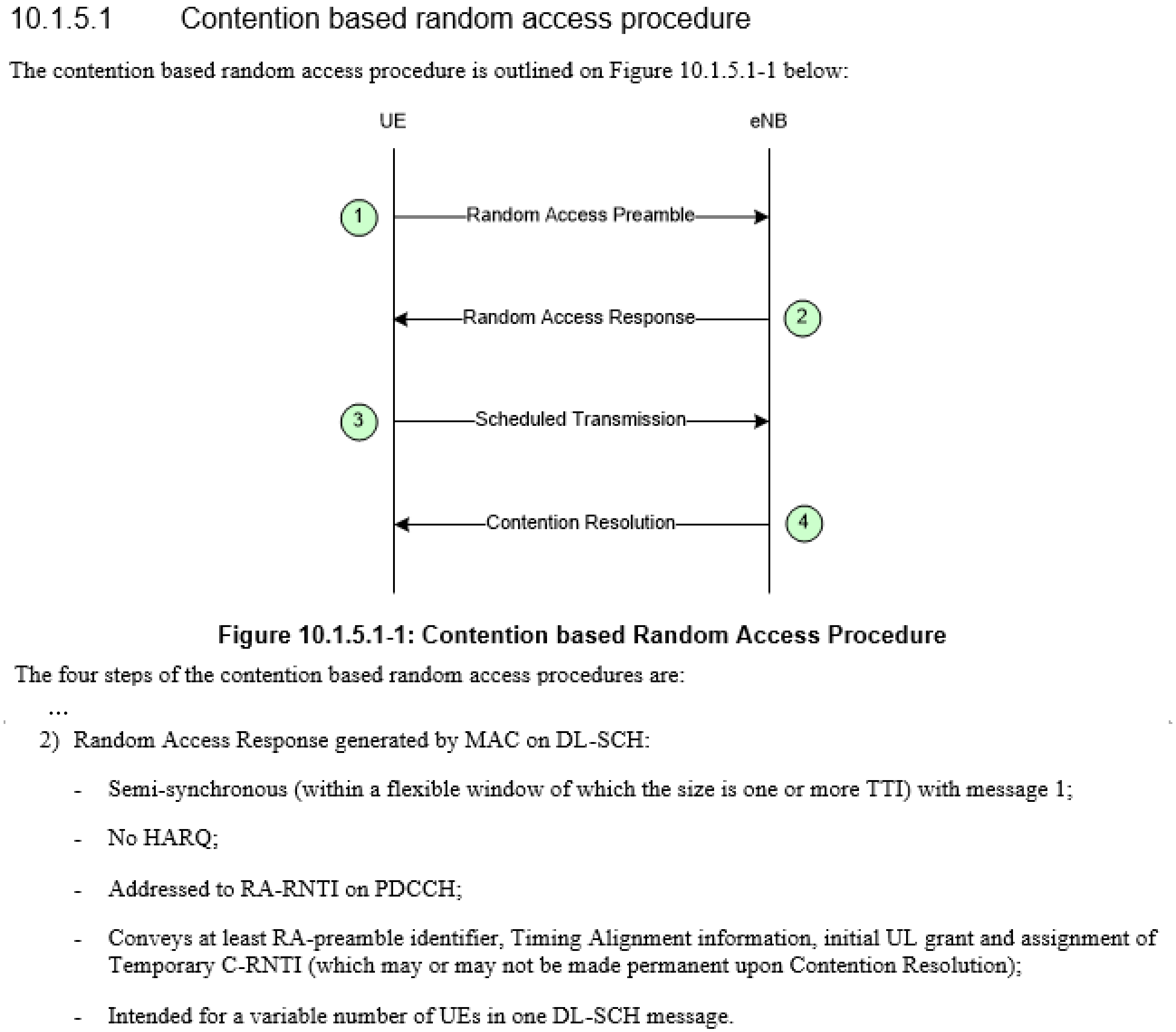
- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

...

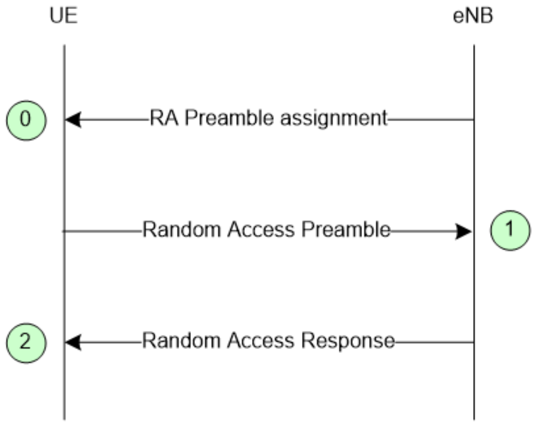
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

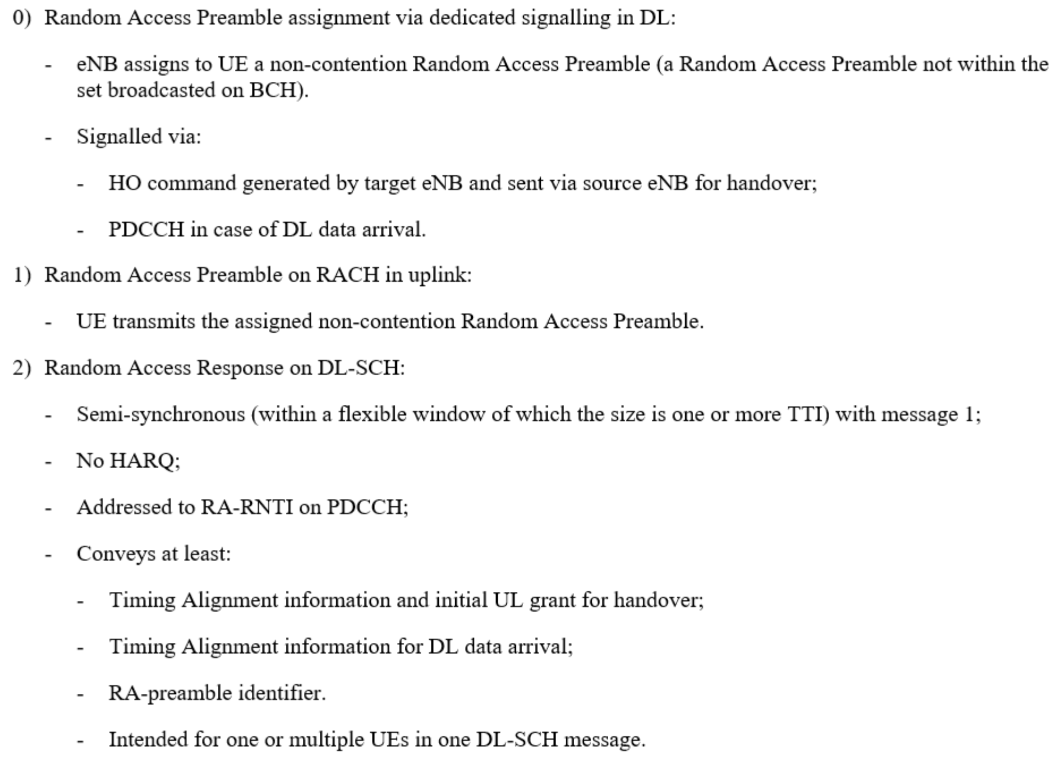
US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

	10.1.5.2 Non-contention based random access procedure The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:  **Figure 10.1.5.2-1: Non-contention based Random Access Procedure** The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

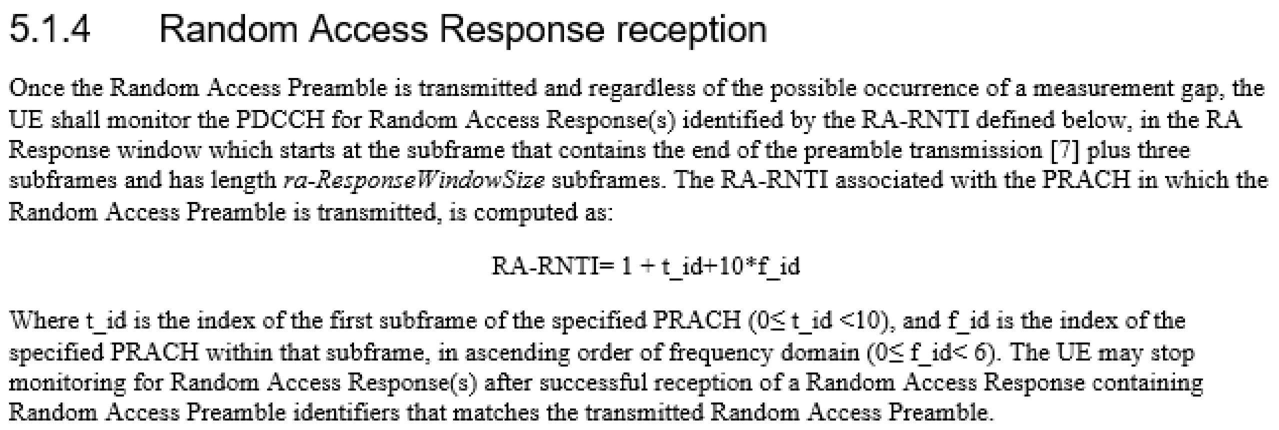


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

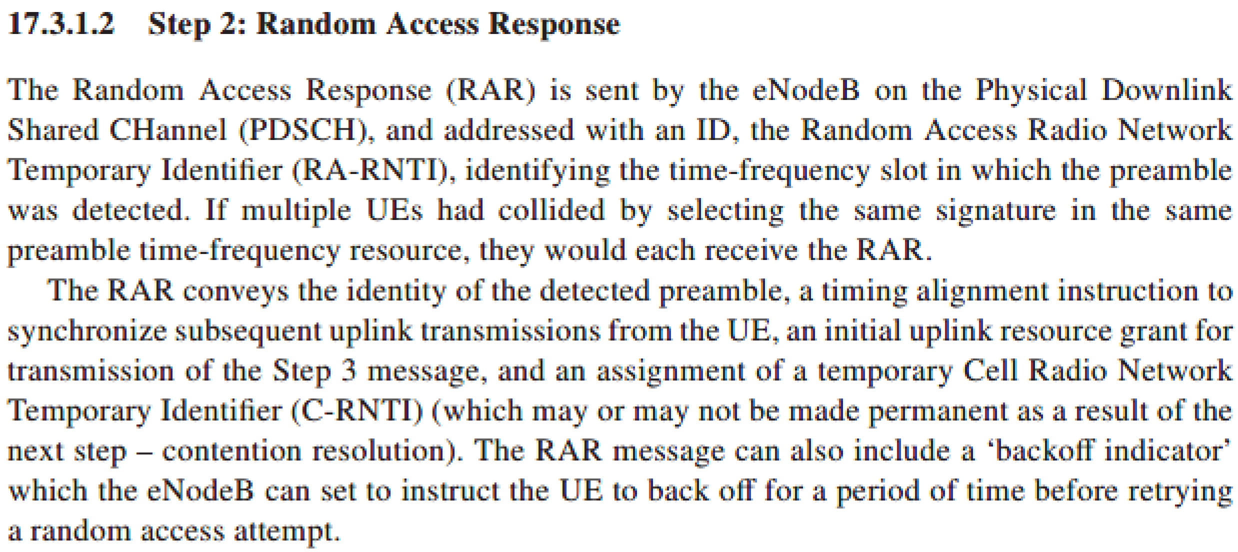
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + \text{t\_id}+10*\text{f\_id}$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq \text{t\_id} <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq \text{f\_id}< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

US Patent No. 10,833,908: Claim 21(h)
“wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message..”

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.



17.3.1.2 Step 2: Random Access Response

The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR.

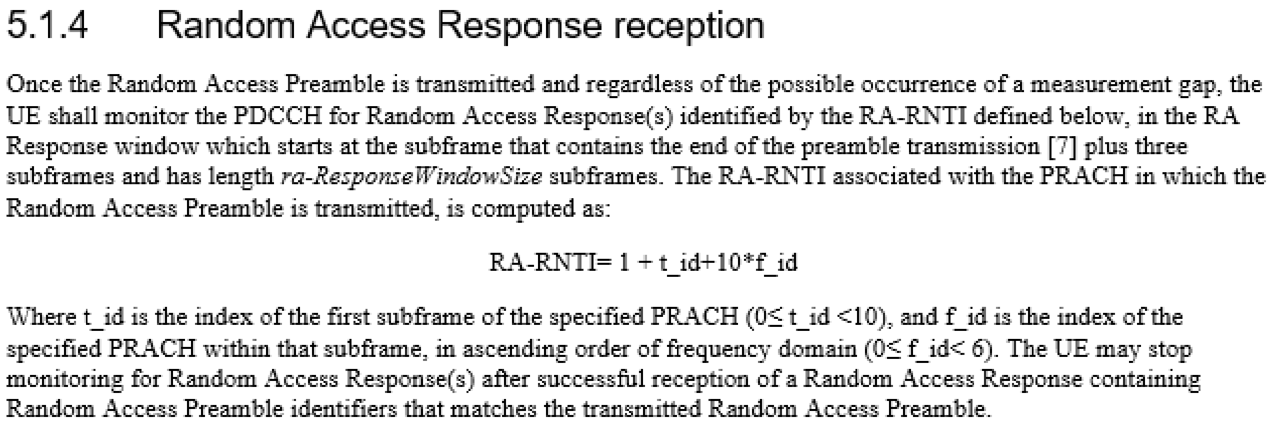
The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt.

See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

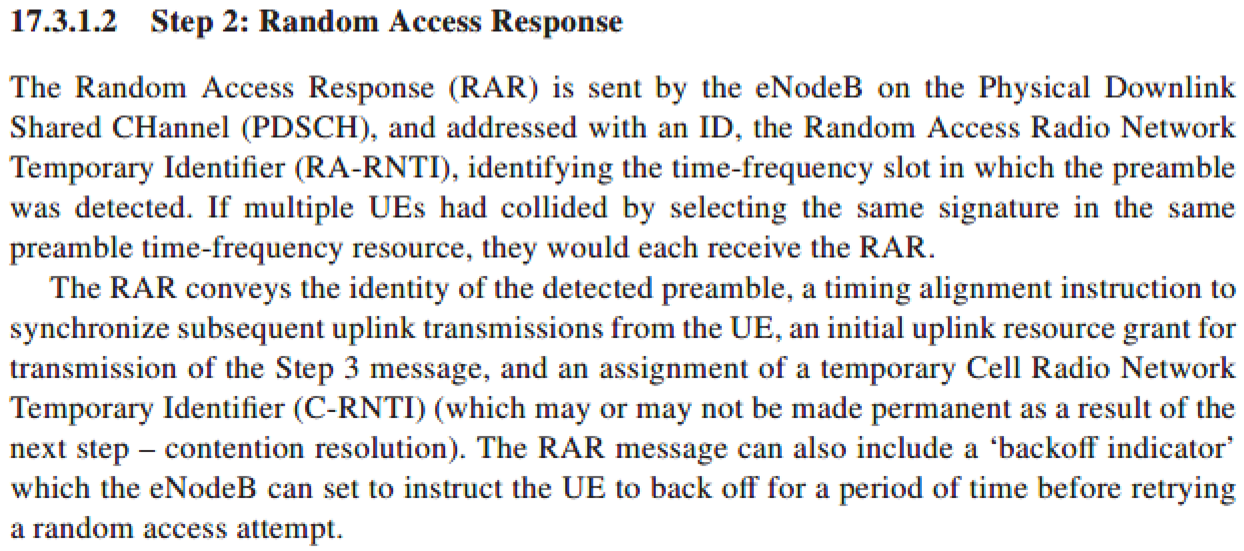
US Patent No. 10,833,908: Claim 22(a)
"The mobile station of claim 21, wherein:"

22. The mobile station of claim 21, wherein:	*See* Claim 21.

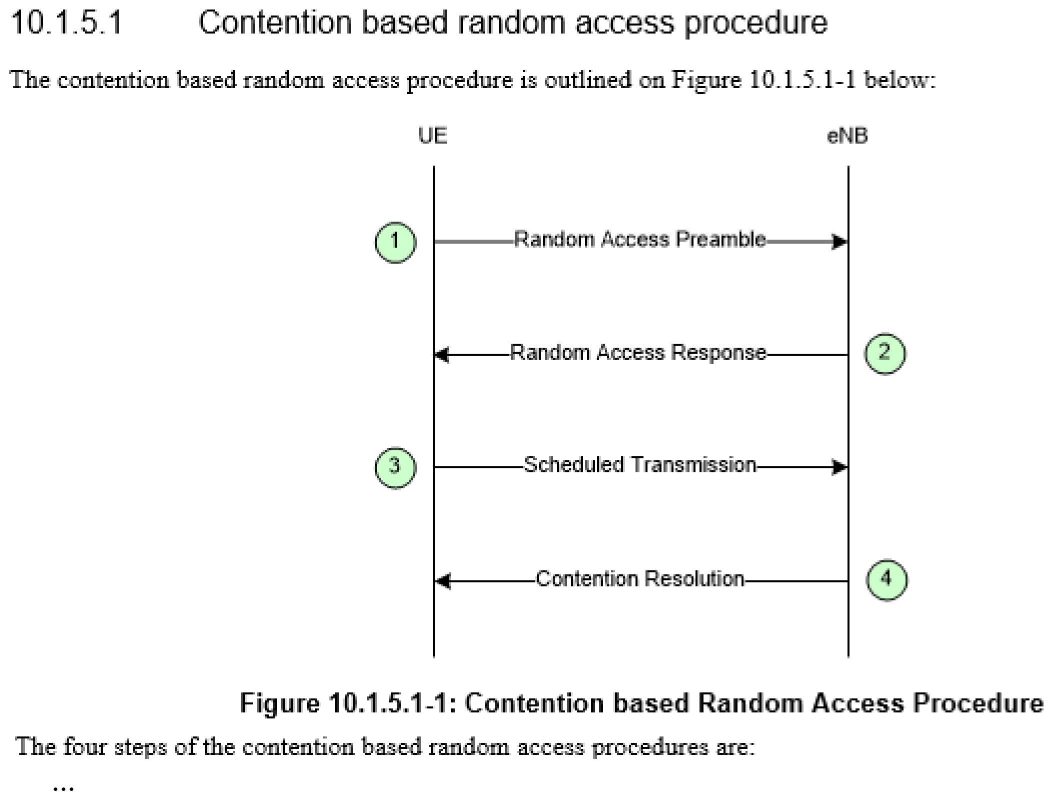
US Patent No. 10,833,908: Claim 22(b)
"the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and"

the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	Mercedes's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

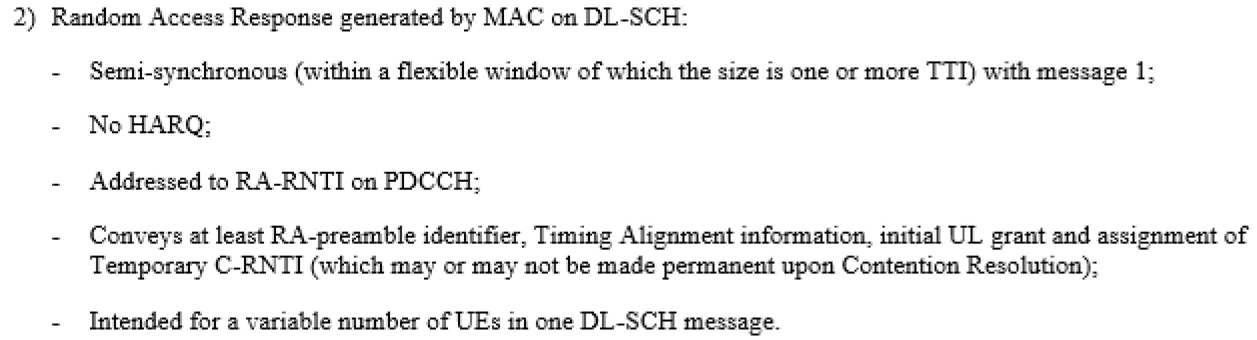
US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, Mercedes’s Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

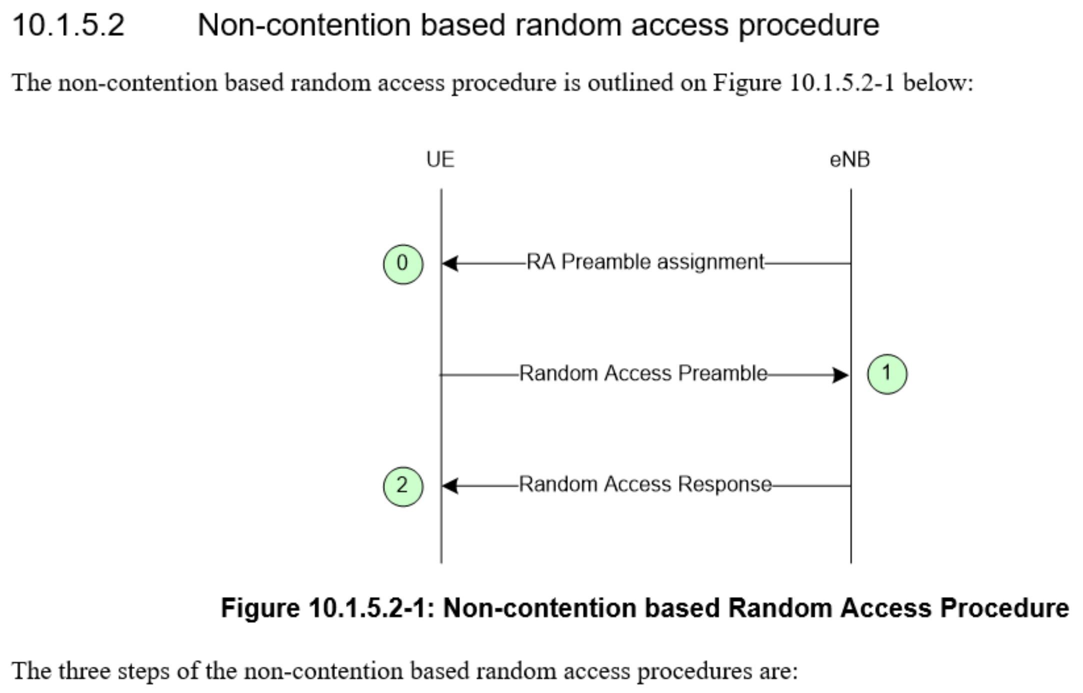
US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



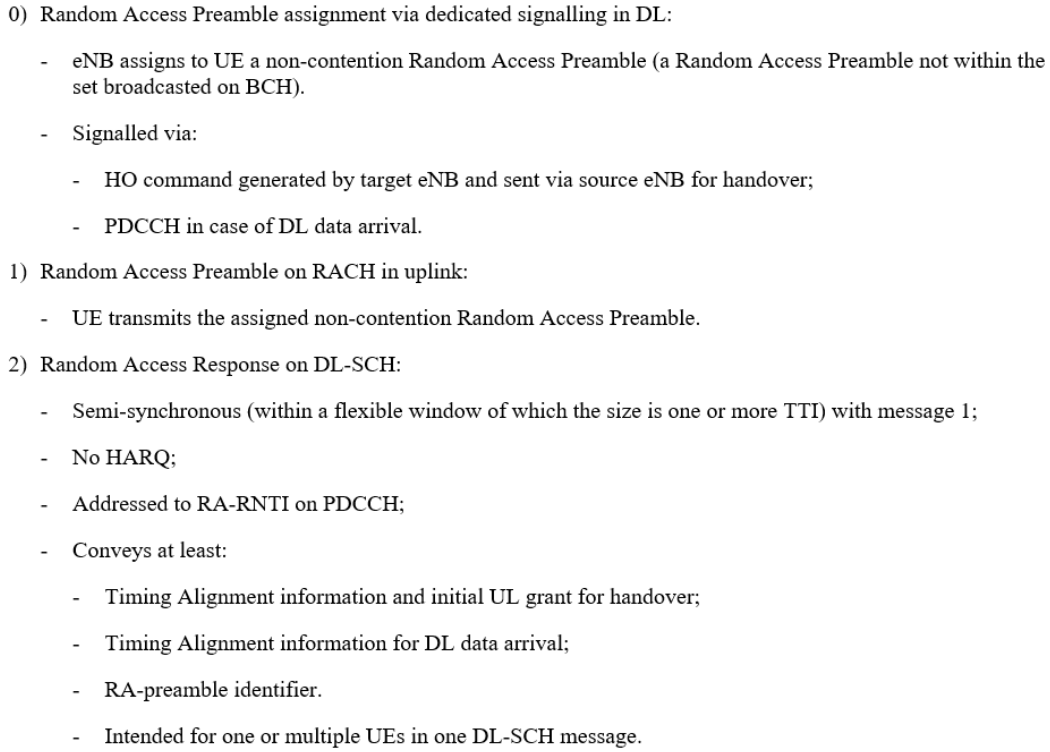
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

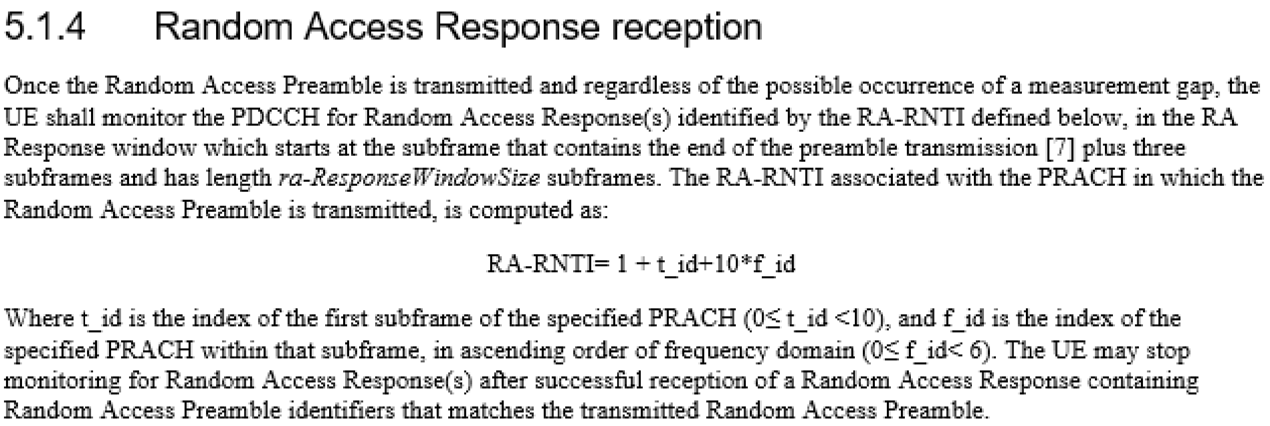


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

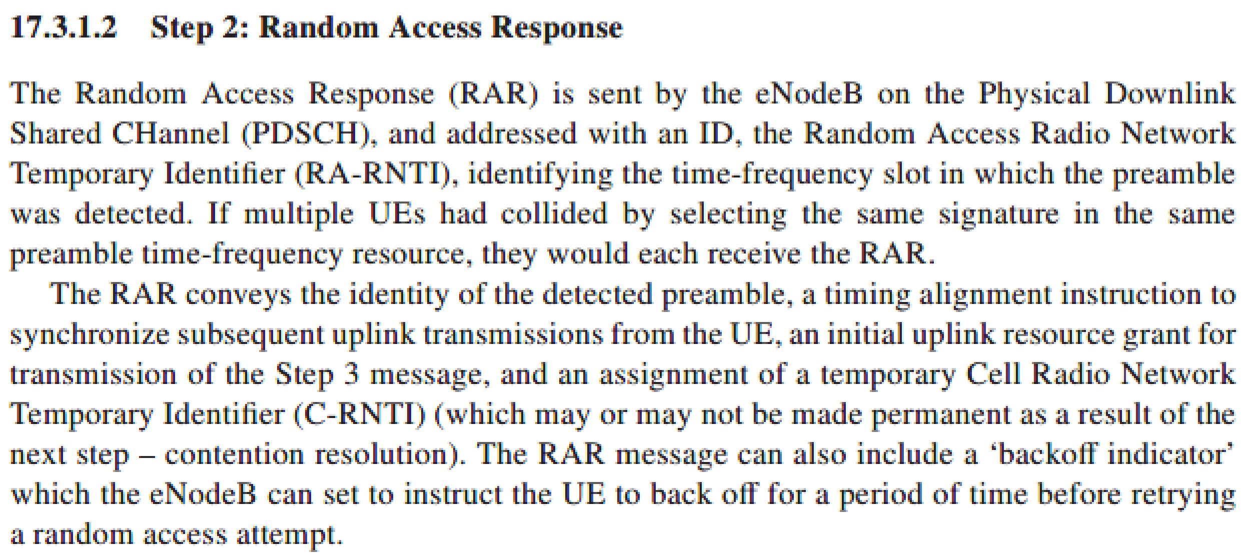
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI= 1 + t_id+10*f_id

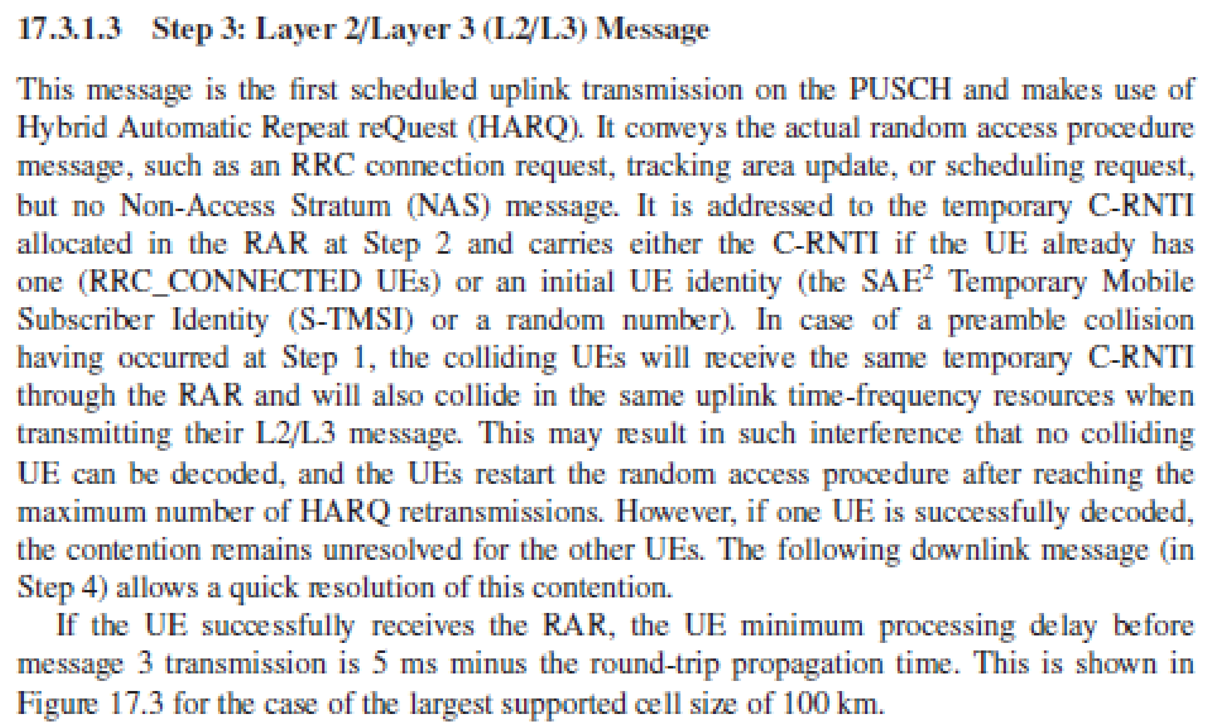
Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."



17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message

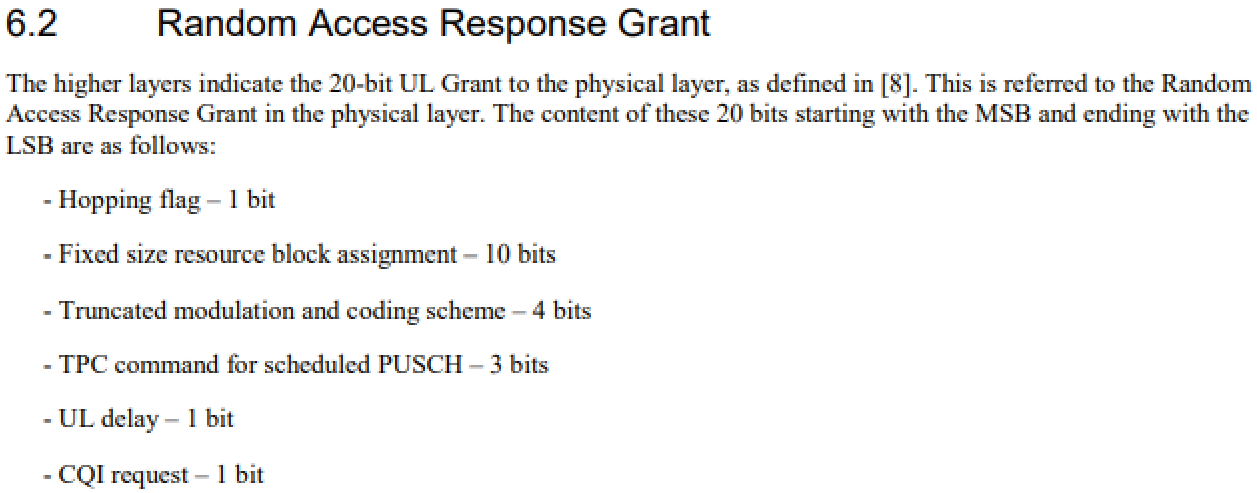
This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention.

If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km.

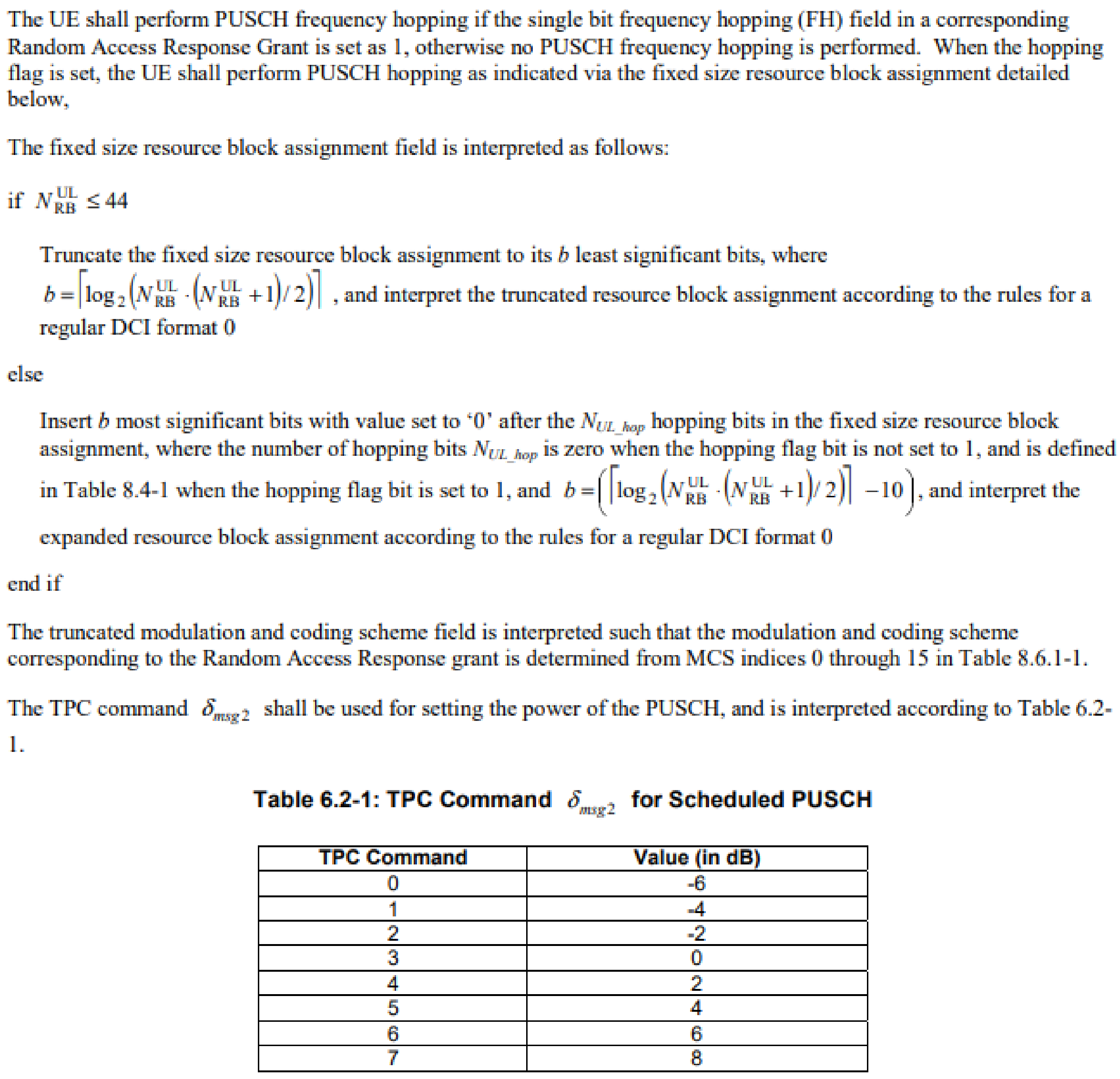
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 375.

See also Claim 2.

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by Mercedes's Accused Instrumentalities includes power adjustment information. *E.g.,* *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(a)
"The mobile station of claim 22, wherein the response message includes power adjustment information and"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

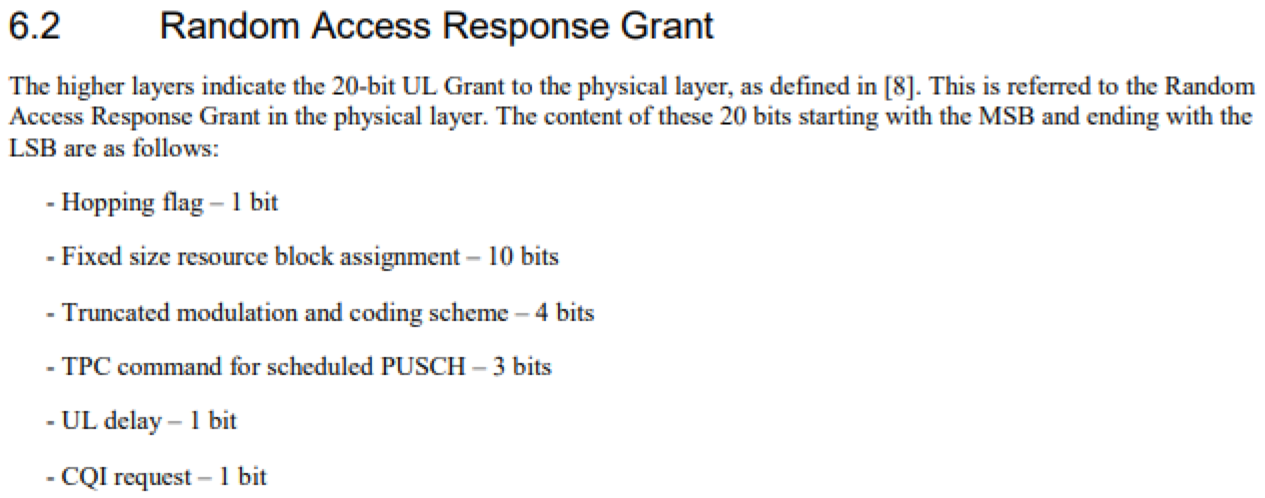
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

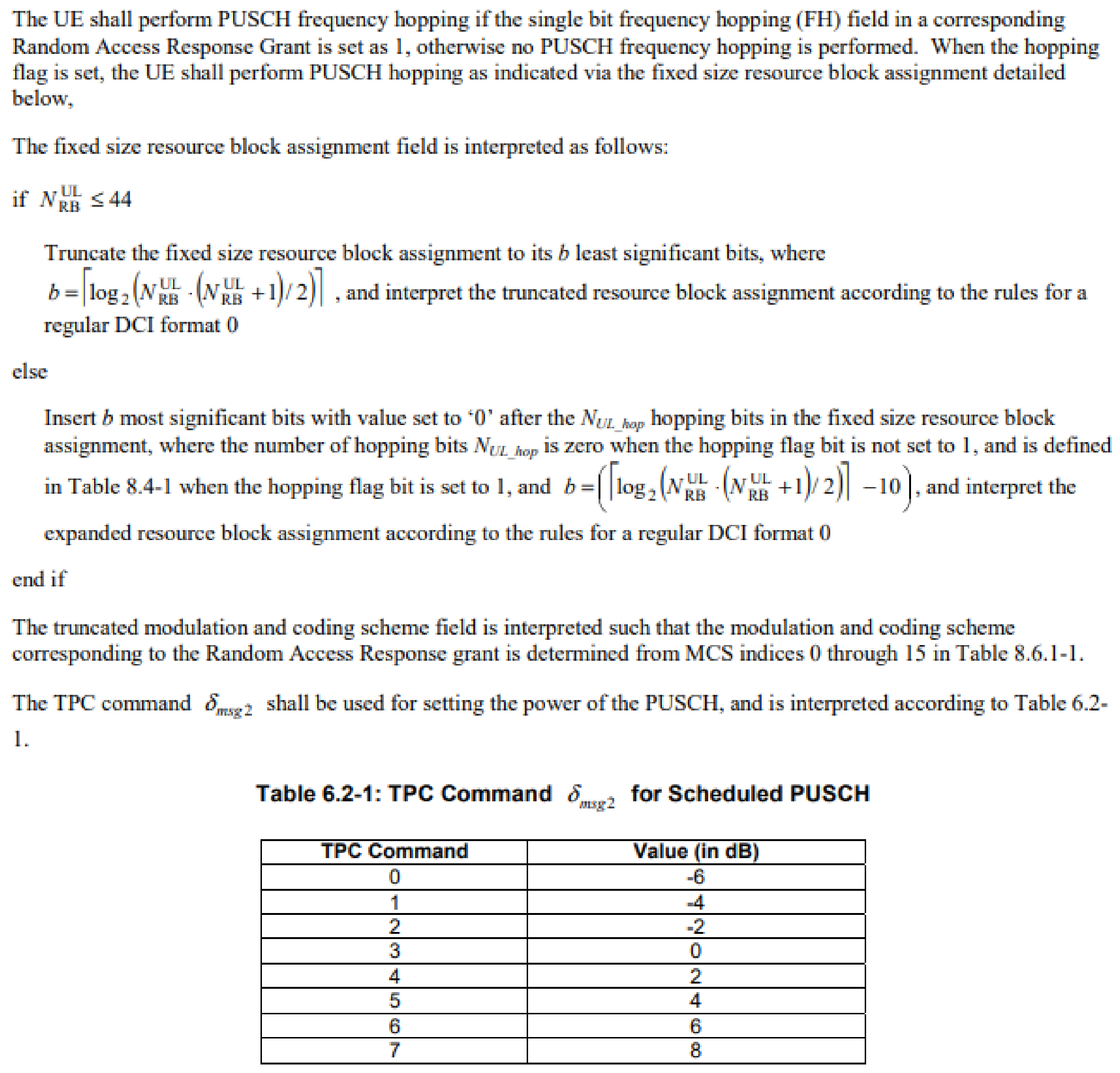
See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	Mercedes's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(b)

“wherein the second uplink signal is transmitted according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2 \left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1 \right) / 2 \right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

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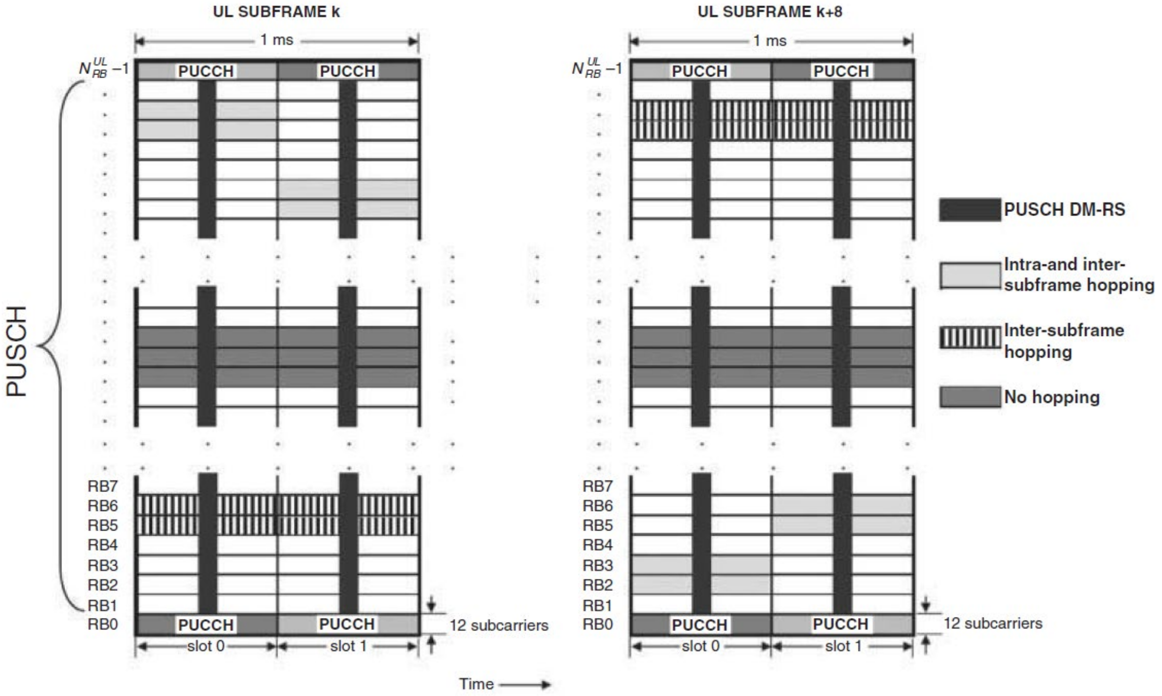
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

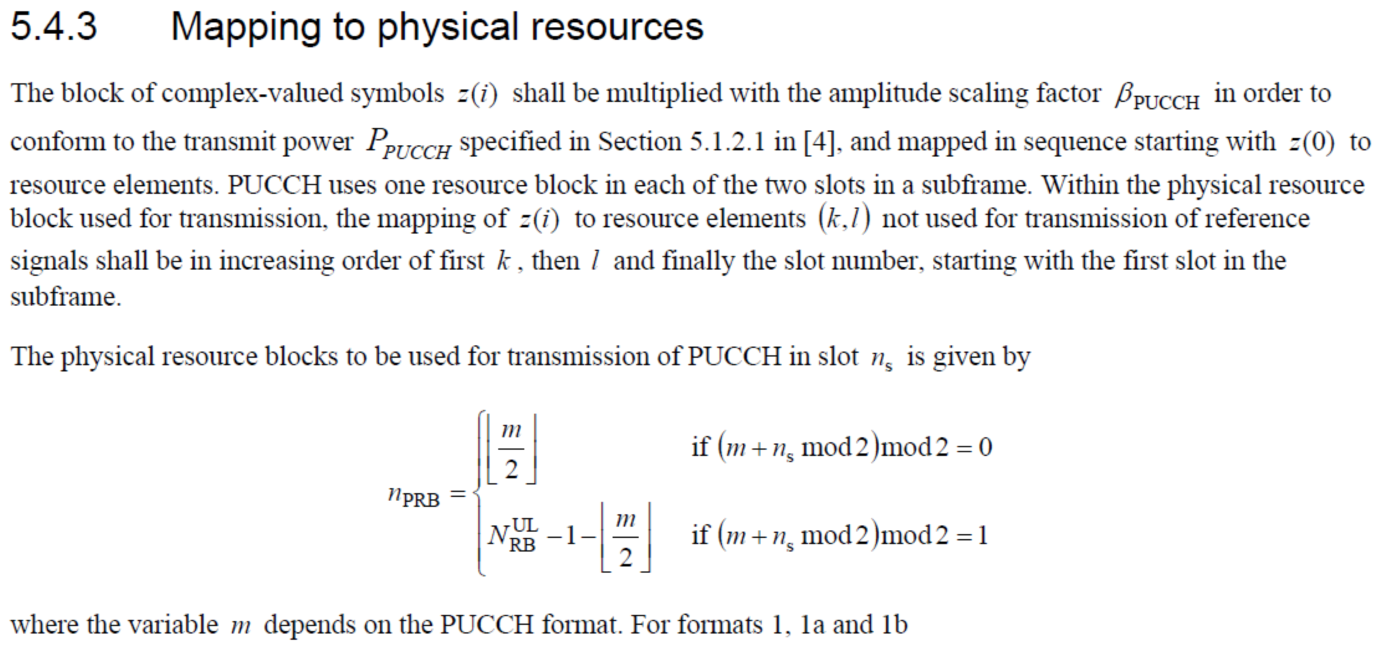
See also Claim 3.

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by Mercedes’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

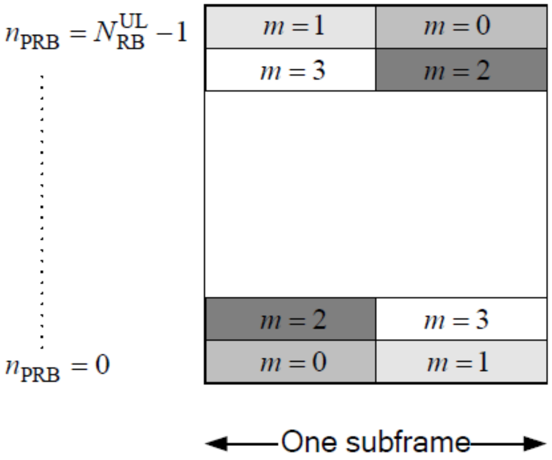


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 24

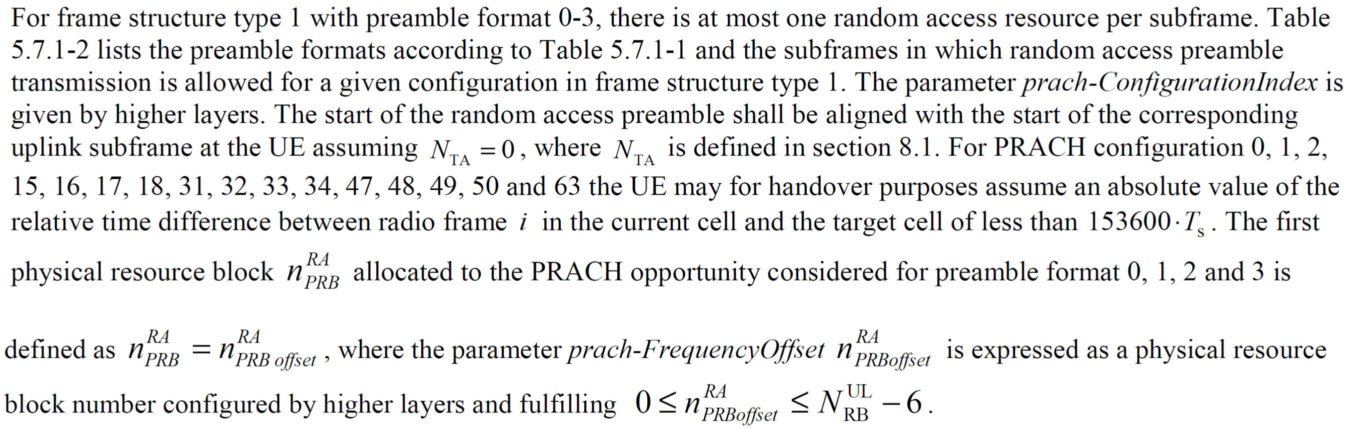
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

...

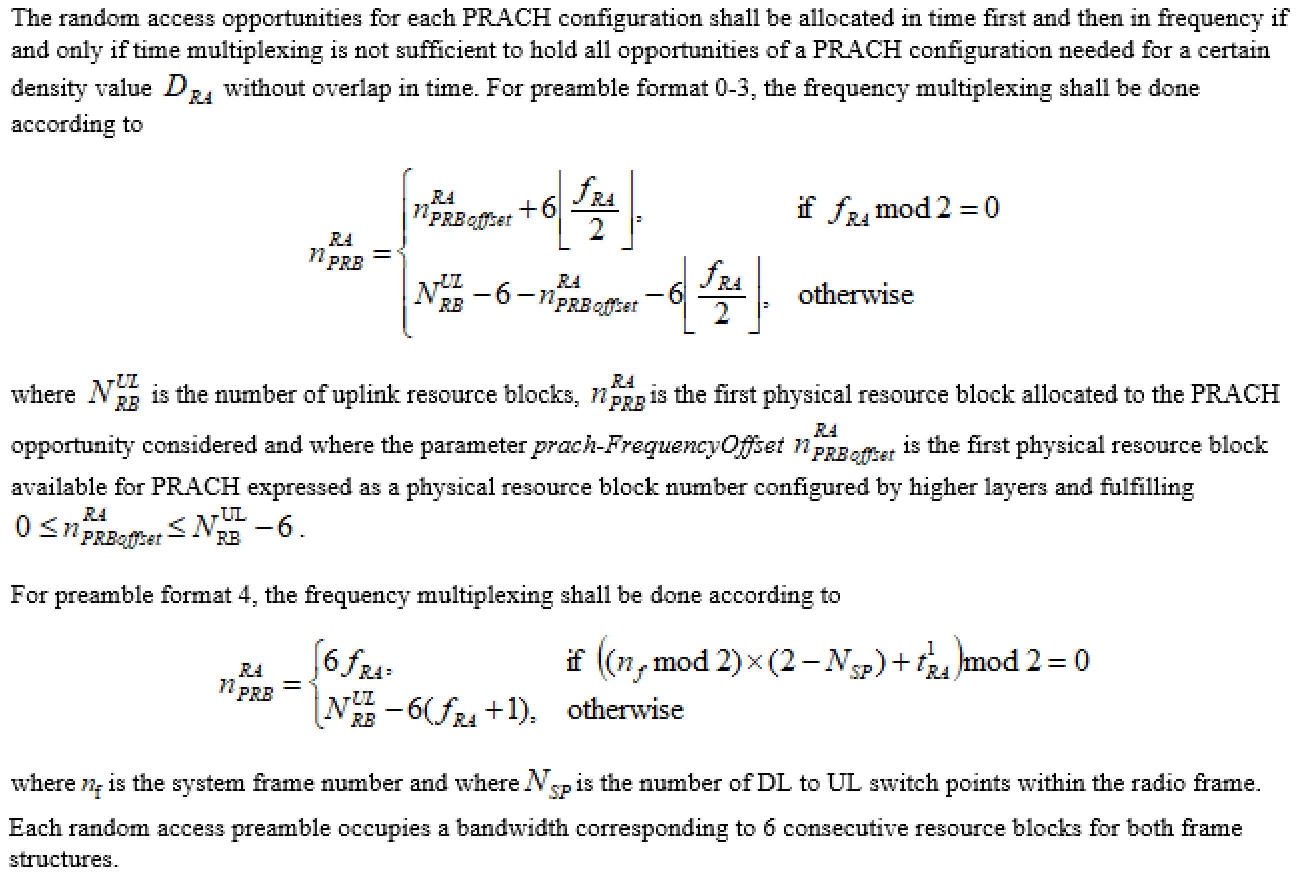


For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 24

" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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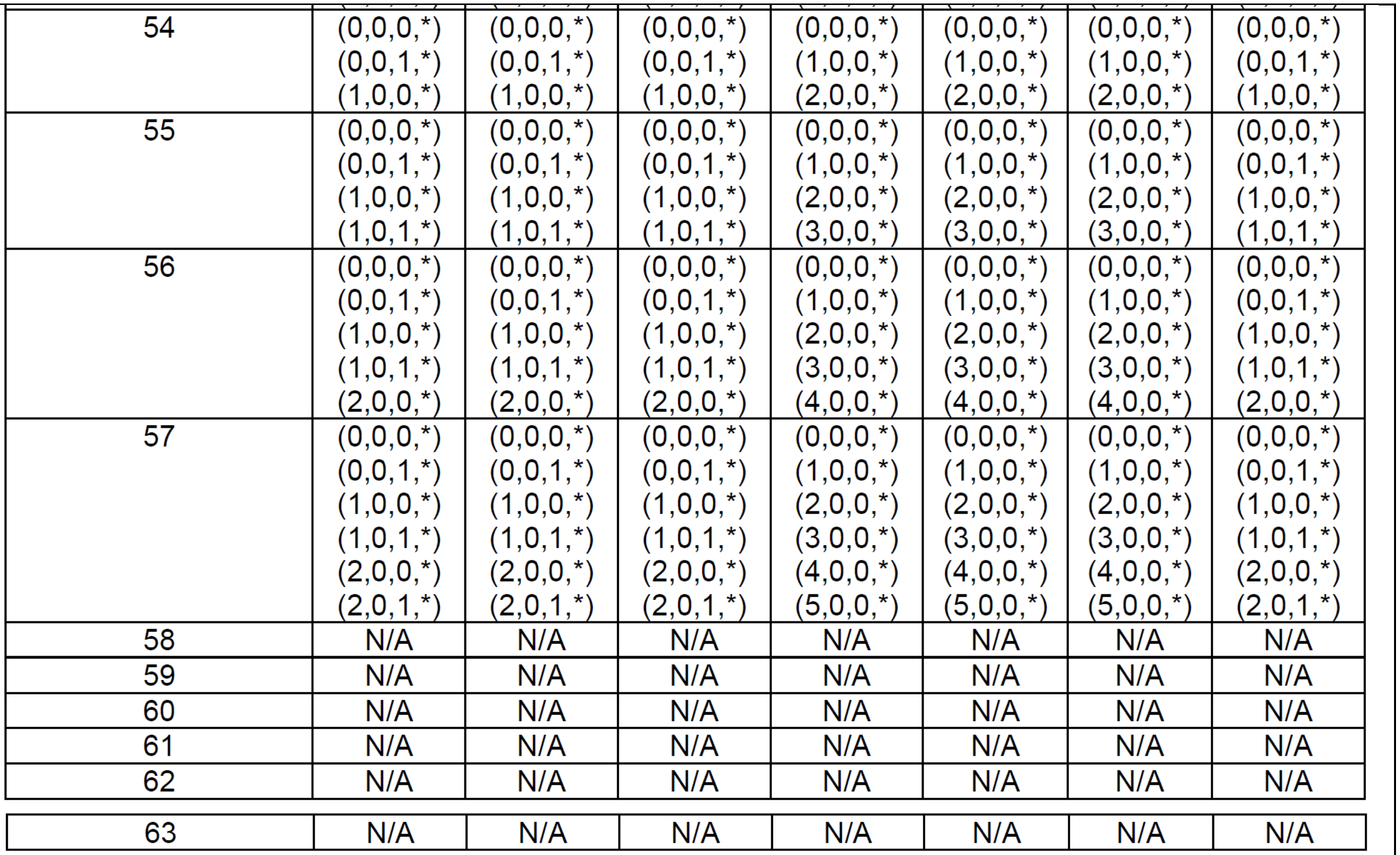
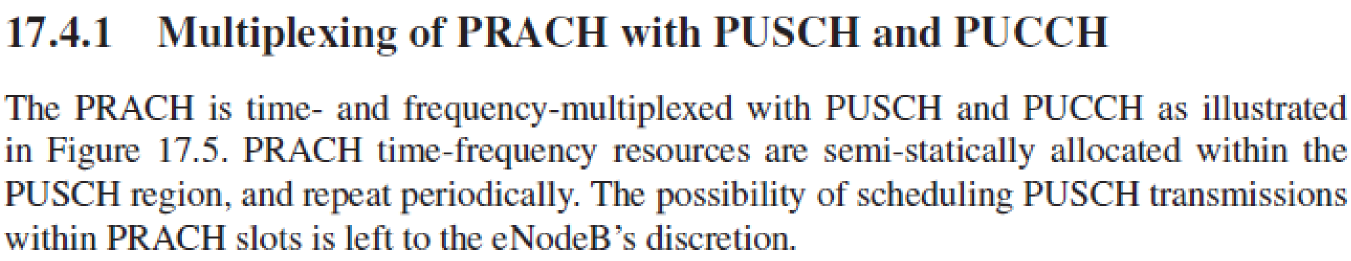
US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

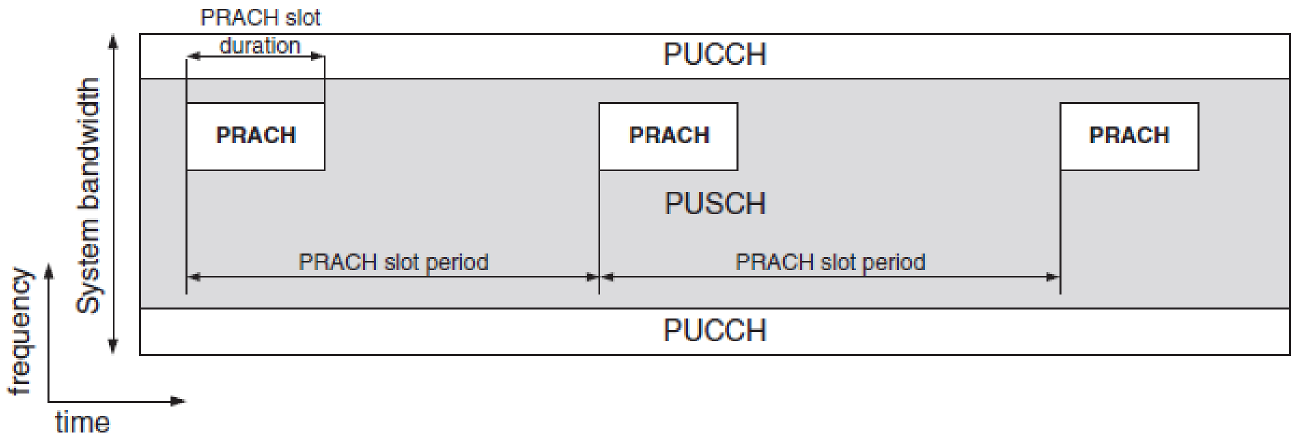
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



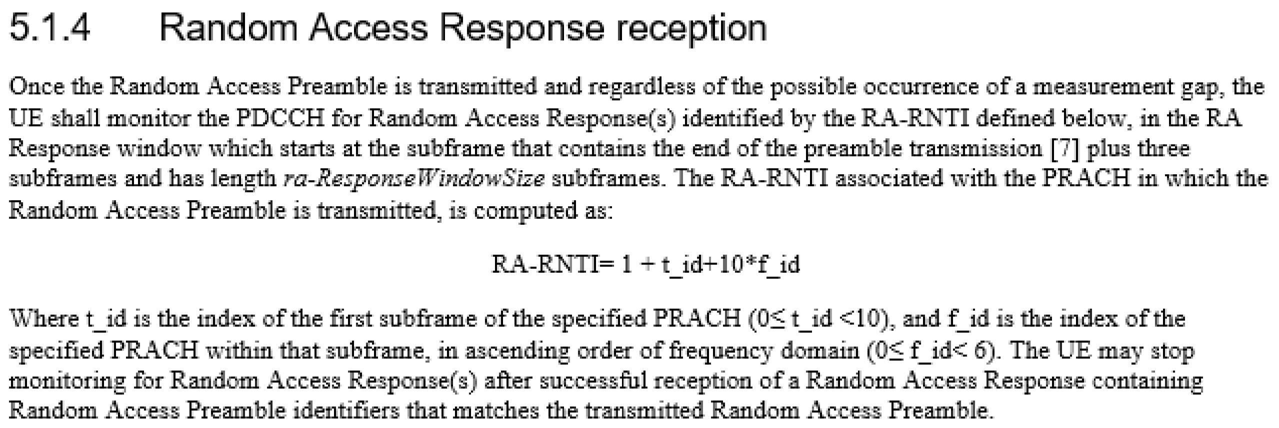
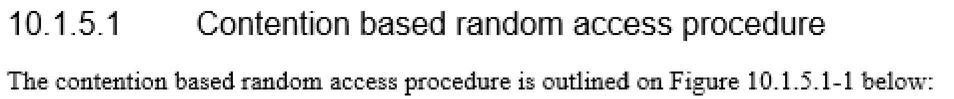
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

US Patent No. 10,833,908: Claim 24
" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 25
“25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.”

25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of Mercedes’s Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station. 5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14. 10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

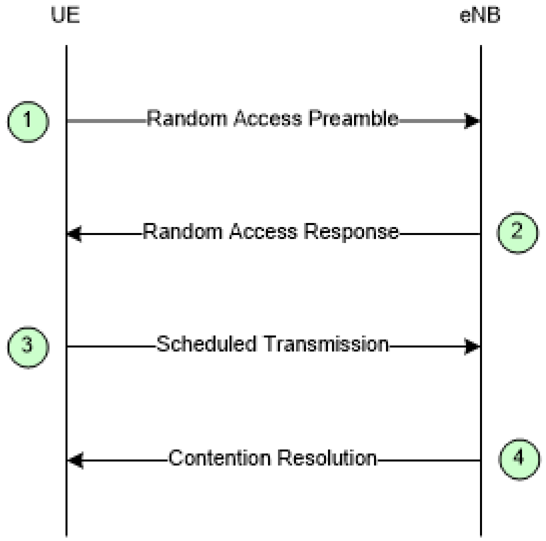
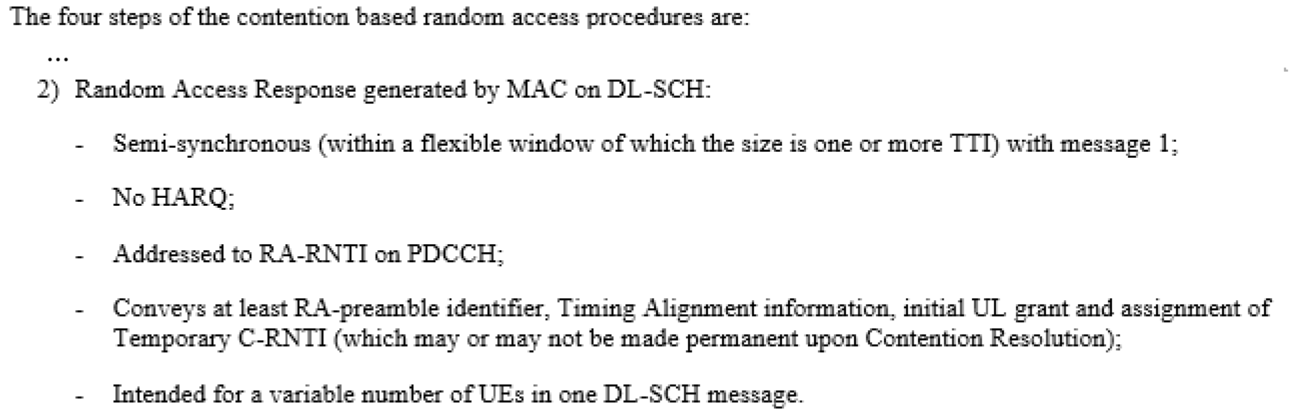


Figure 10.1.5.1-1: Contention based Random Access Procedure


The four steps of the contention based random access procedures are:

...

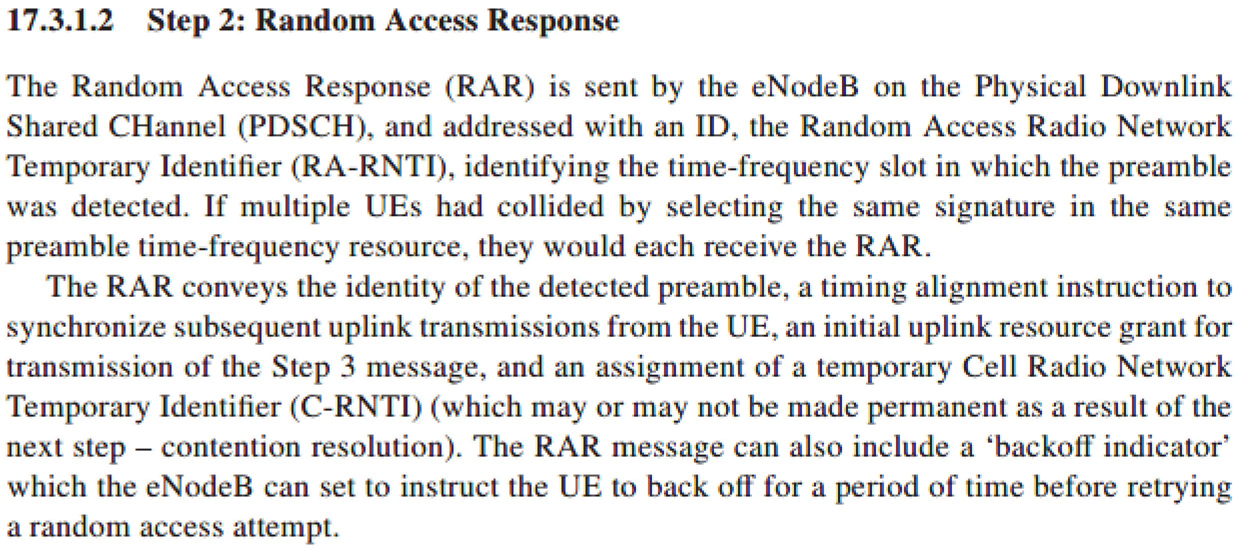
2) Random Access Response generated by MAC on DL-SCH:

  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
  - Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25

“25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.”

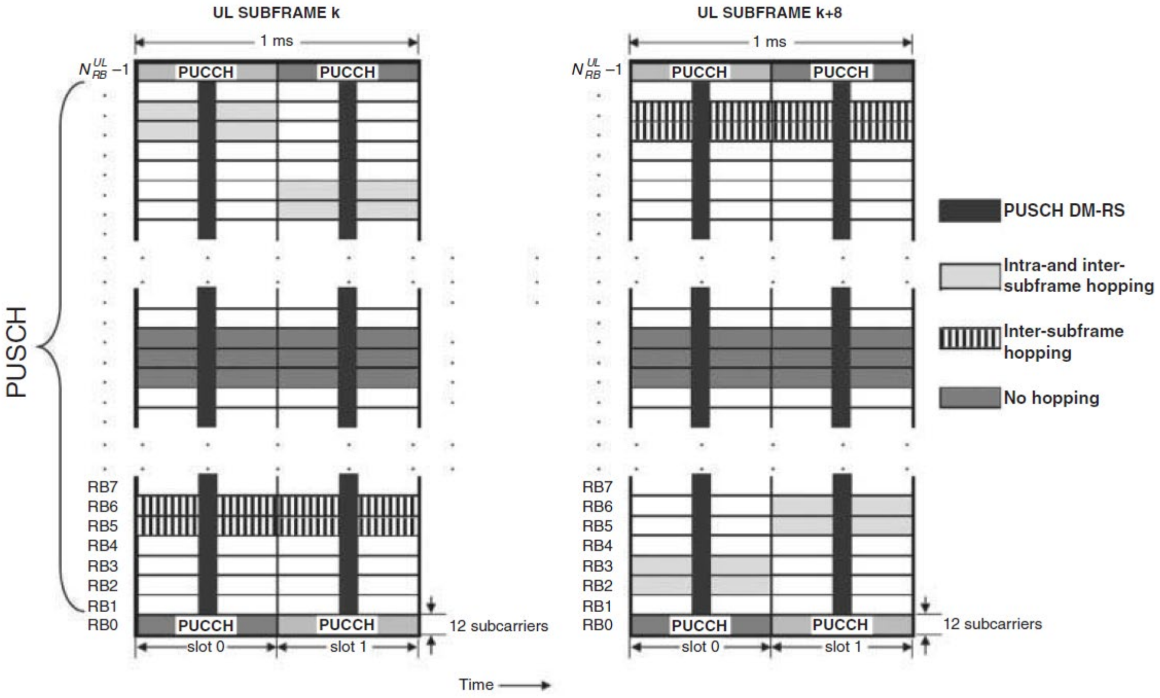
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with Mercedes's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

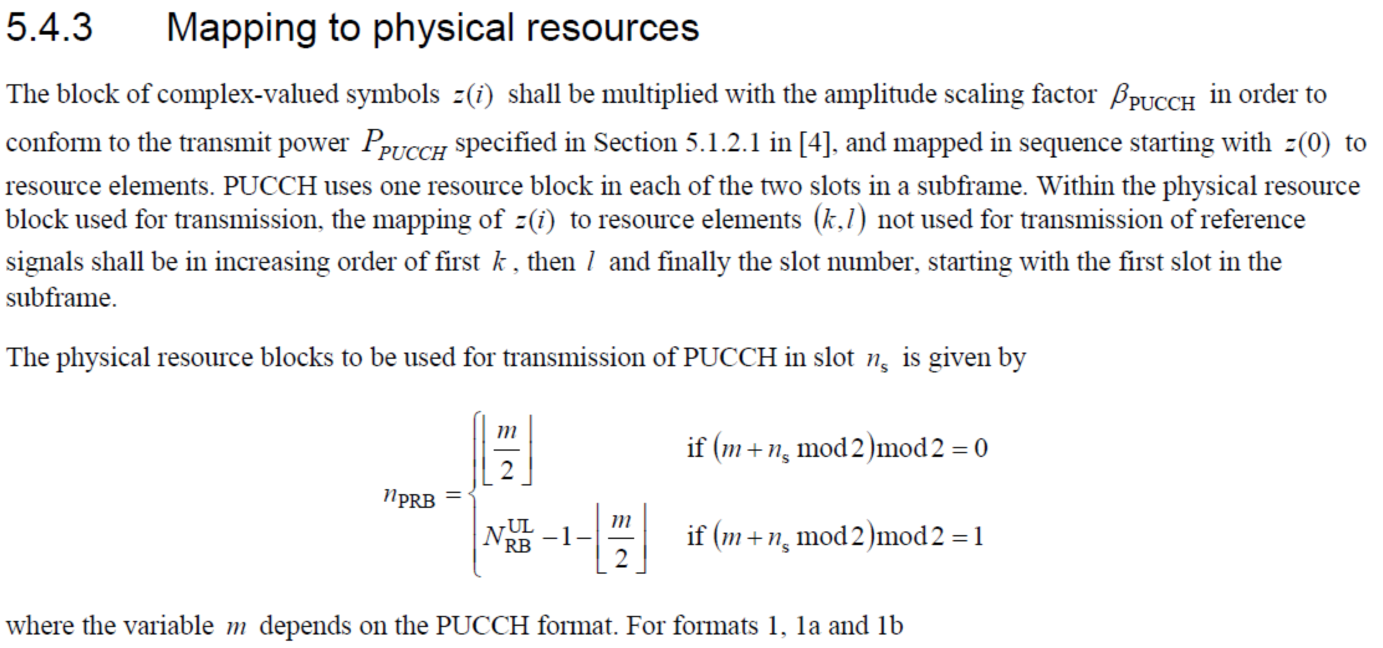
US Patent No. 10,833,908: Claim 27

“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with Mercedes’s Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing.

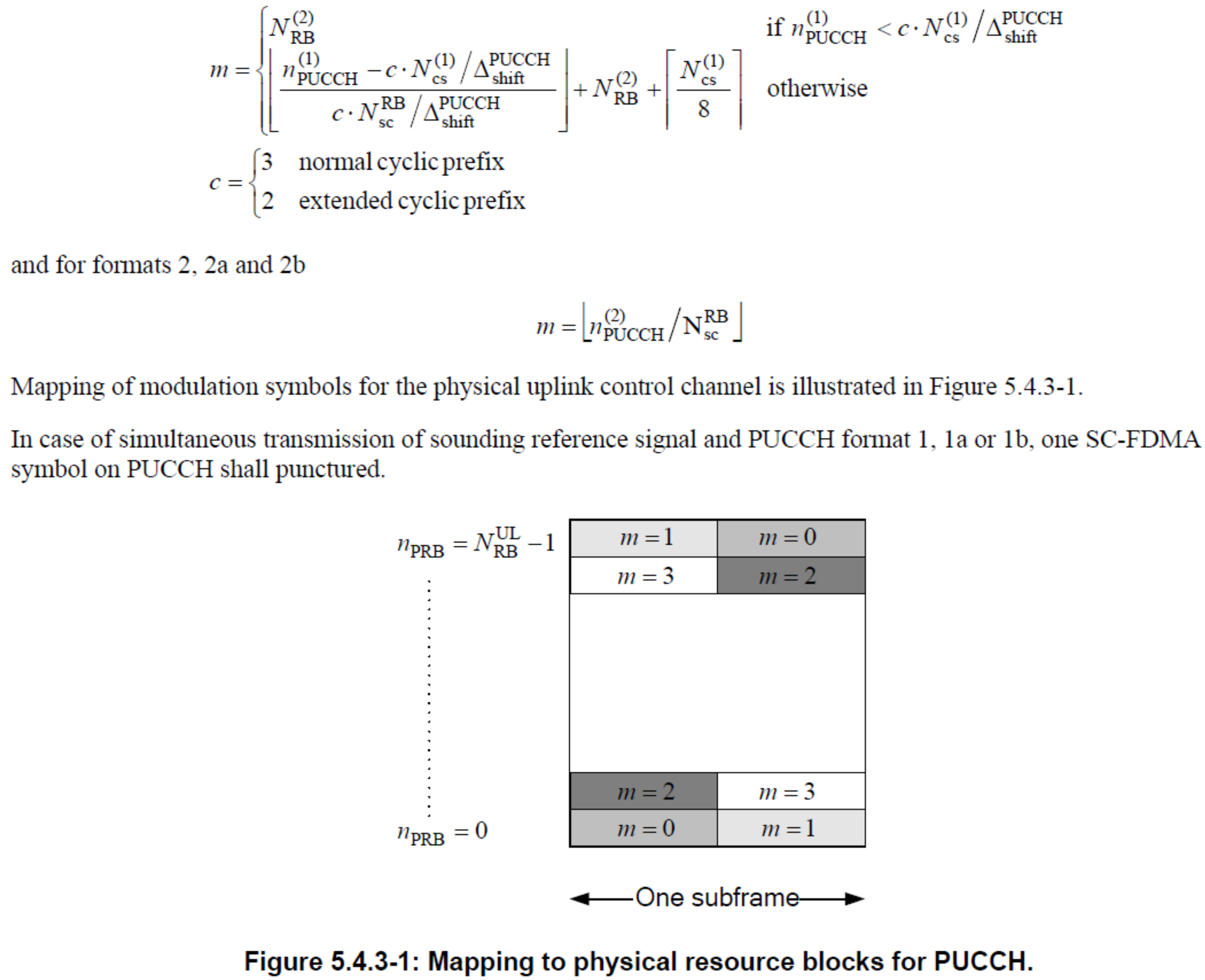
US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure"). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  **5.4.3 Mapping to physical resources** The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by $$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

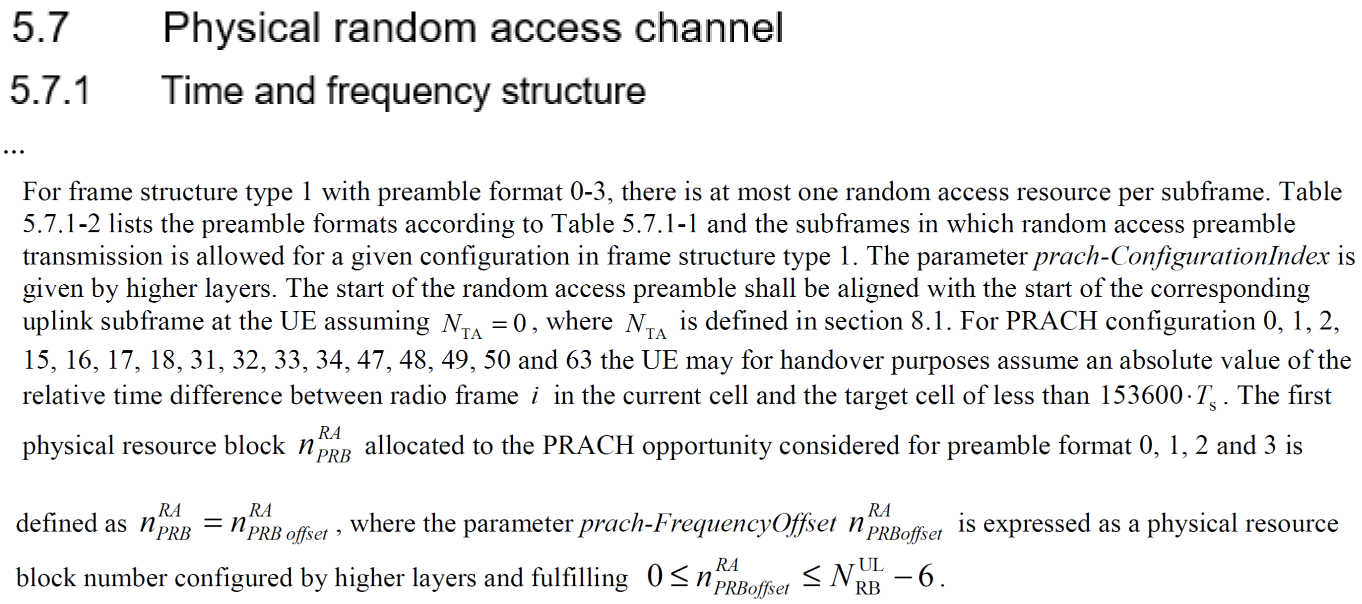
Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

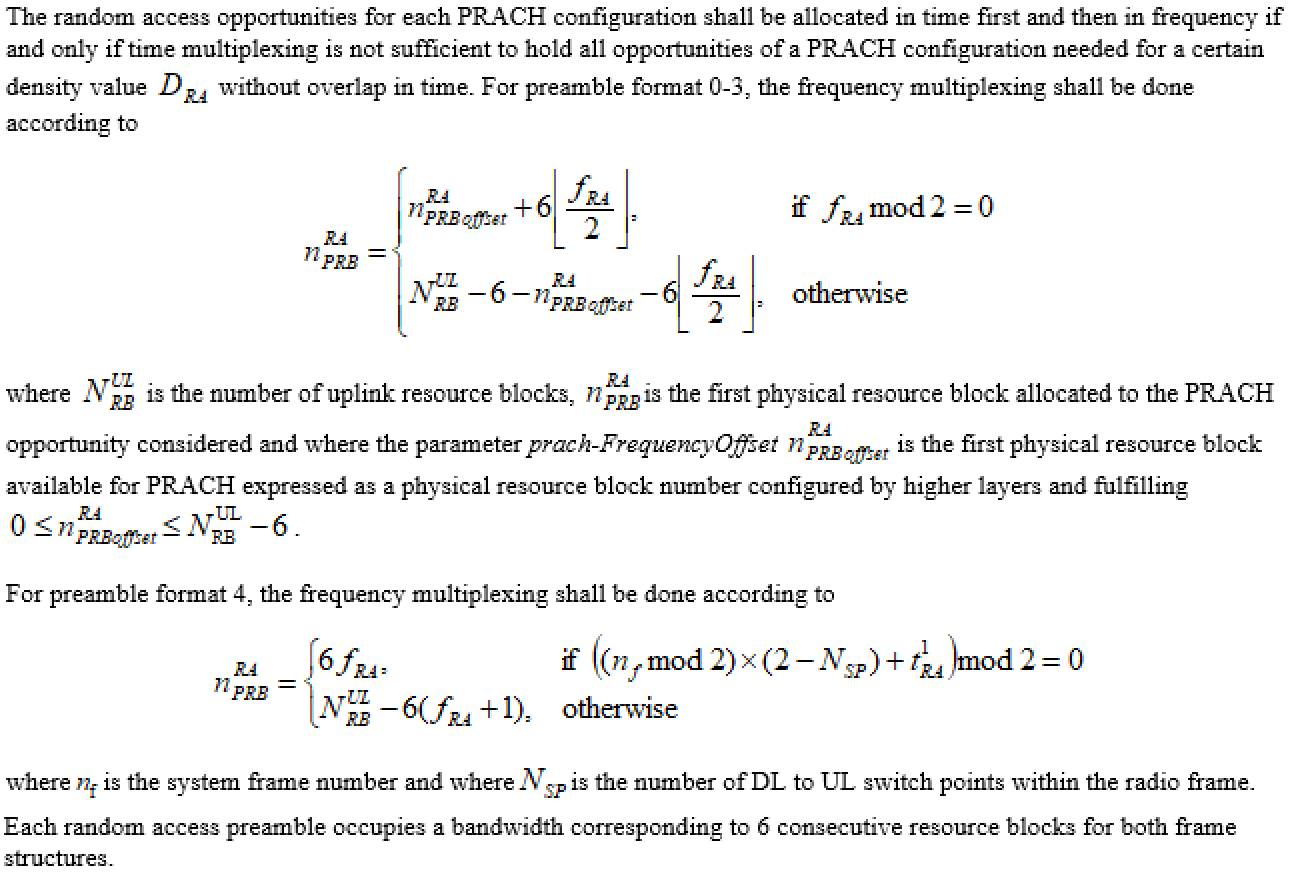
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  **5.7 Physical random access channel** **5.7.1 Time and frequency structure** … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$. …

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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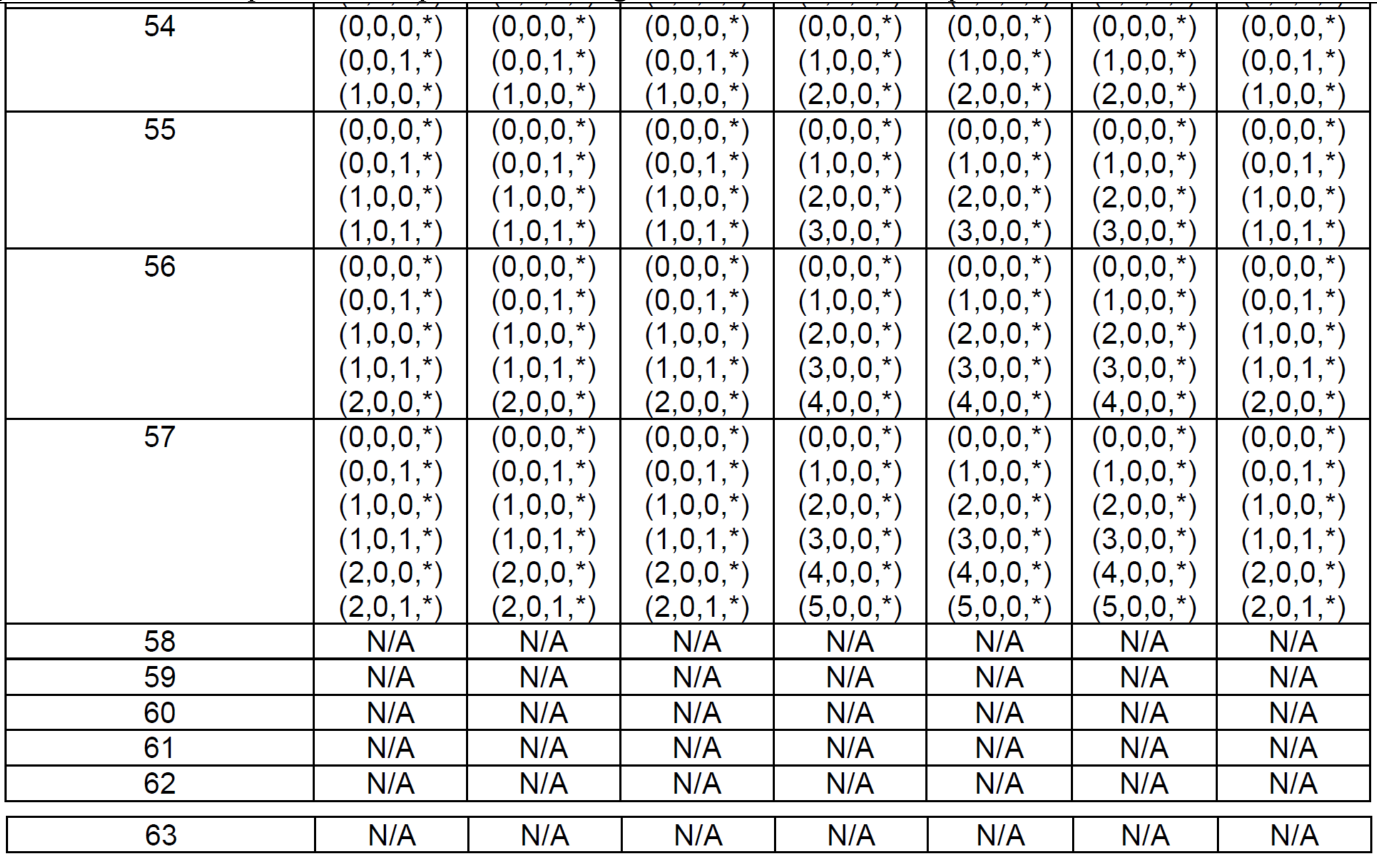
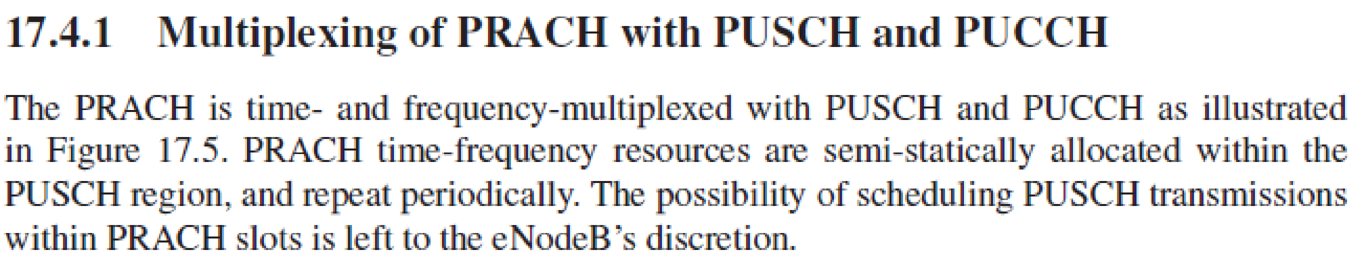
US Patent No. 10,833,908: Claim 27
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

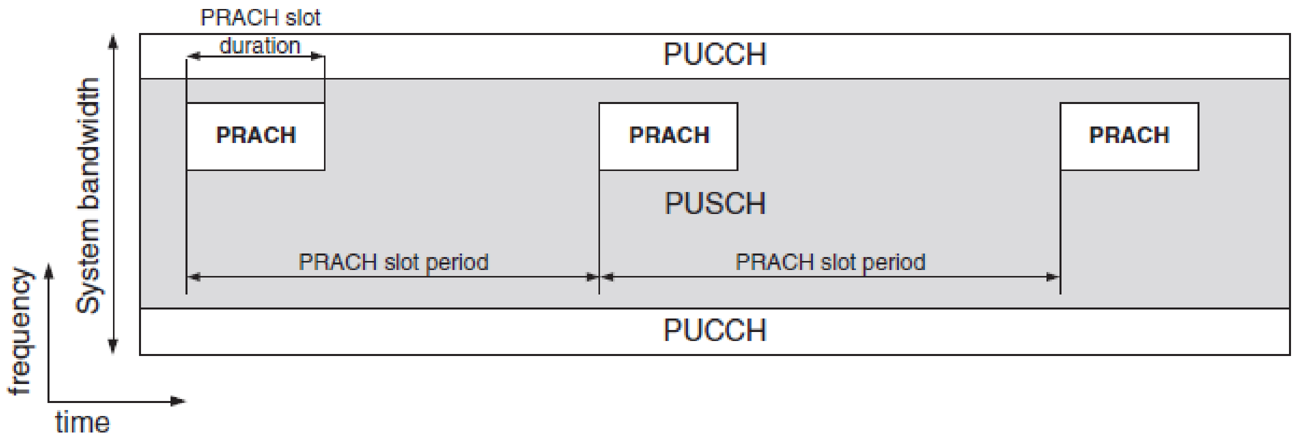


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

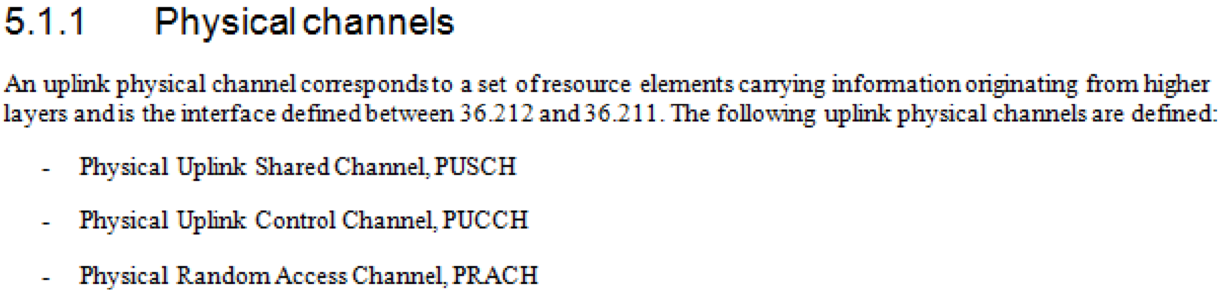
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 27

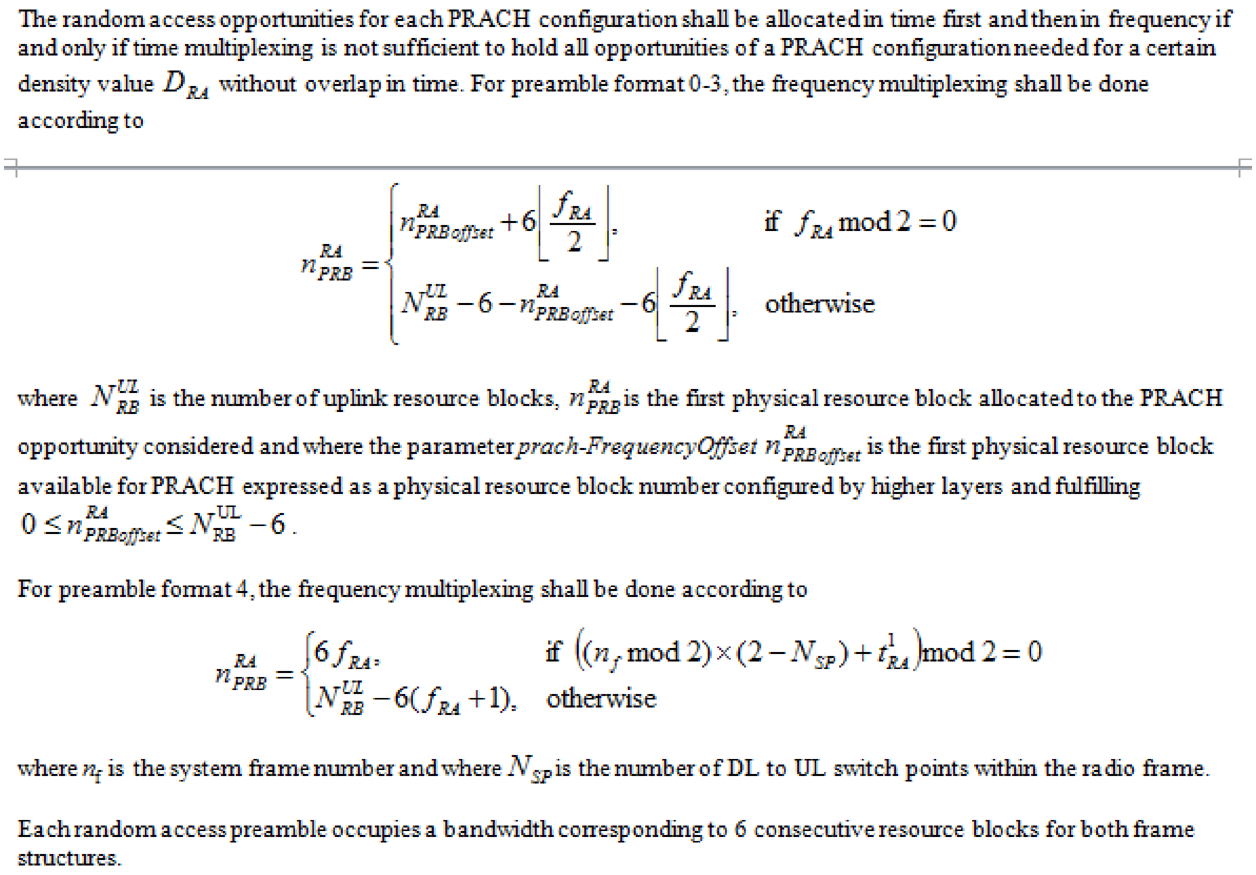
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

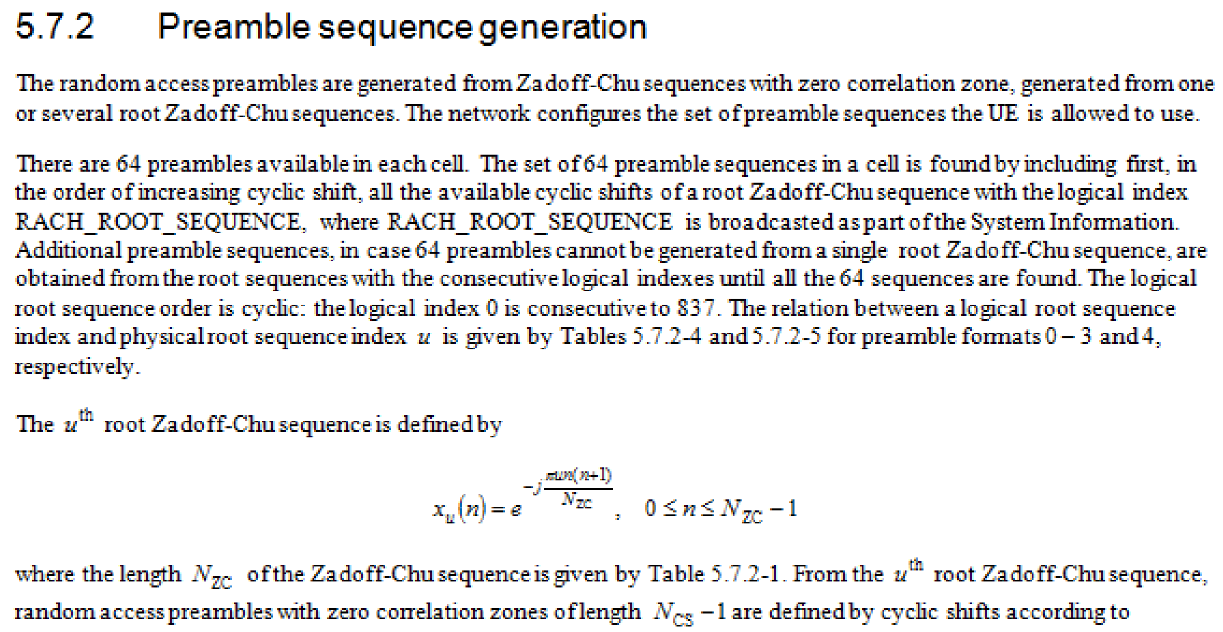
US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with Mercedes's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB. 5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at p. 35. The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n)=e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0\le n\le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

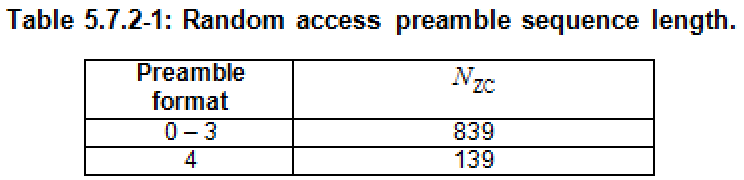
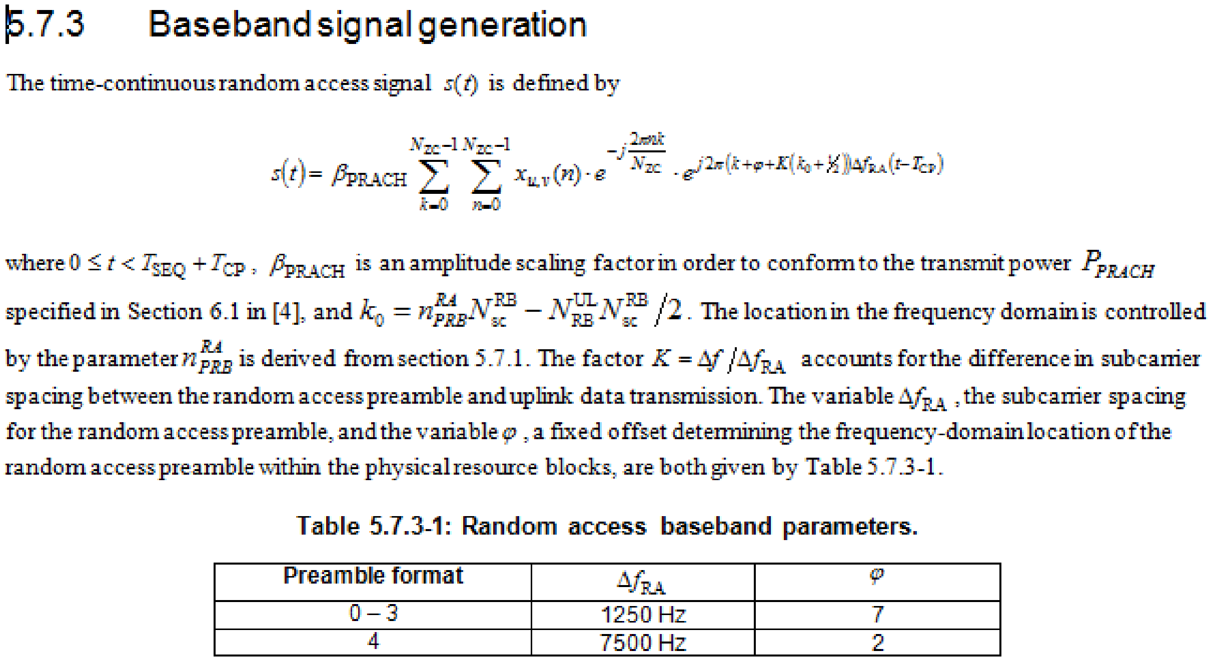


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\mathrm{RA}}(t-T_{\mathrm{CP}})}$$

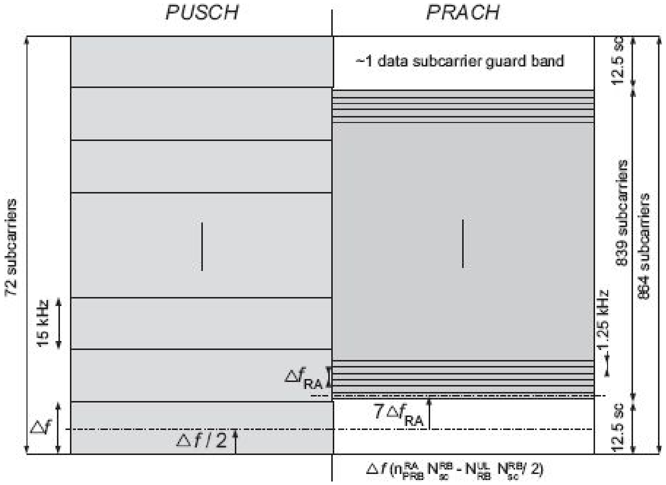
where $0\le t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

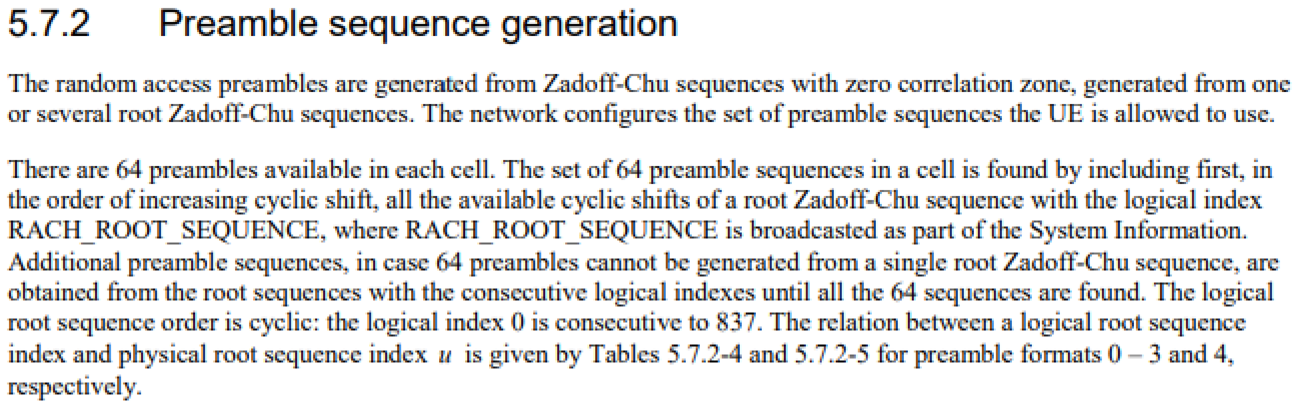
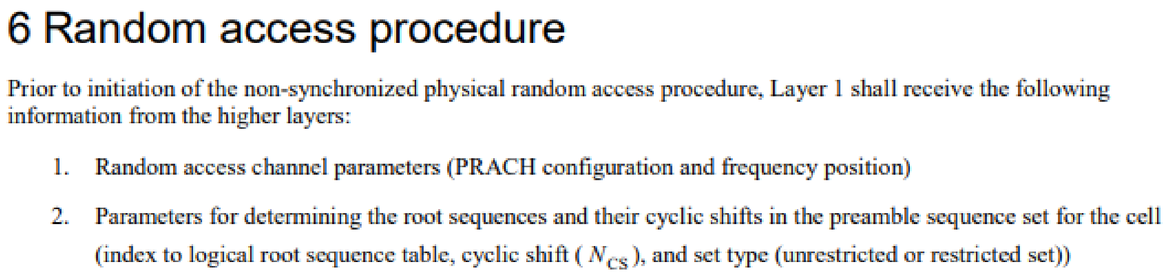
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of Mercedes’s Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information. 5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39. 6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

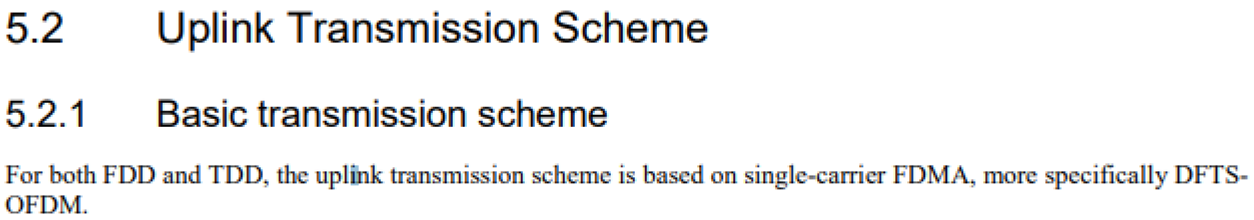
RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 Mercedes’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* Mercedes’s Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

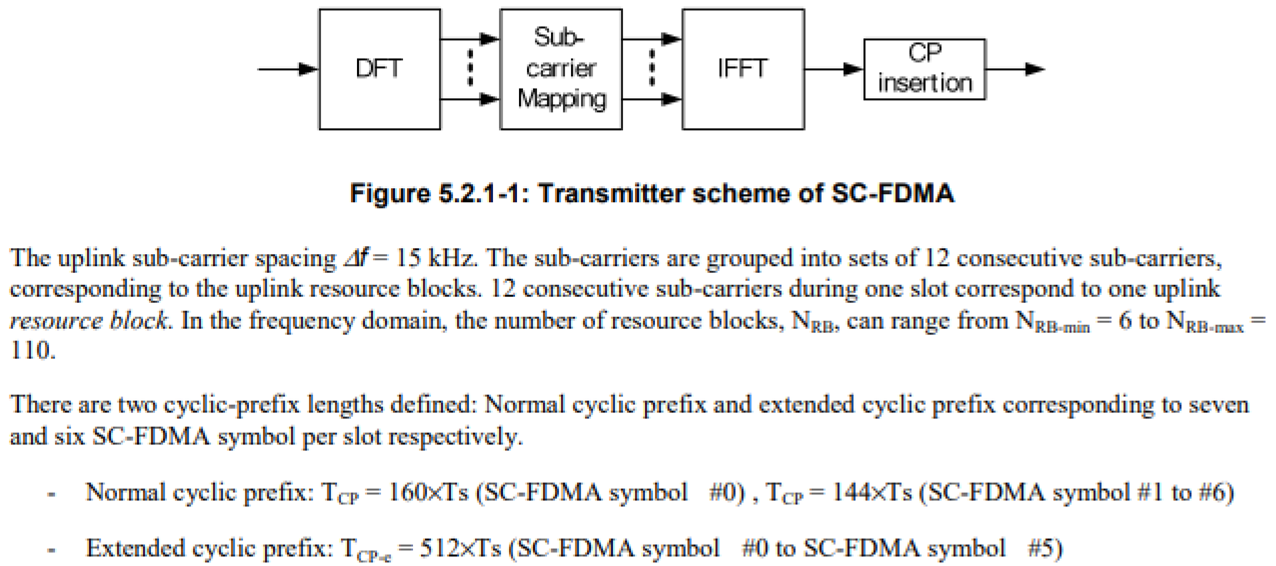


Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

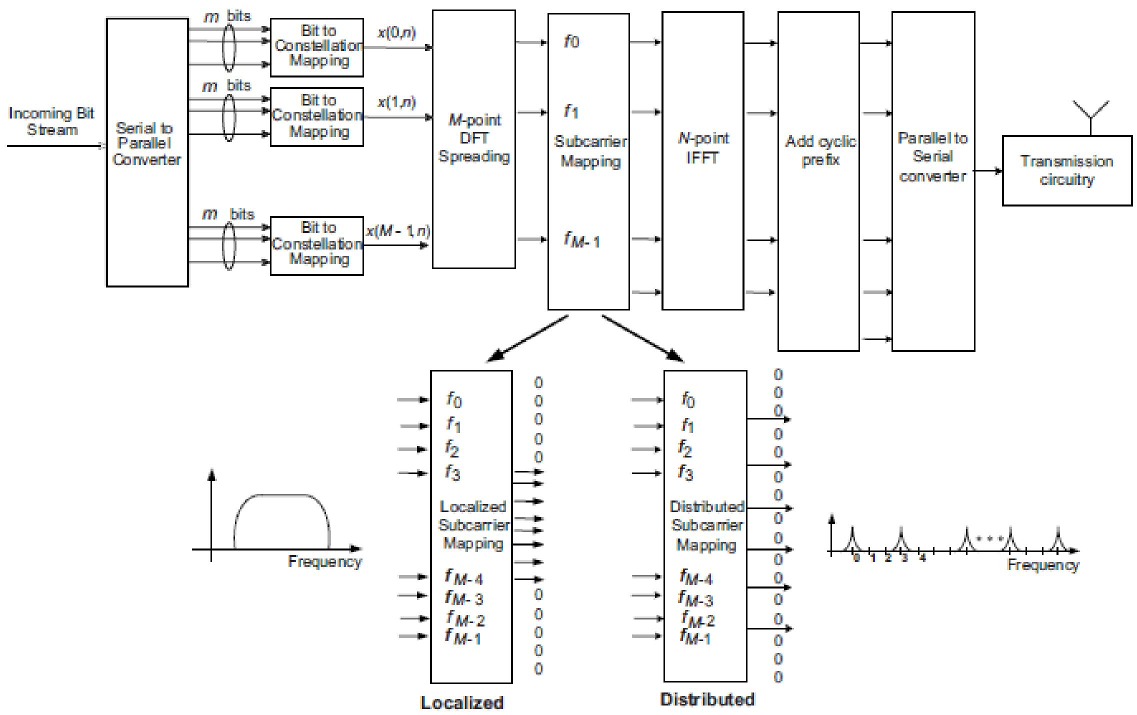


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

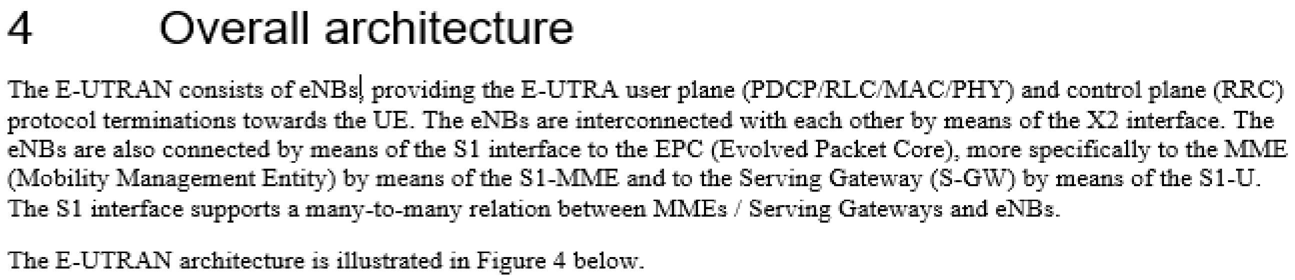
See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

See also Claim 10.

Plaintiff's Infringement Contentions to FCA

Exhibit 908
U.S. Patent No. 10,833,908
Claims 1-30

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

1. A mobile station comprising:	To the extent the preamble is considered a limitation, FCA’s Accused Instrumentalities meet the preamble of claim 1 of the ’908 patent. *E.g.,* FCA’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, FCA offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff’s Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipment (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 1(a)
"A mobile station comprising:

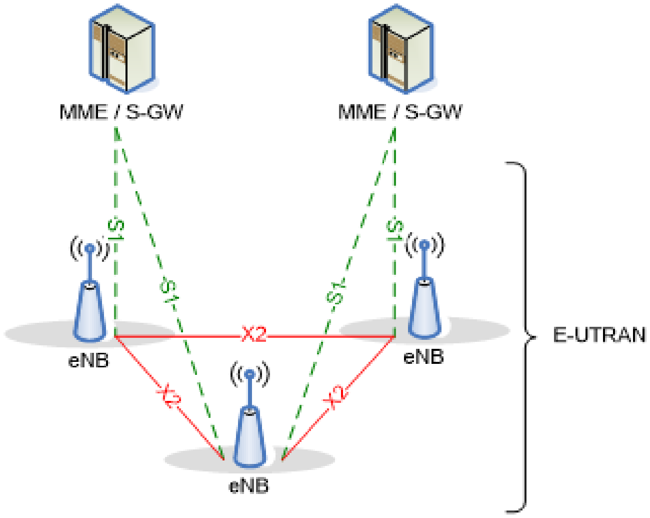


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

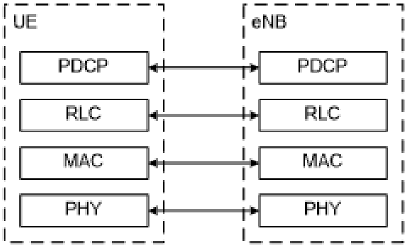


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

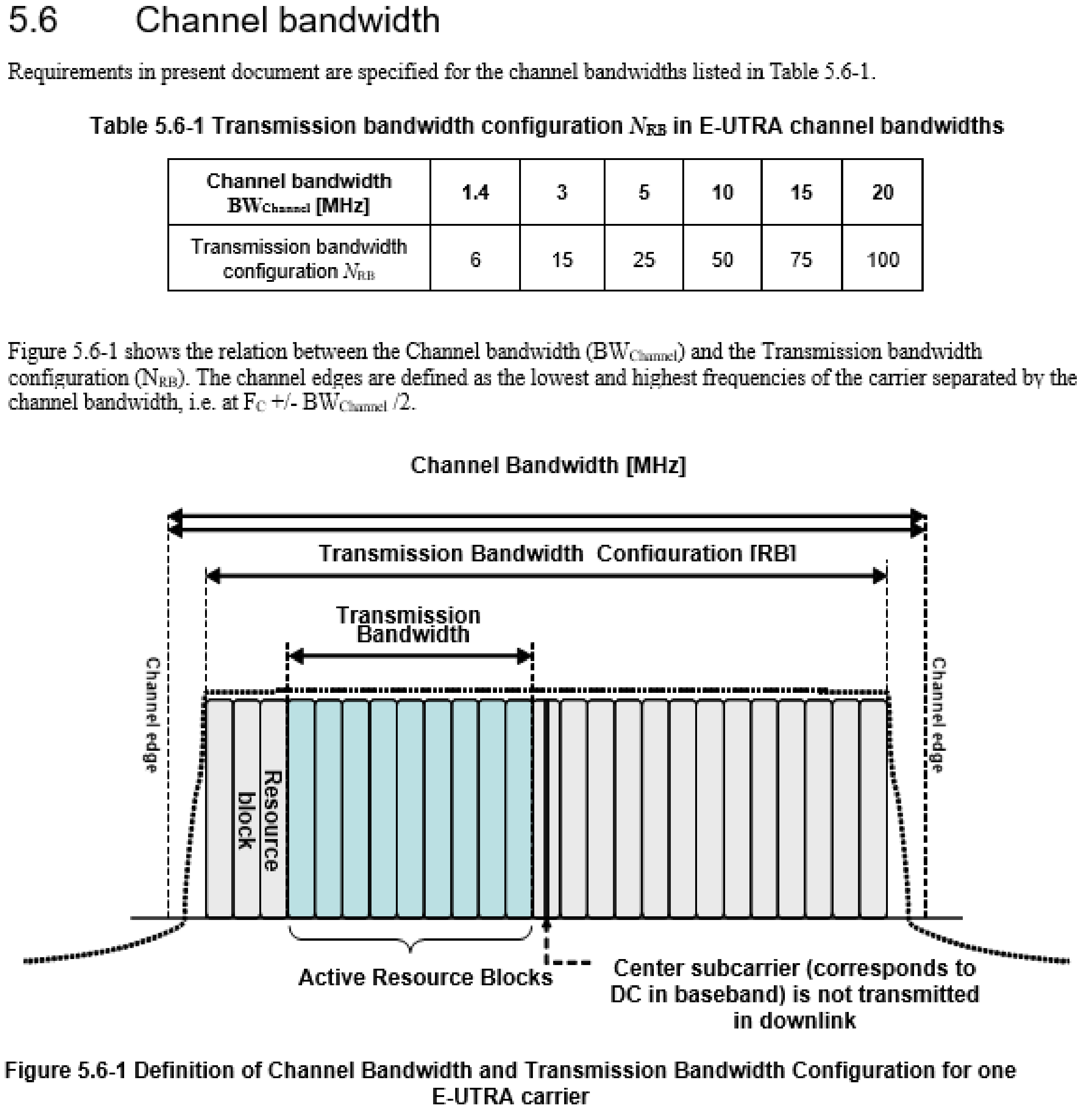
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	FCA's Accused Instrumentalities include a transmitter configured to a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, For example, FCA's Accused Instrumentalities include one or more antennas for transmitting, with electronic circuitry, signals on an uplink band as defined in the standard. In particular, a frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

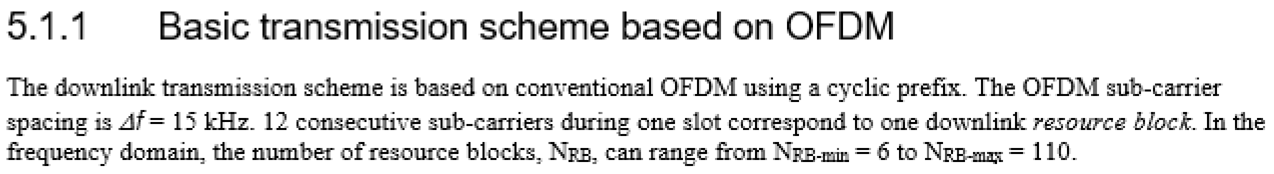
Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 1(b)

“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

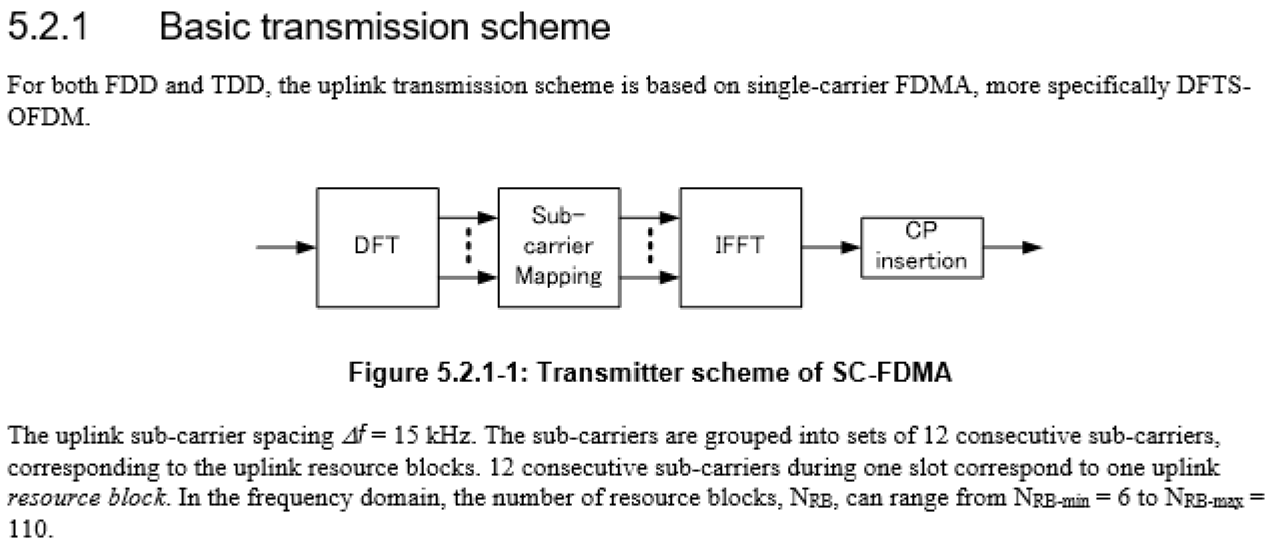
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

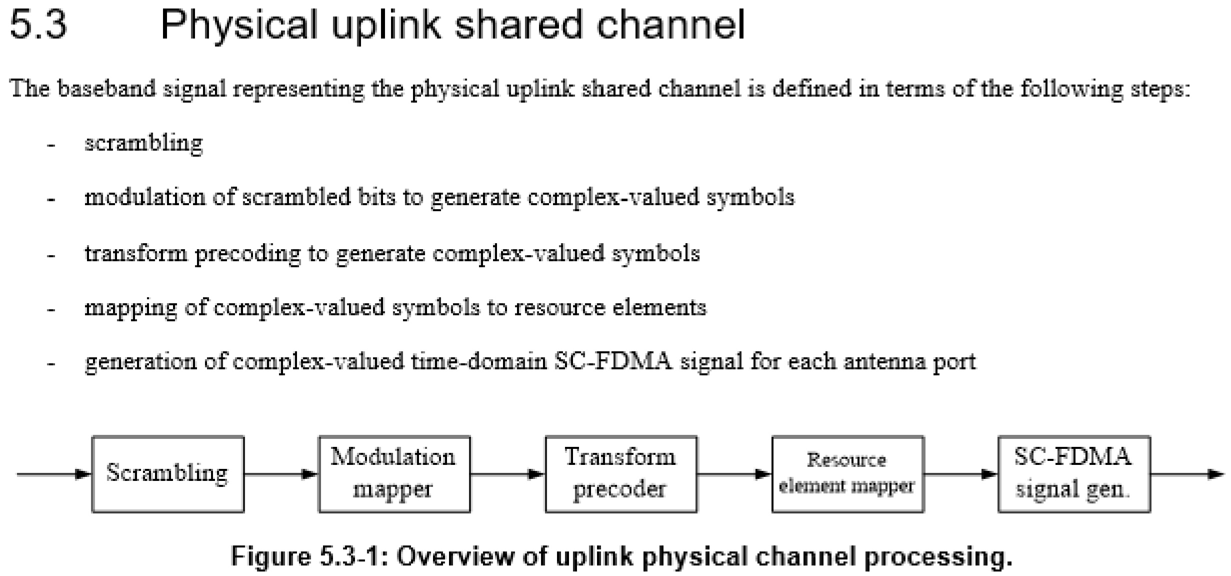
The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"



5.3 Physical uplink shared channel

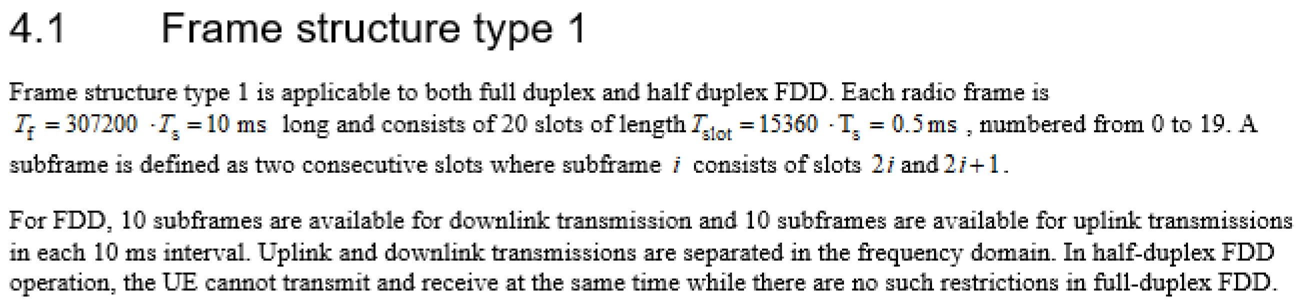
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

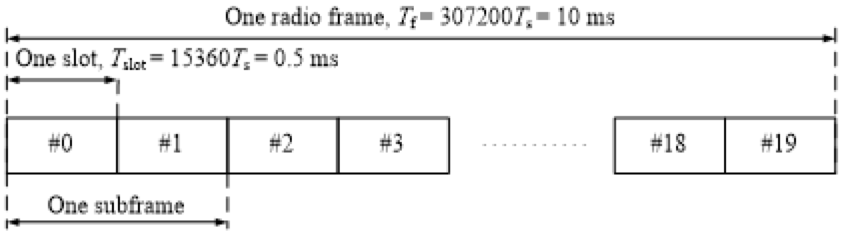
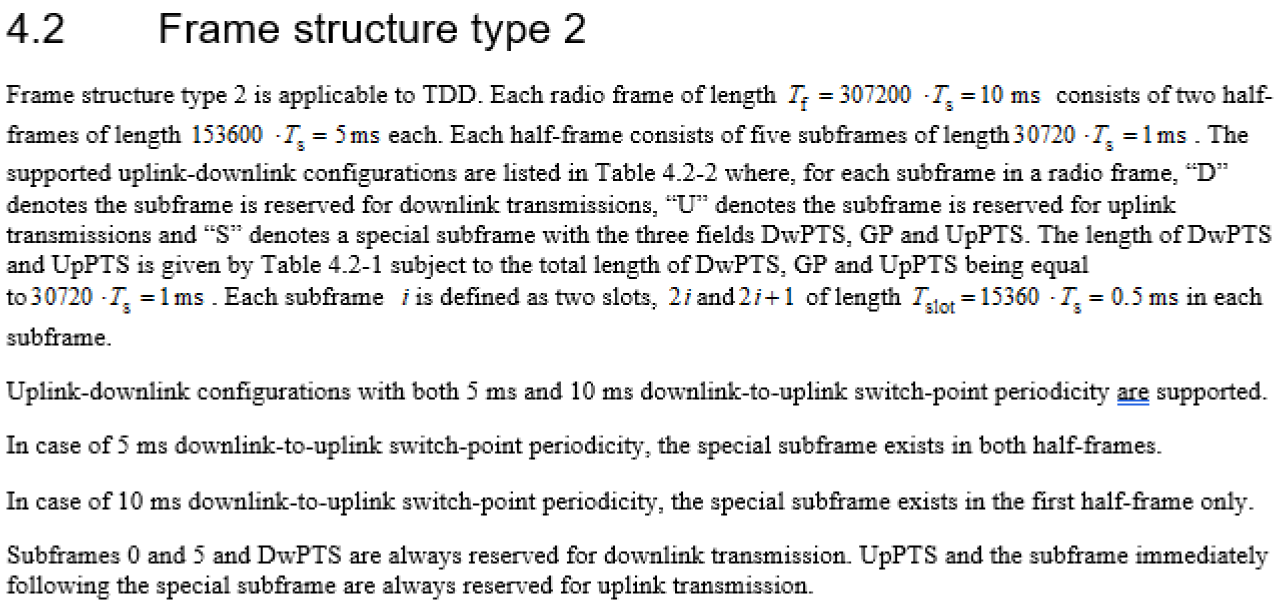


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

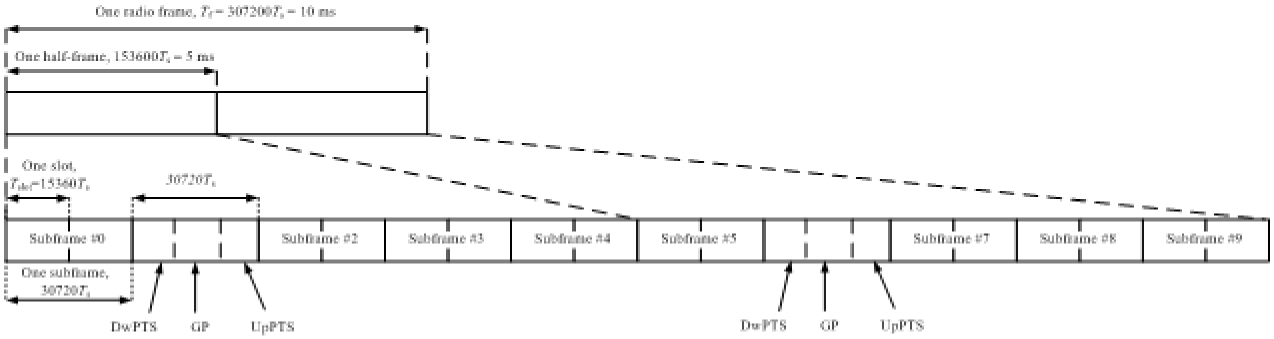
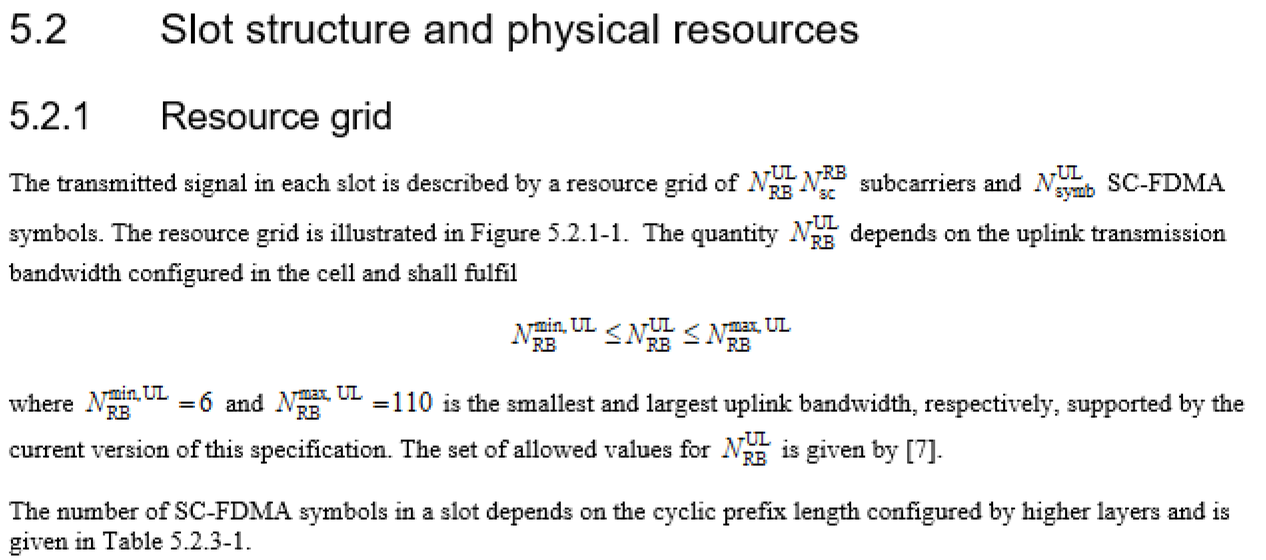


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{RB}^{UL} N_{sc}^{RB}$ subcarriers and N_{symb}^{UL} SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity N_{RB}^{UL} depends on the uplink transmission bandwidth configured in the cell and shall fulfil

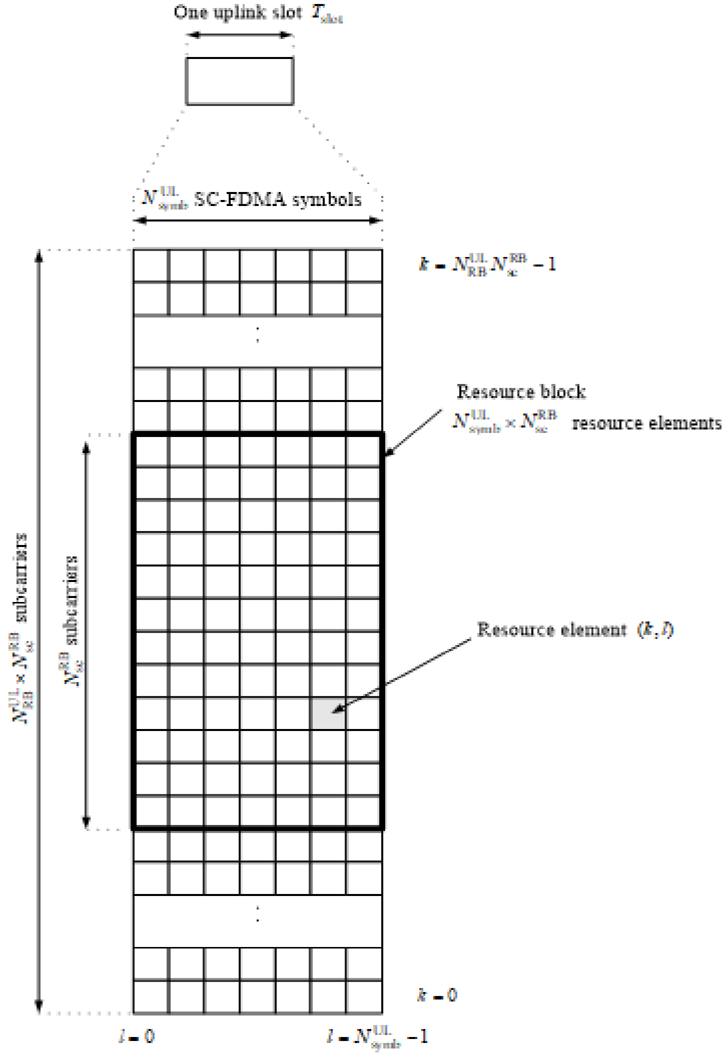
$$N_{RB}^{min,UL} \le N_{RB}^{UL} \le N_{RB}^{max,UL}$$

where $N_{RB}^{min,UL} = 6$ and $N_{RB}^{max,UL} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for N_{RB}^{UL} is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

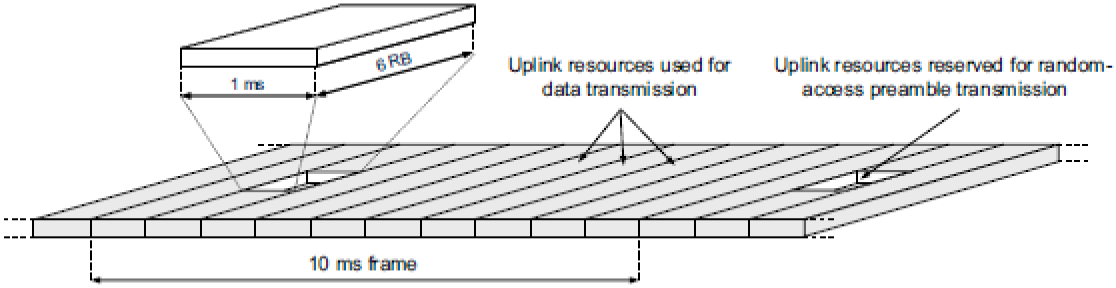
US Patent No. 10,833,908: Claim 1(b)

"a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols"

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 1(b)

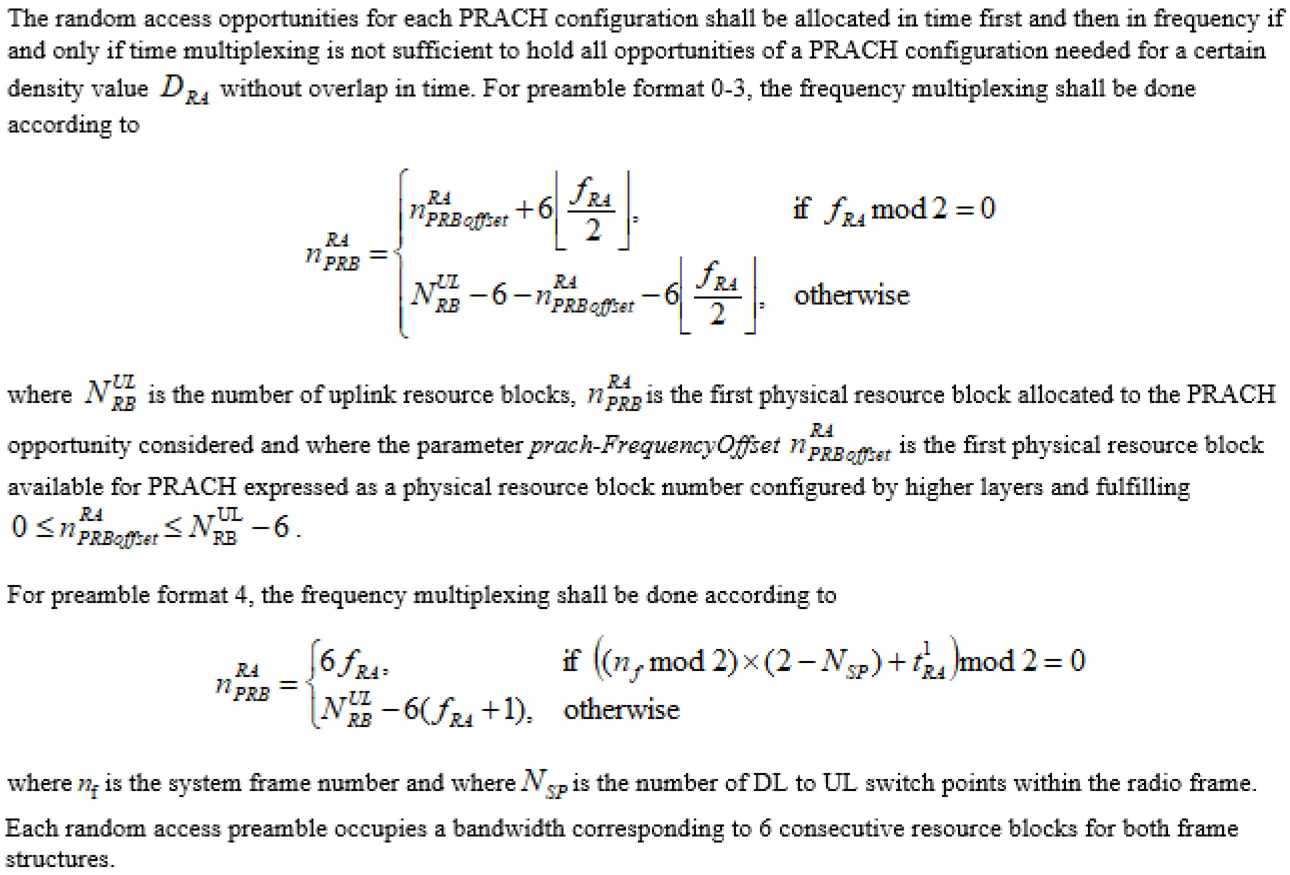
“a transmitter configured to: transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols”

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, “4G: LTE/LTE-Advanced for Mobile Broadband,” Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources in only a portion of the frequency band)

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"

transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station	FCA's Accused Instrumentalities also transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble, transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 1(c)
"transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station"

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

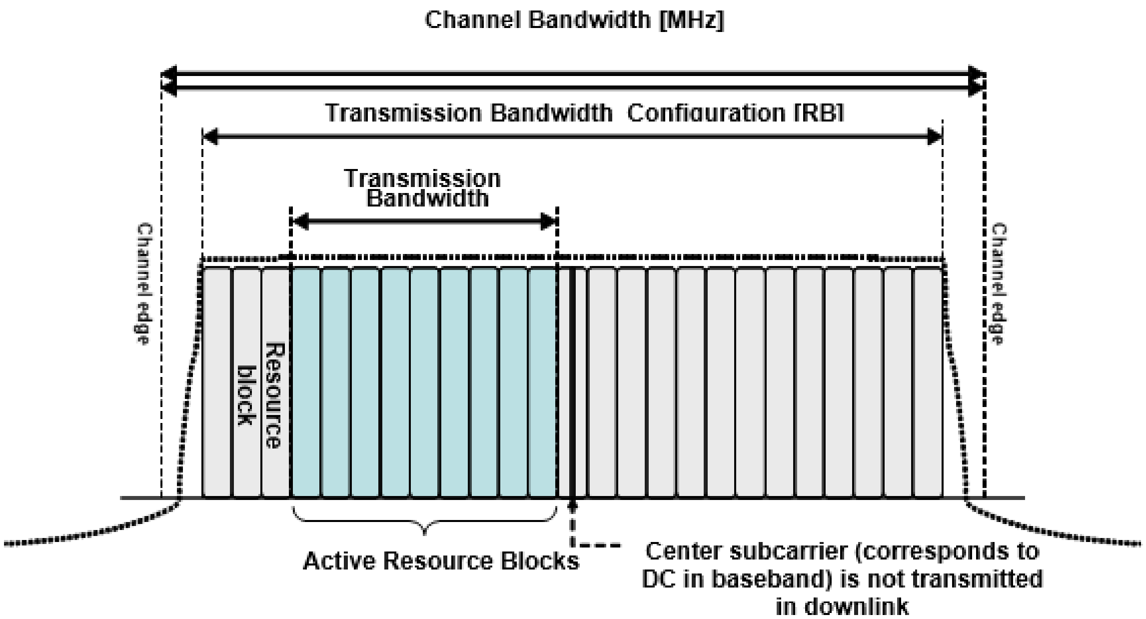
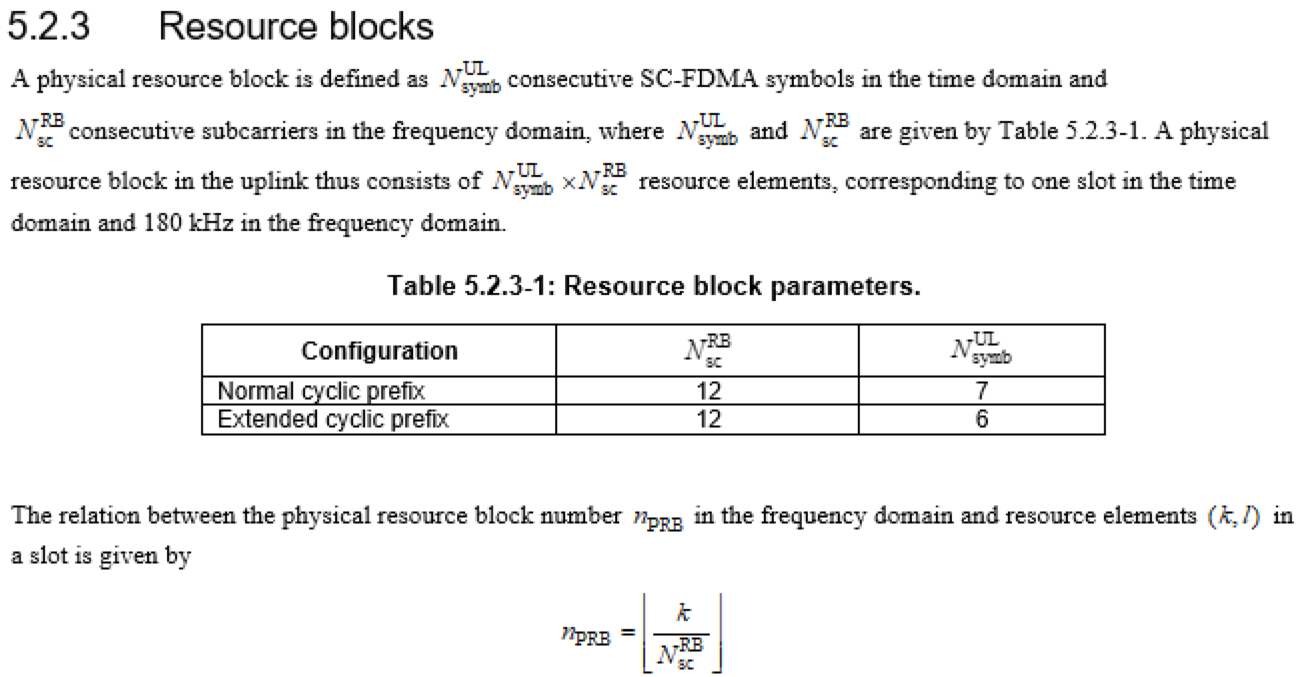


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 1(c)

“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

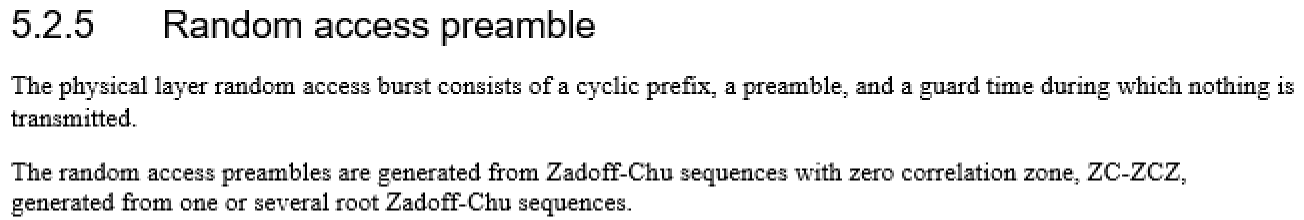
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

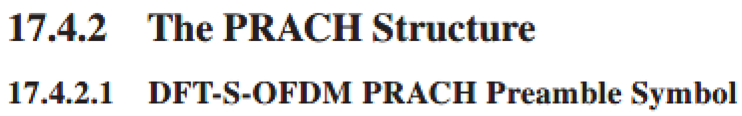


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

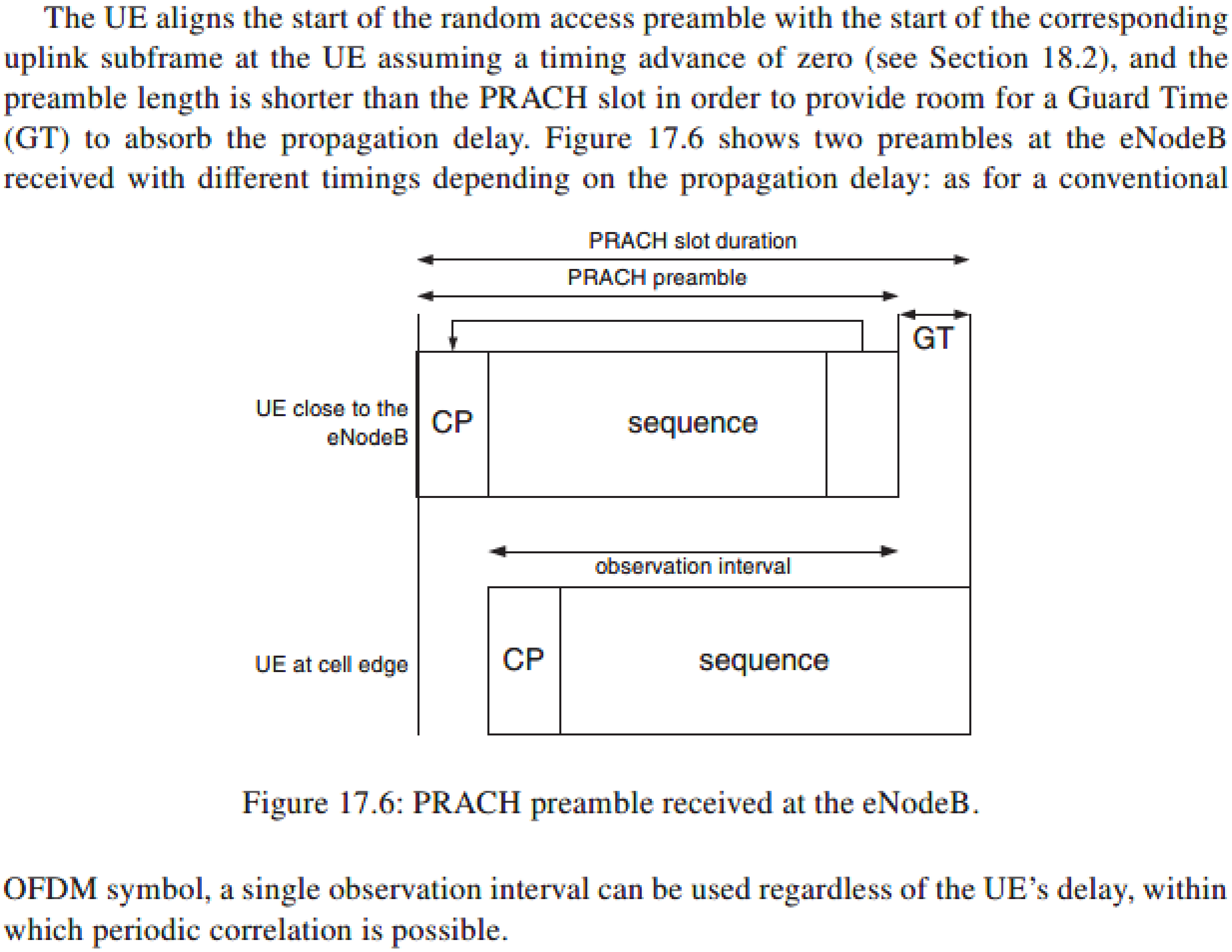


17.4.2 The PRACH Structure

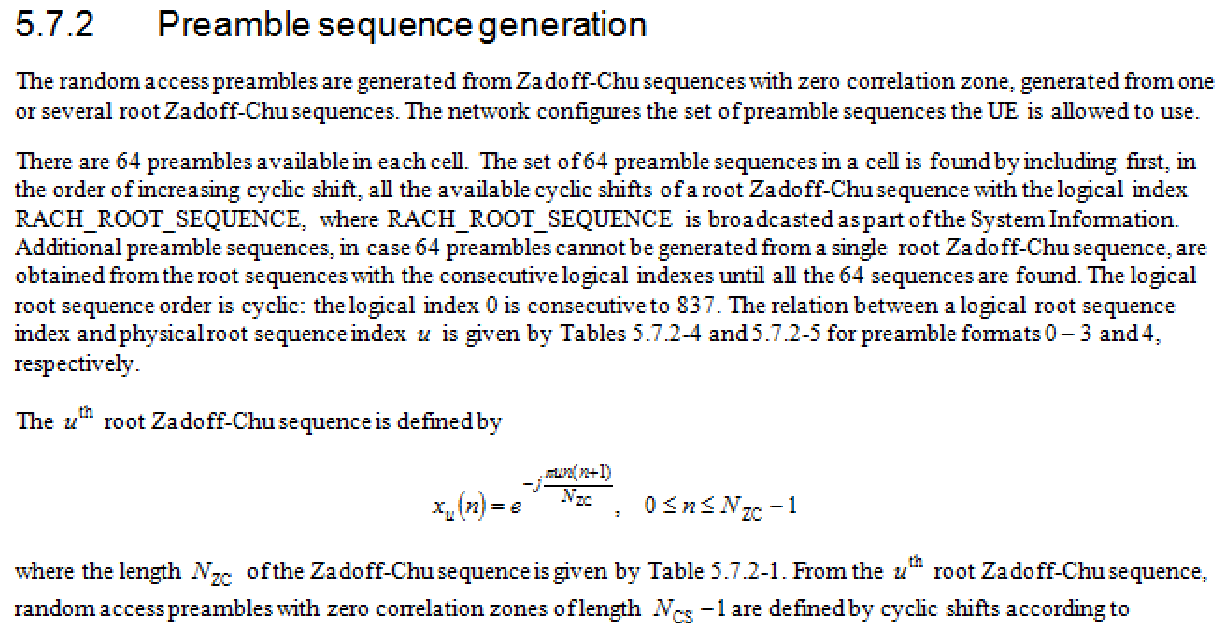
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

...

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”

	 The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. Figure 17.6: PRACH preamble received at the eNodeB. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences, e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 1(c)
“transmit, to the base station, a random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

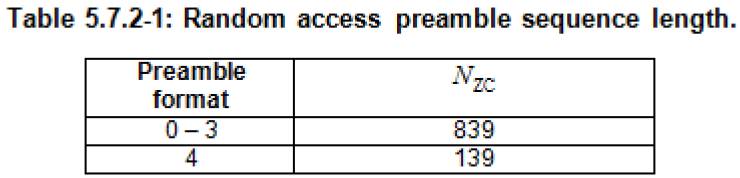
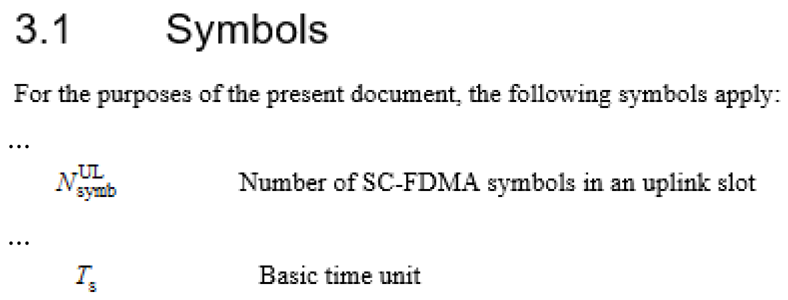
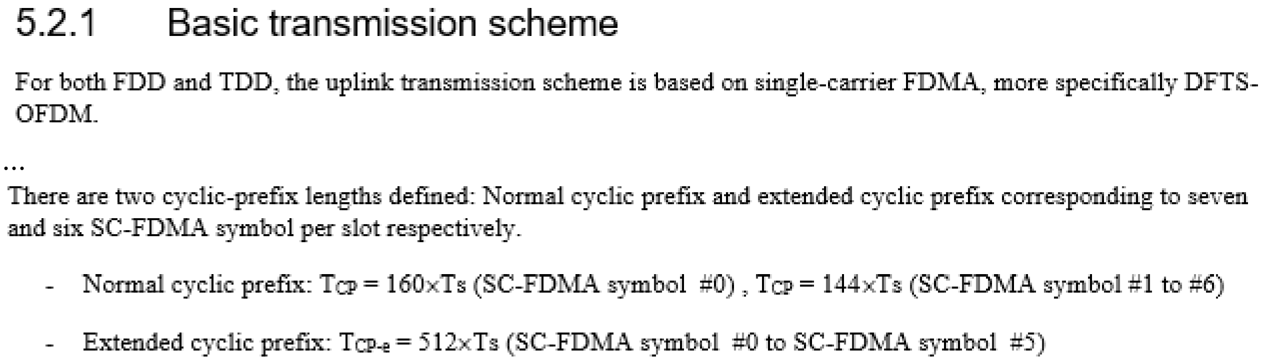


Table 5.7.2-1: Random access preamble sequence length.

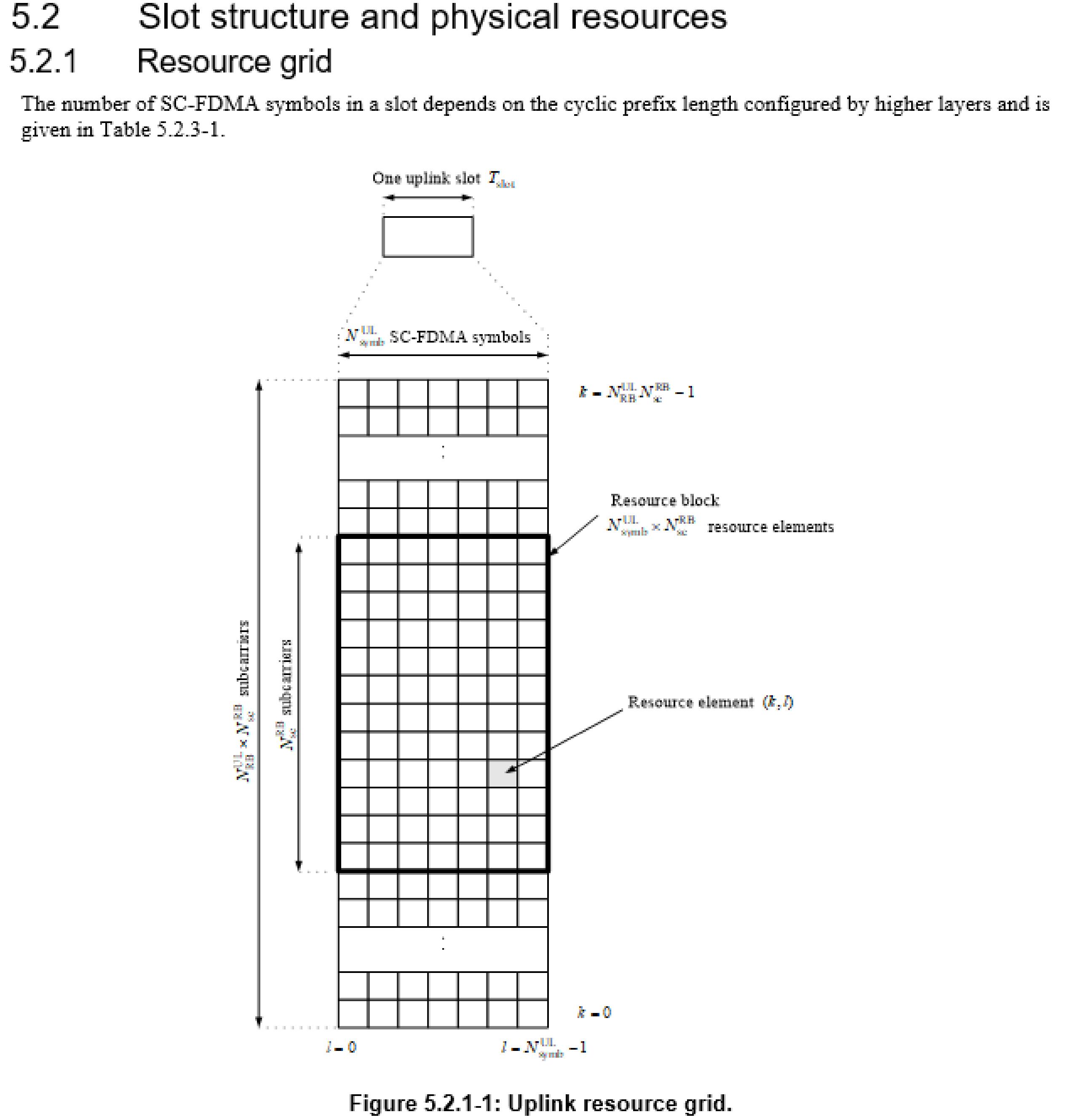
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols	The time duration of a combination of the random access signal and the guard period implemented using FCA’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: … $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot … T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. … There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”



5.2 Slot structure and physical resources

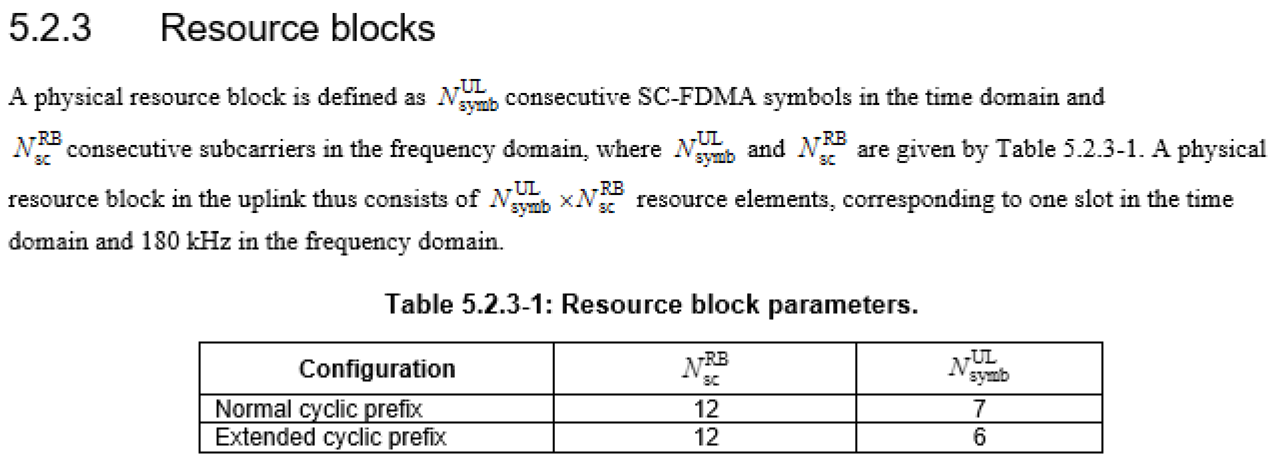
5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

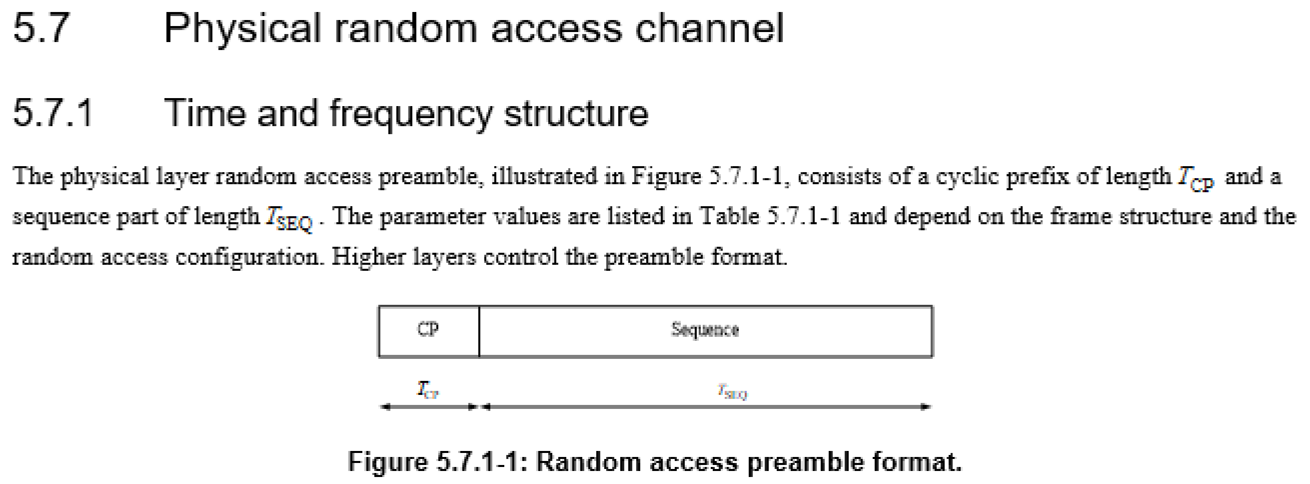
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 1(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols”

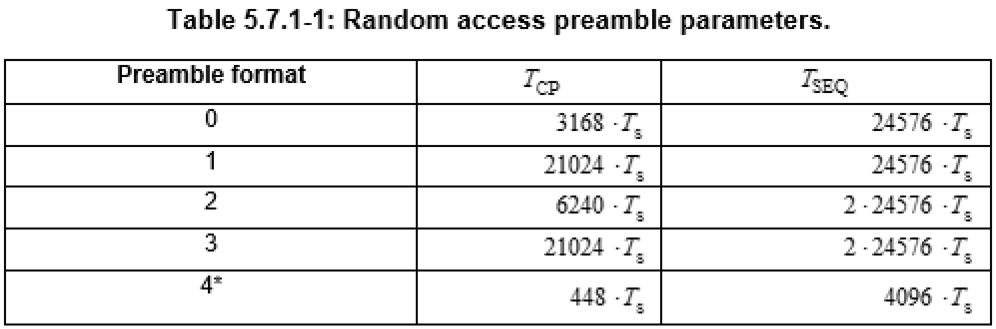
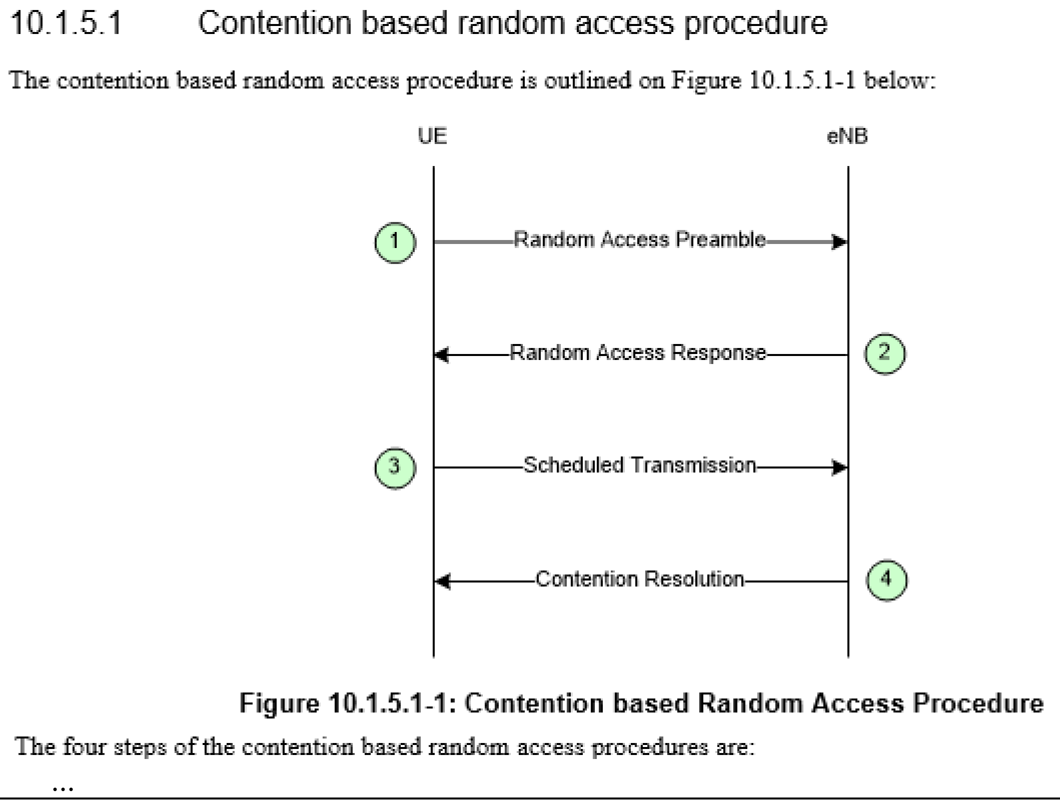


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

a receiver configured to receive, from the base station, a response message.	FCA's Accused Instrumentalities include a receiver configured to receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

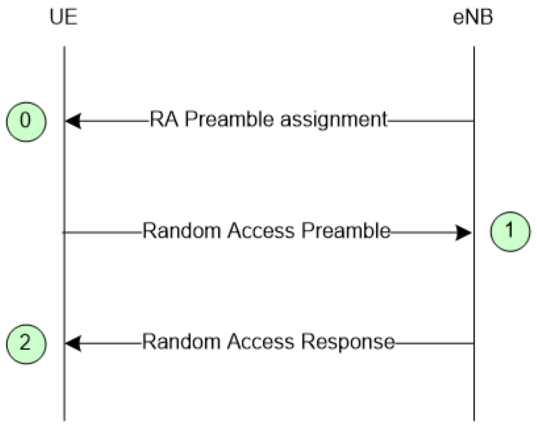
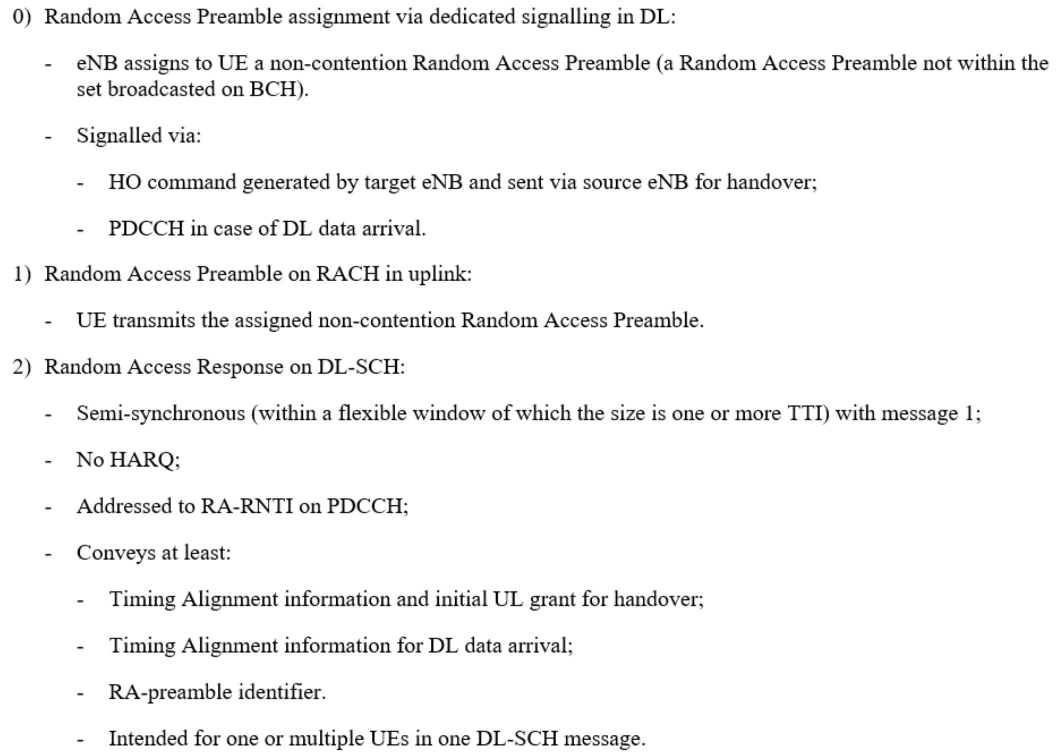


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

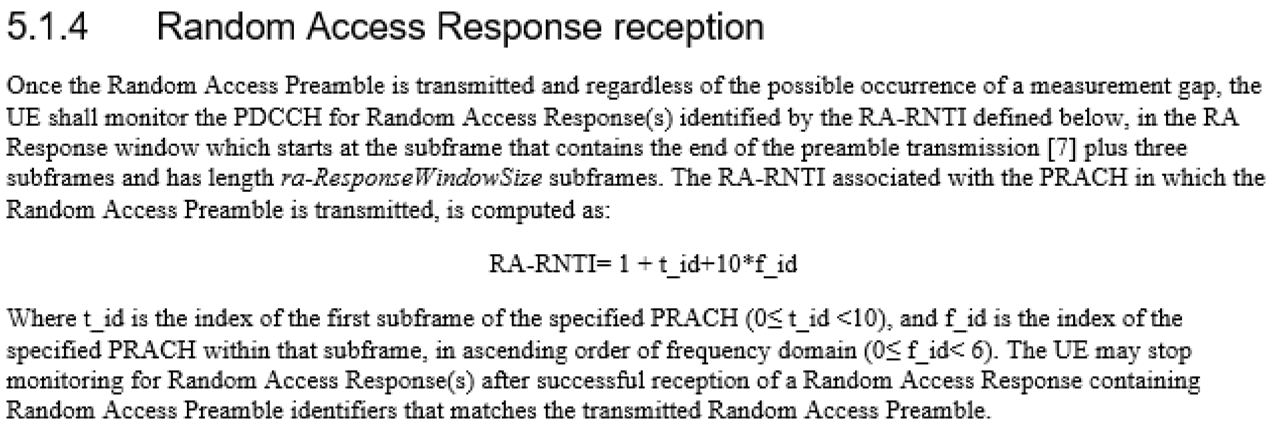


0) Random Access Preamble assignment via dedicated signalling in DL:
   - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
   - Signalled via:
     - HO command generated by target eNB and sent via source eNB for handover;
     - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
   - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
   - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
   - No HARQ;
   - Addressed to RA-RNTI on PDCCH;
   - Conveys at least:
     - Timing Alignment information and initial UL grant for handover;
     - Timing Alignment information for DL data arrival;
     - RA-preamble identifier.
     - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

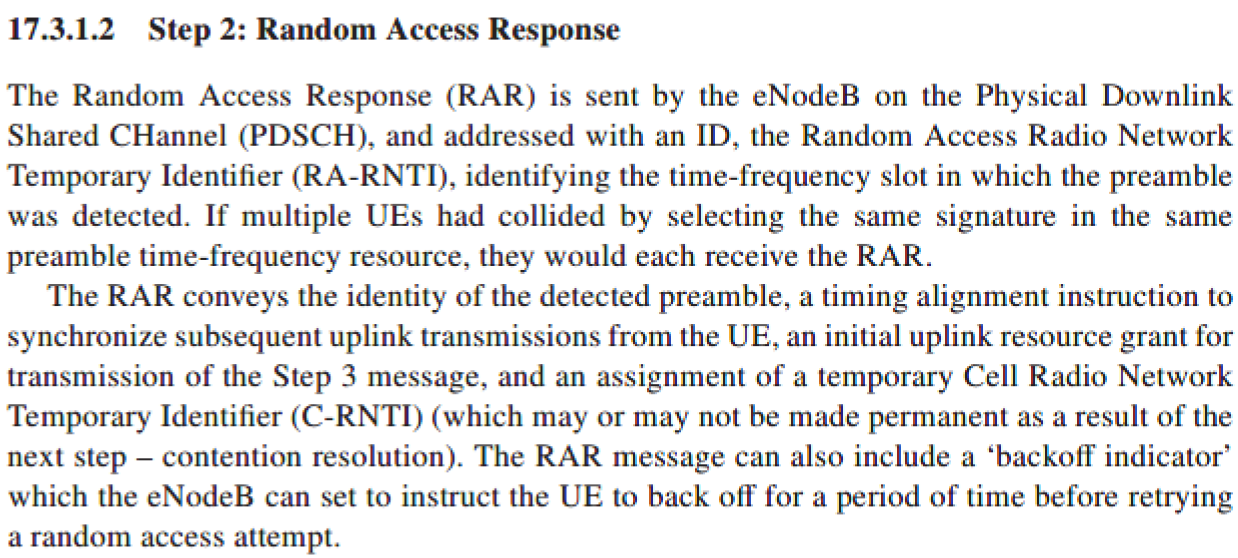
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

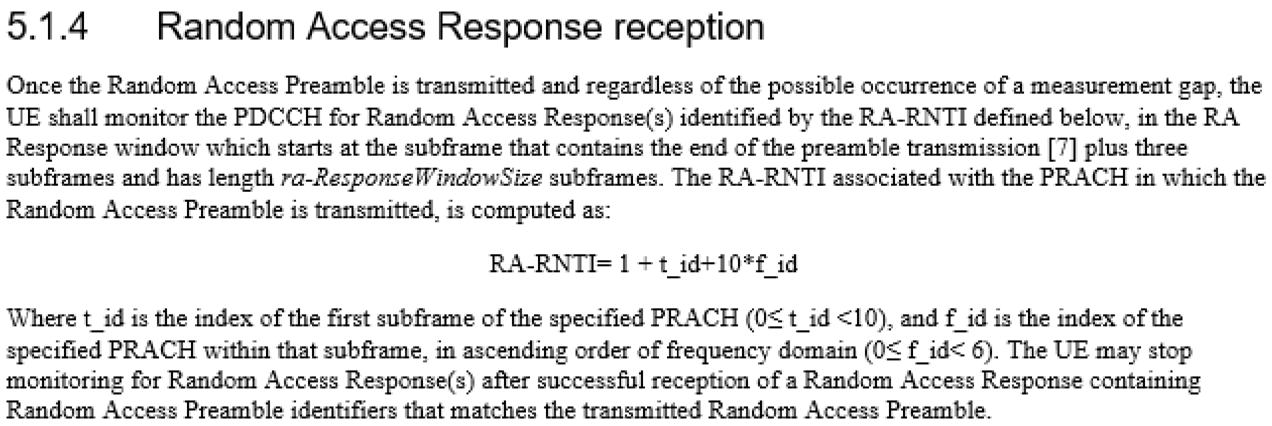
US Patent No. 10,833,908: Claim 1(e)
"a receiver configured to receive, from the base station, a response message"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

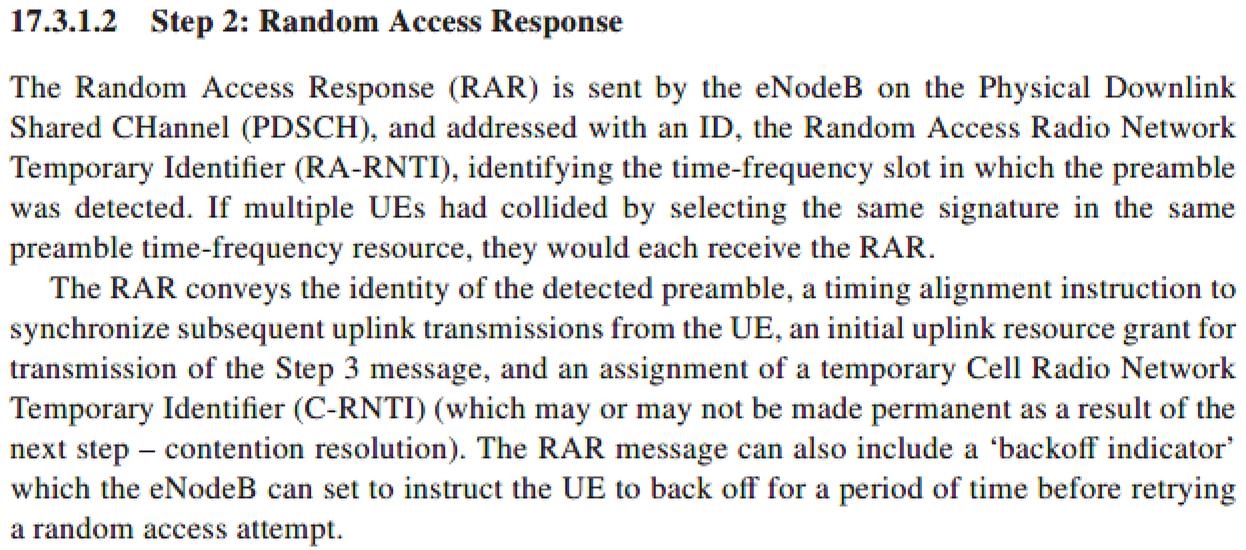
US Patent No. 10,833,908: Claim 2(a)
"The mobile station of claim 1, wherein:"

2. The mobile station of claim 1, wherein:	*See* Claim 1.

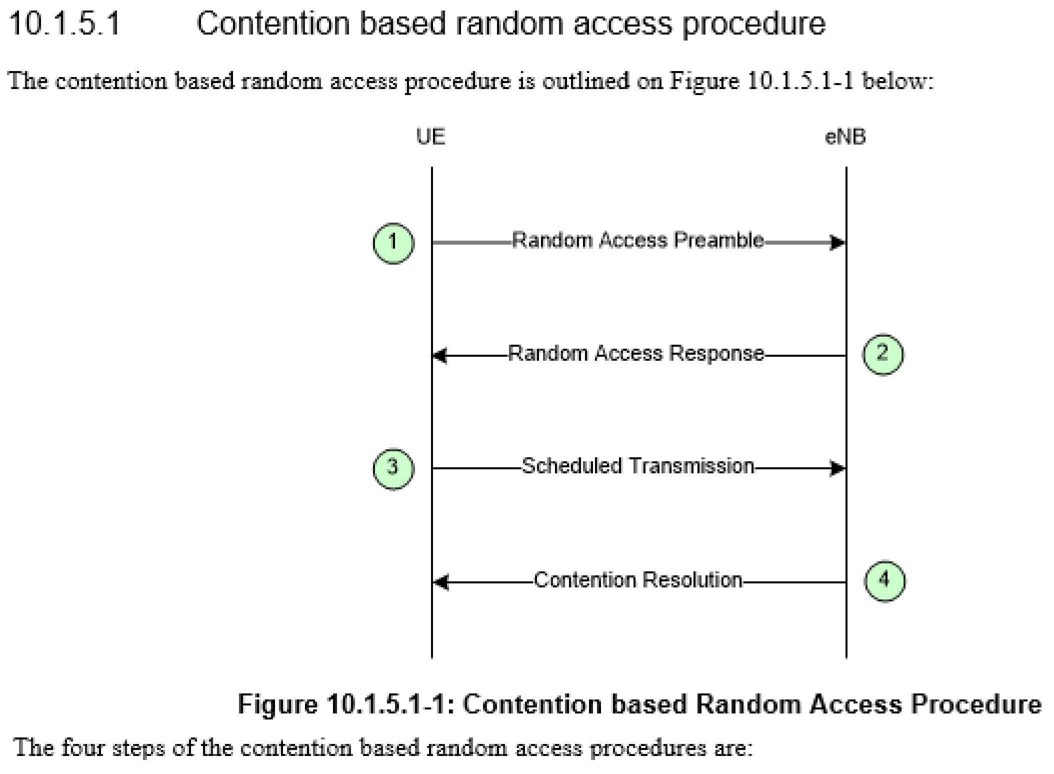
US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

the receiver is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	The receiver of FCA’s Accused Instrumentalities is configured to determine if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + t\_id+10*f\_id$ Where t_id is the index of the first subframe of the specified PRACH $(0\le t\_id < 10)$, and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain $(0\le f\_id < 6)$. The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 2(b)
“the receiver is configured to determine if the response
message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter in FCA's Accused Instrumentalities is configured to transmit a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …

US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

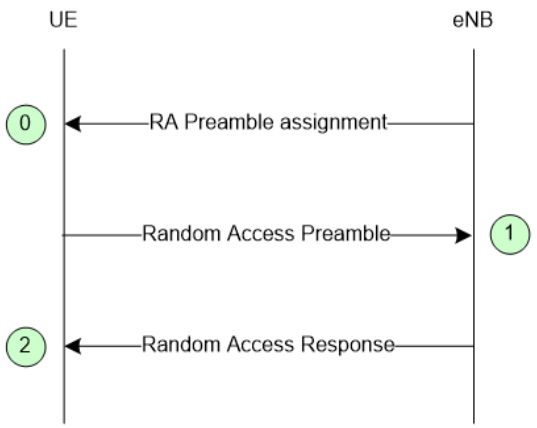
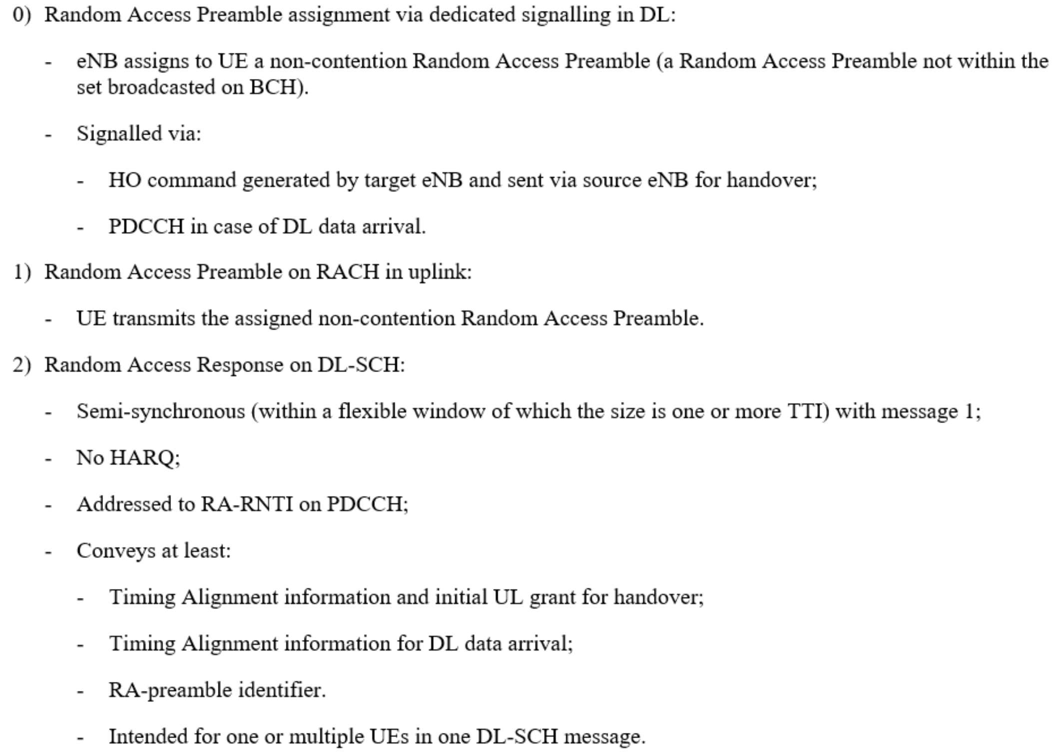


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

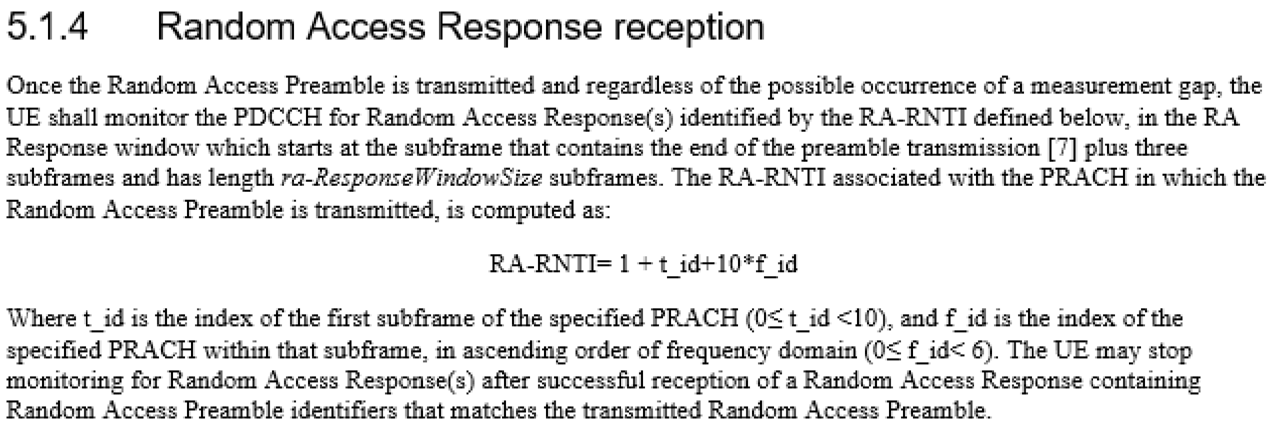


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

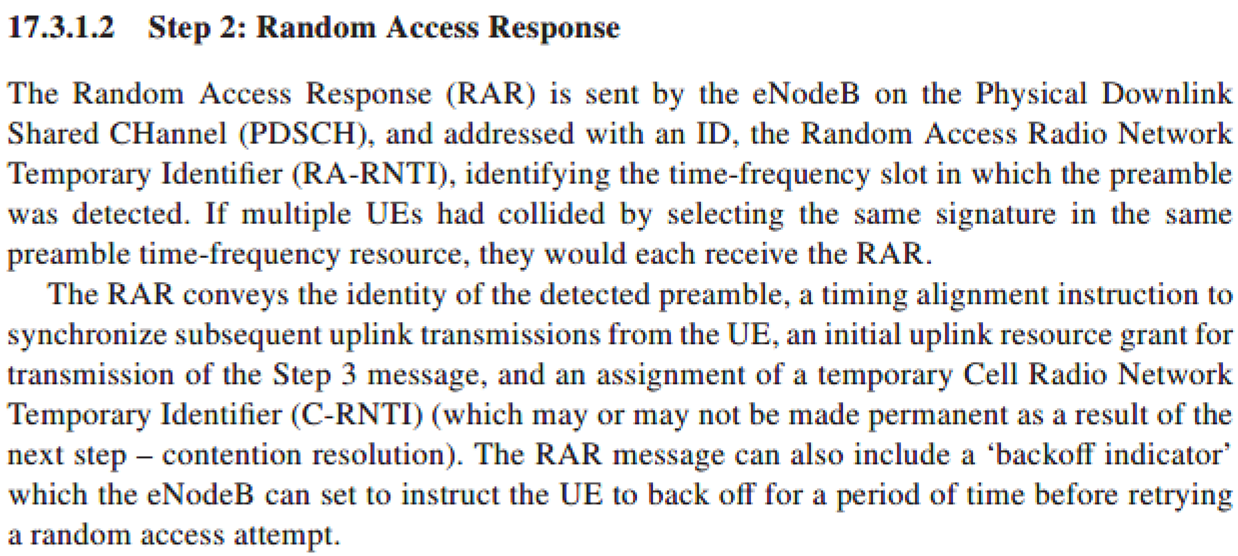
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

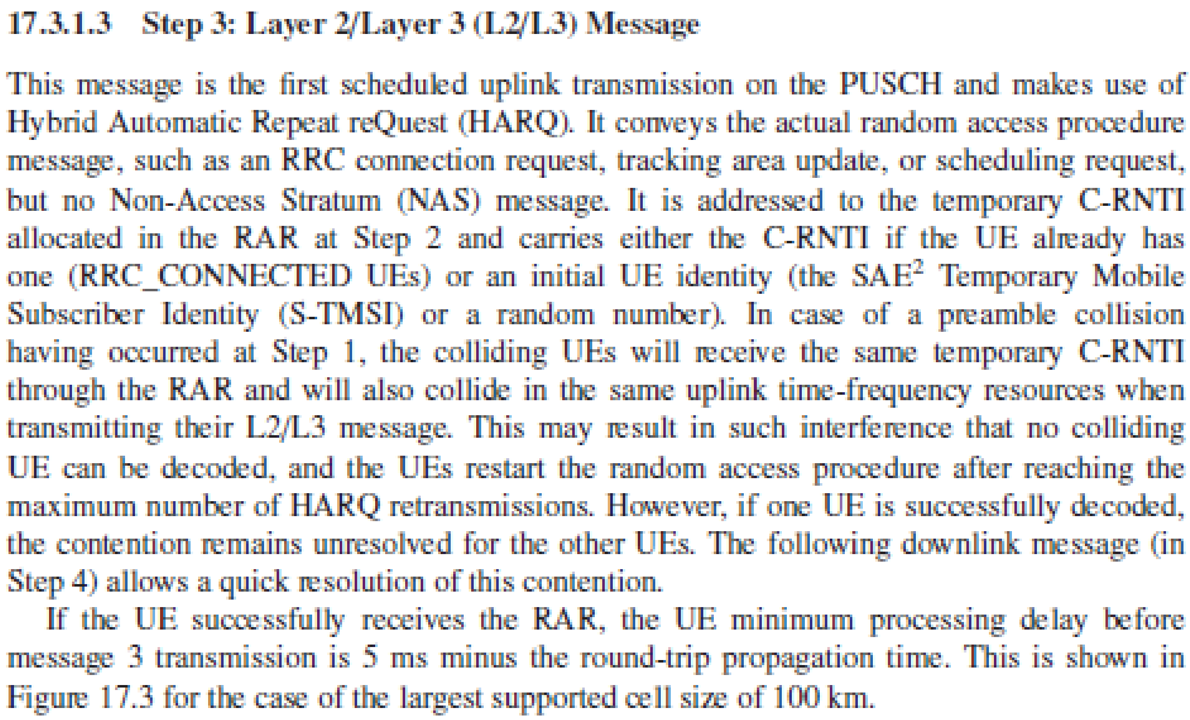
Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

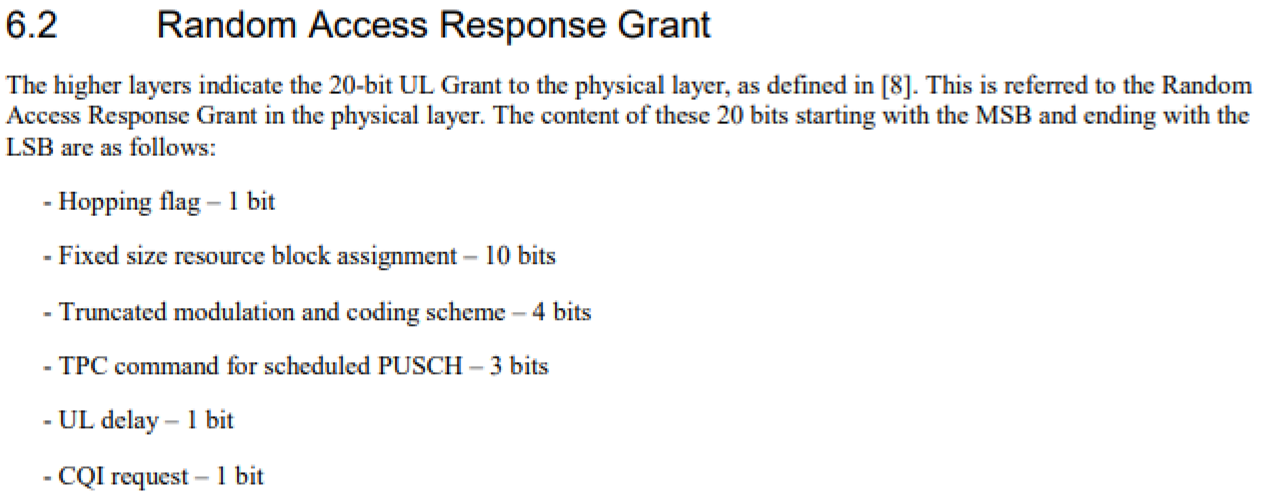
US Patent No. 10,833,908: Claim 2(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

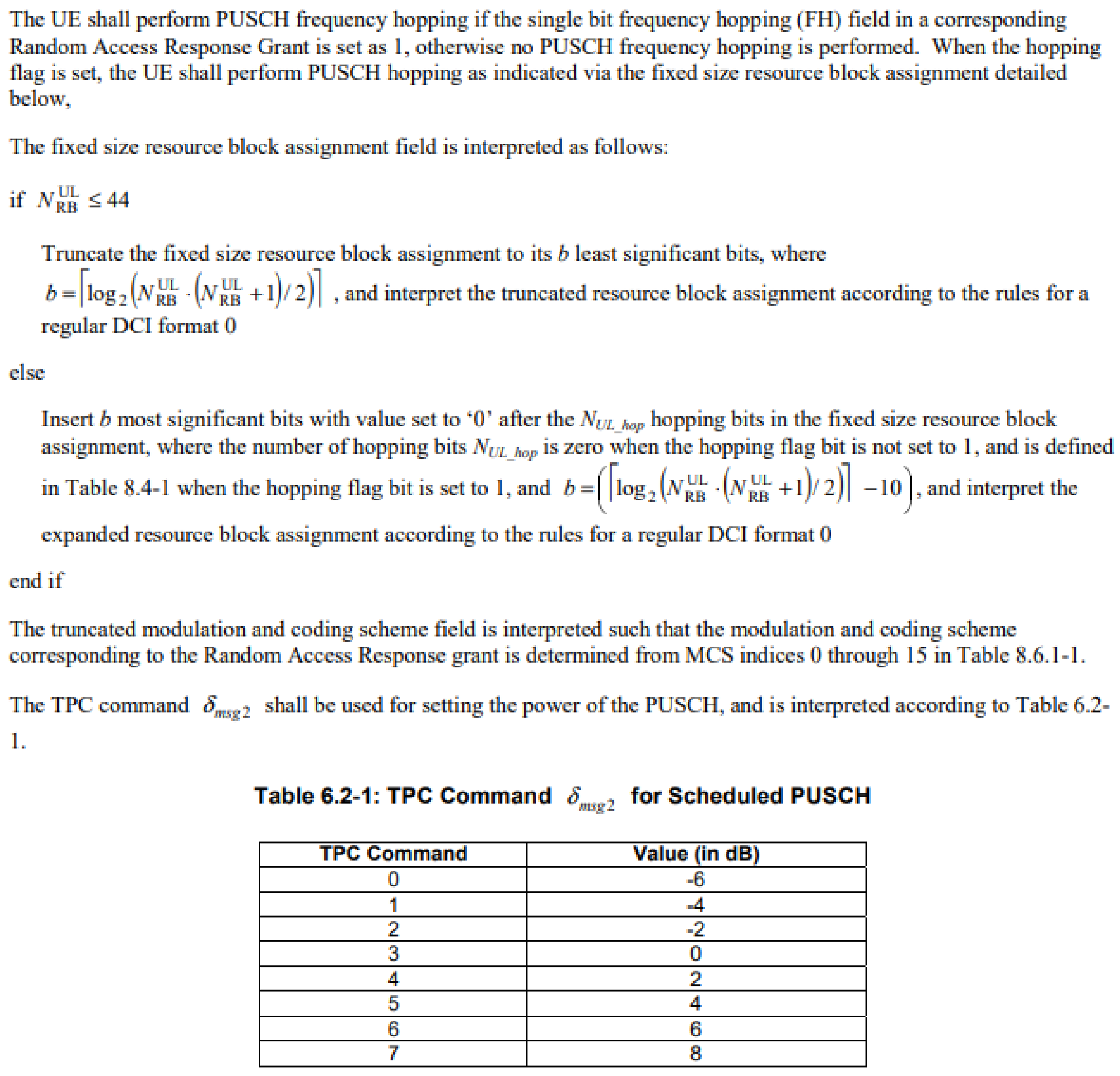
US Patent No. 10,833,908: Claim 2(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, the transmitter is configured to transmit a second uplink signal”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375.

US Patent No. 10,833,908: Claim 3(a)
“The mobile station of claim 2, wherein the response message includes power adjustment information and”

3. The mobile station of claim 2, wherein the response message includes power adjustment information and	The response message received by the receiver of FCA’s Accused Instrumentalities includes power adjustment information. *E.g.*, *See* Claim 12. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(a)
“The mobile station of claim 2, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

> Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

> Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

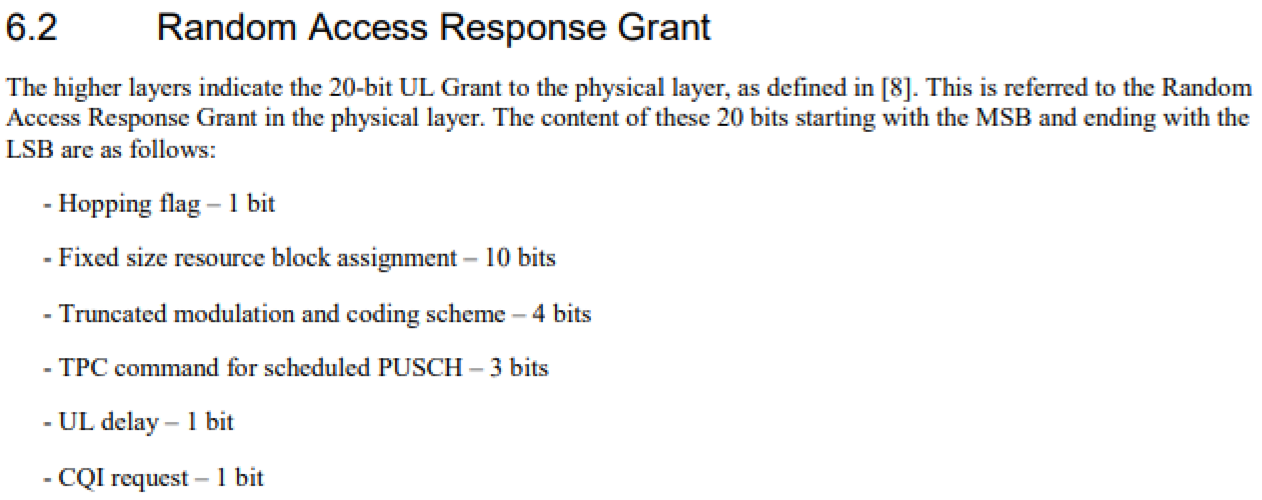
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

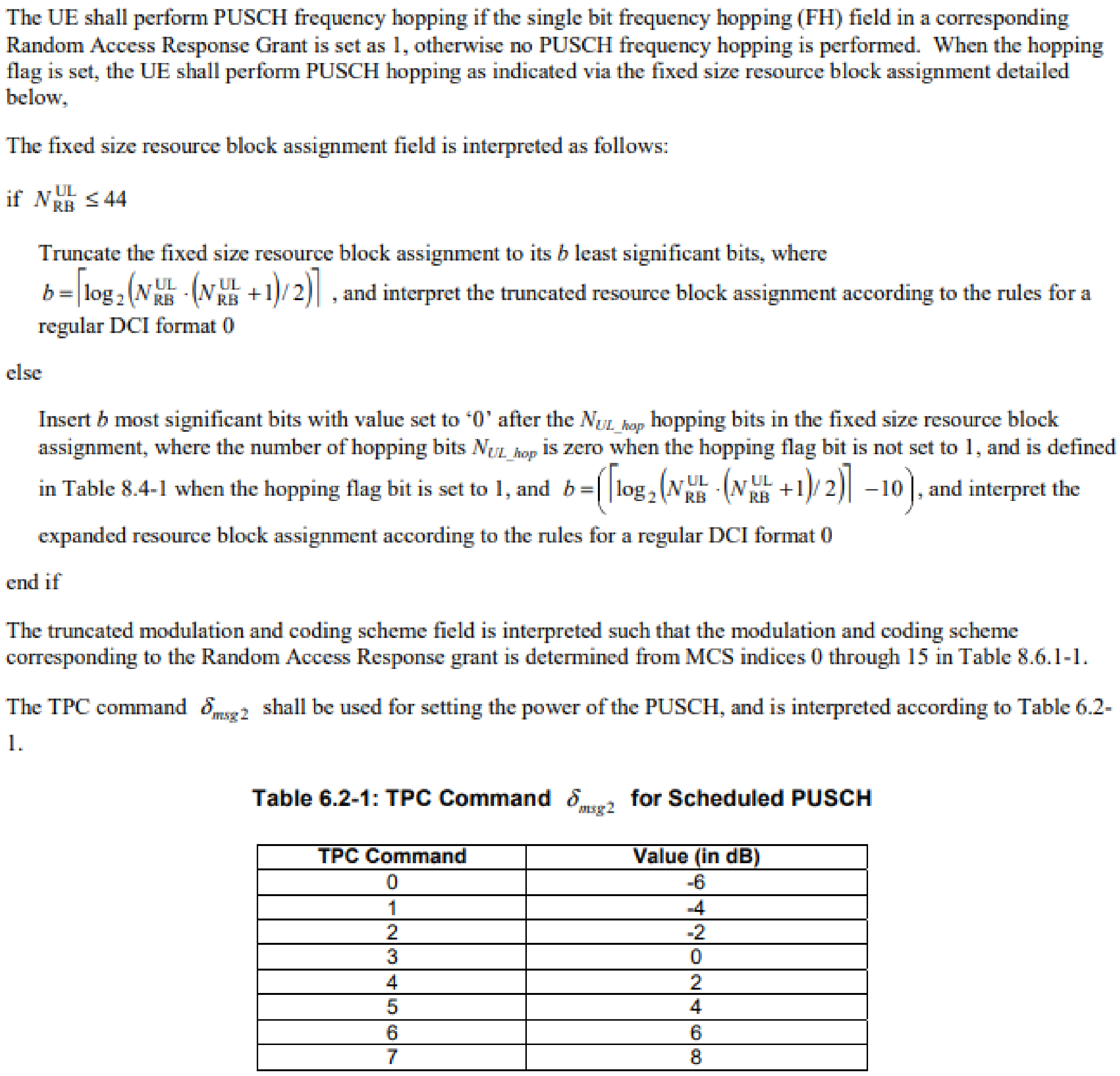
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”

wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information.	The transmitter of FCA’s Accused Instrumentalities is configured to transmit the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 3(b)
“wherein the transmitter is configured to transmit the second uplink signal according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \le 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

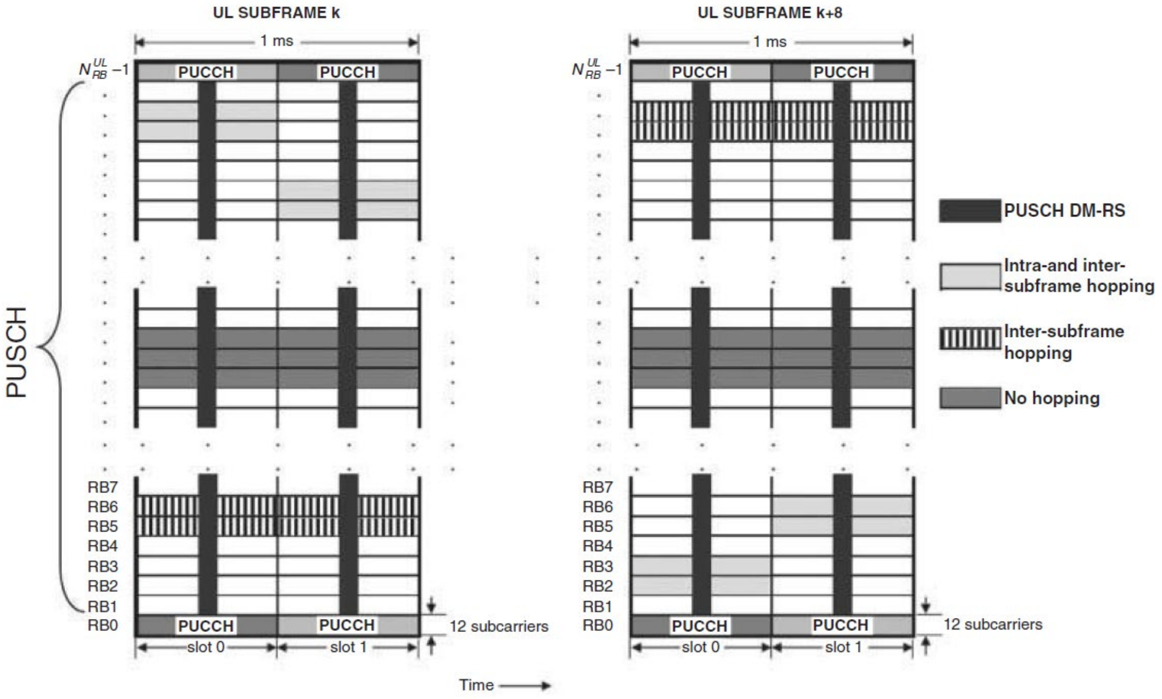
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

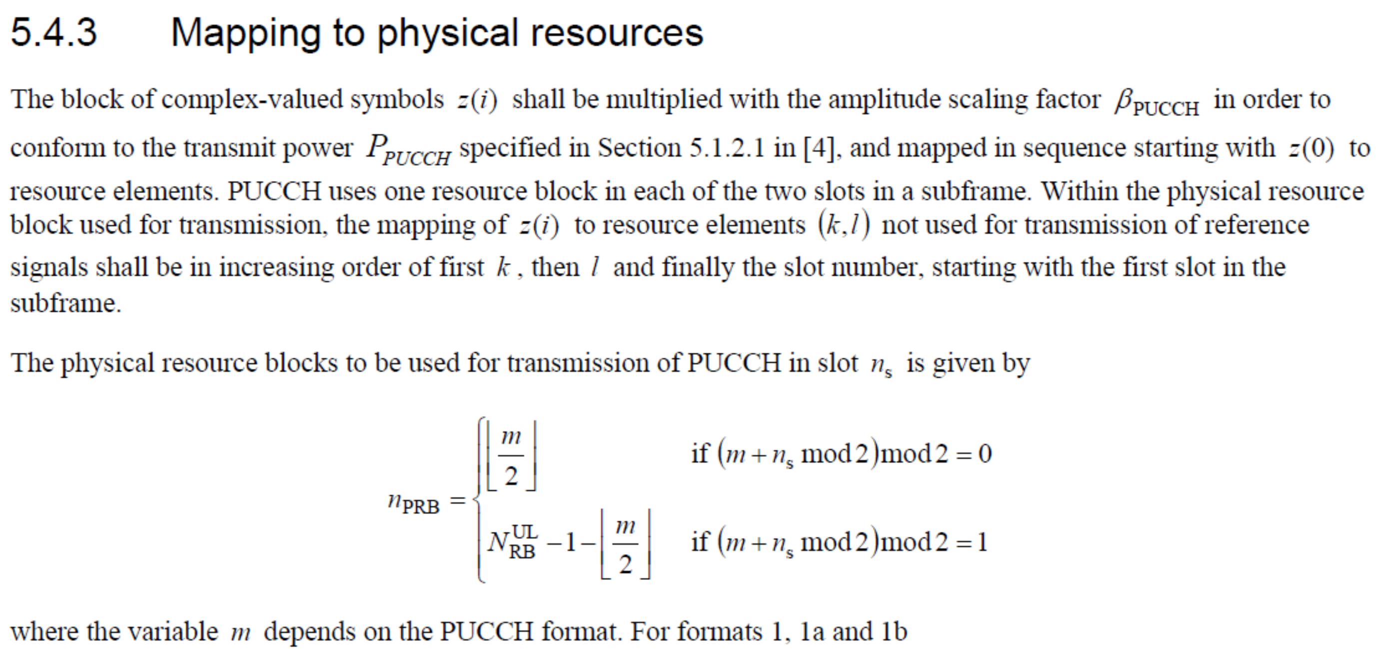
US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

4. The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by the transmitter of FCA's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 1. The uplink control channels, such as the PUCCH, do not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure"). For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

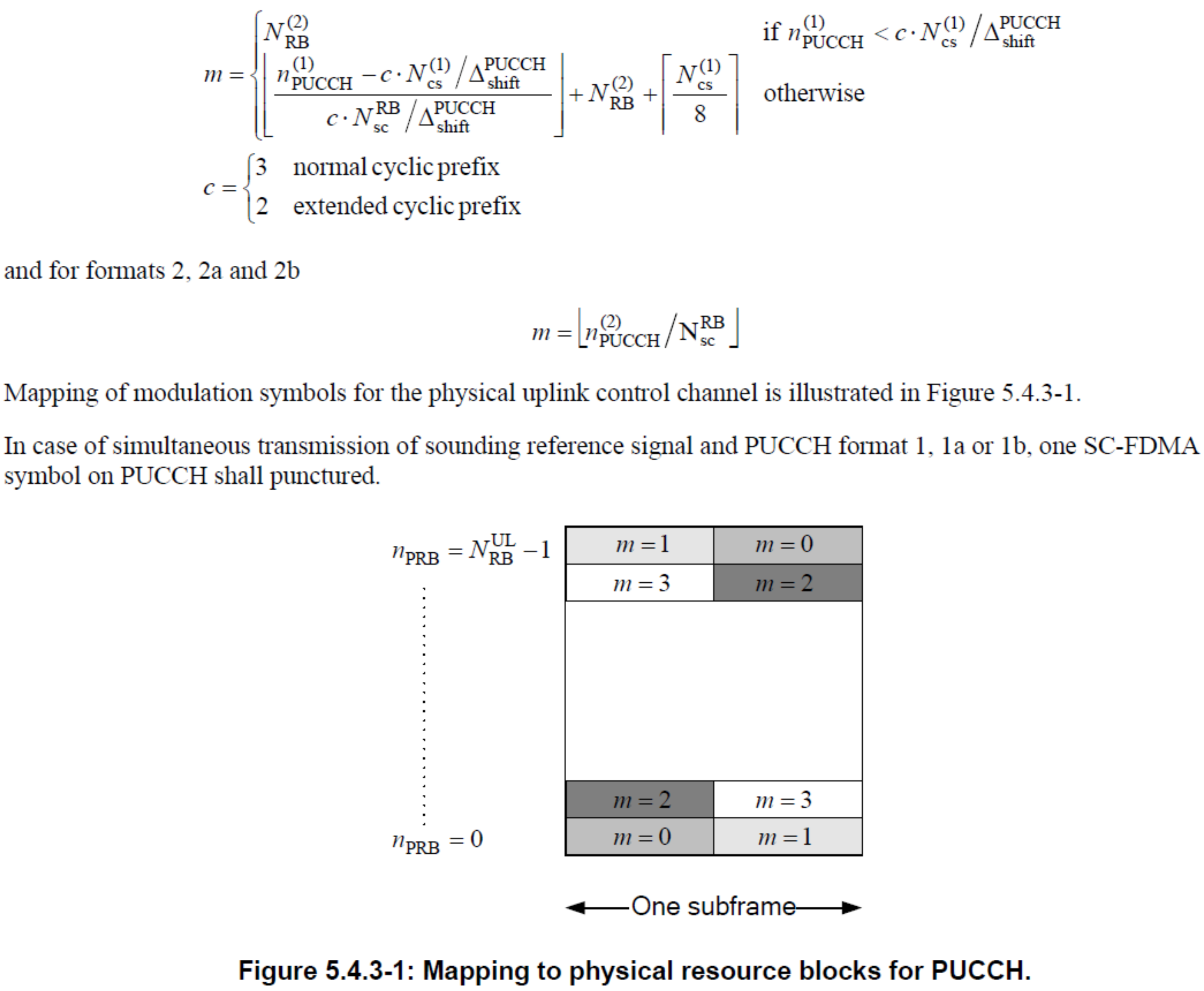
The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

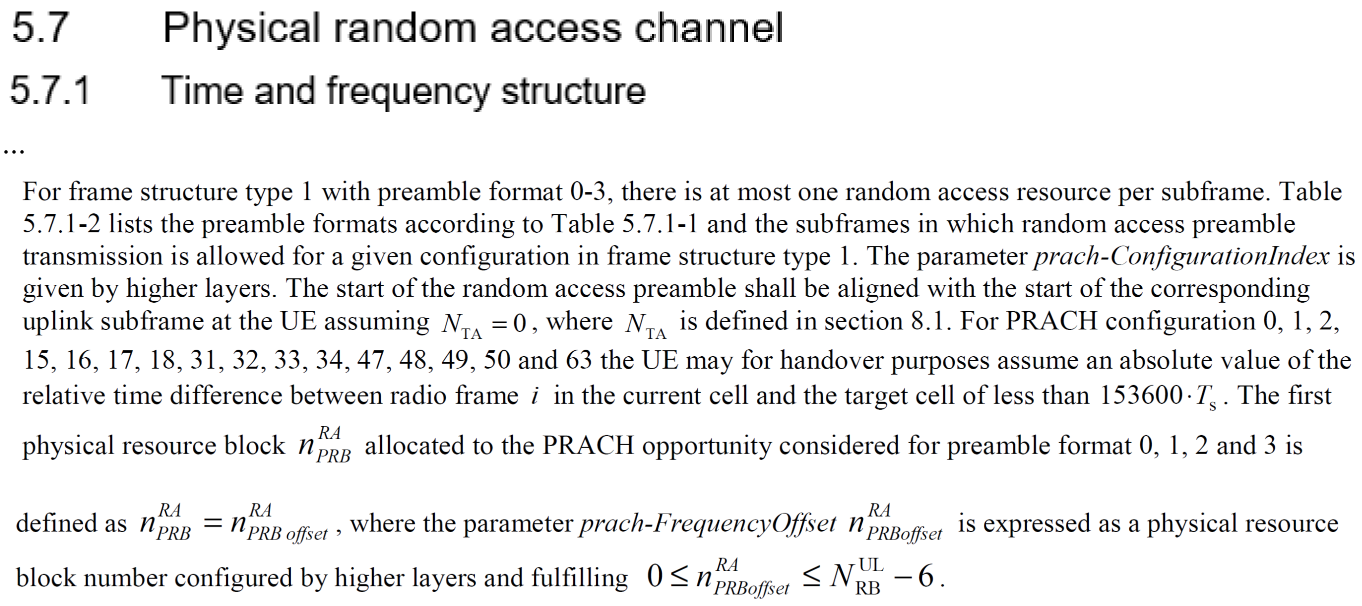
In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

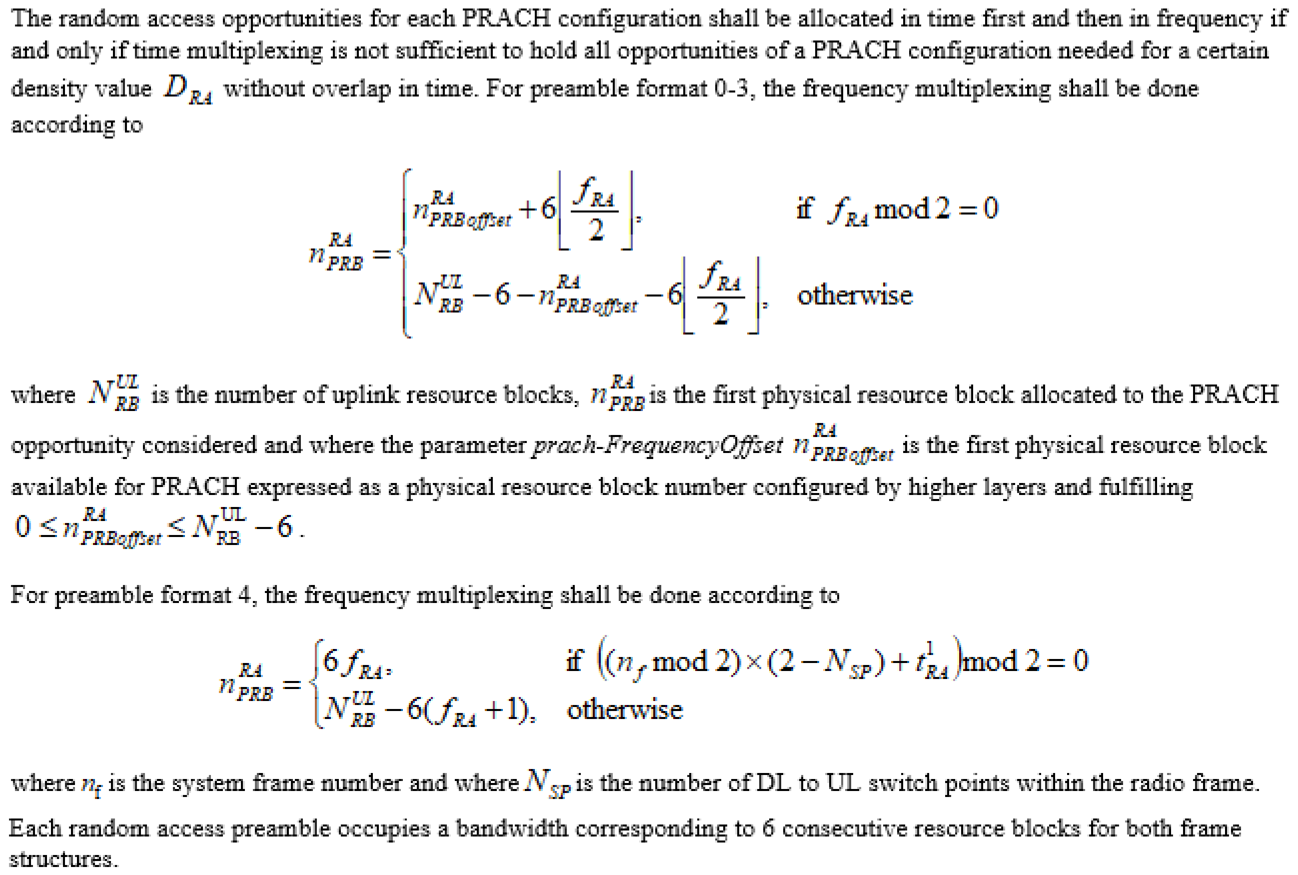
The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

US Patent No. 10,833,908: Claim 4
“The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.  5.7 Physical random access channel 5.7.1 Time and frequency structure ... For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\,offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. …

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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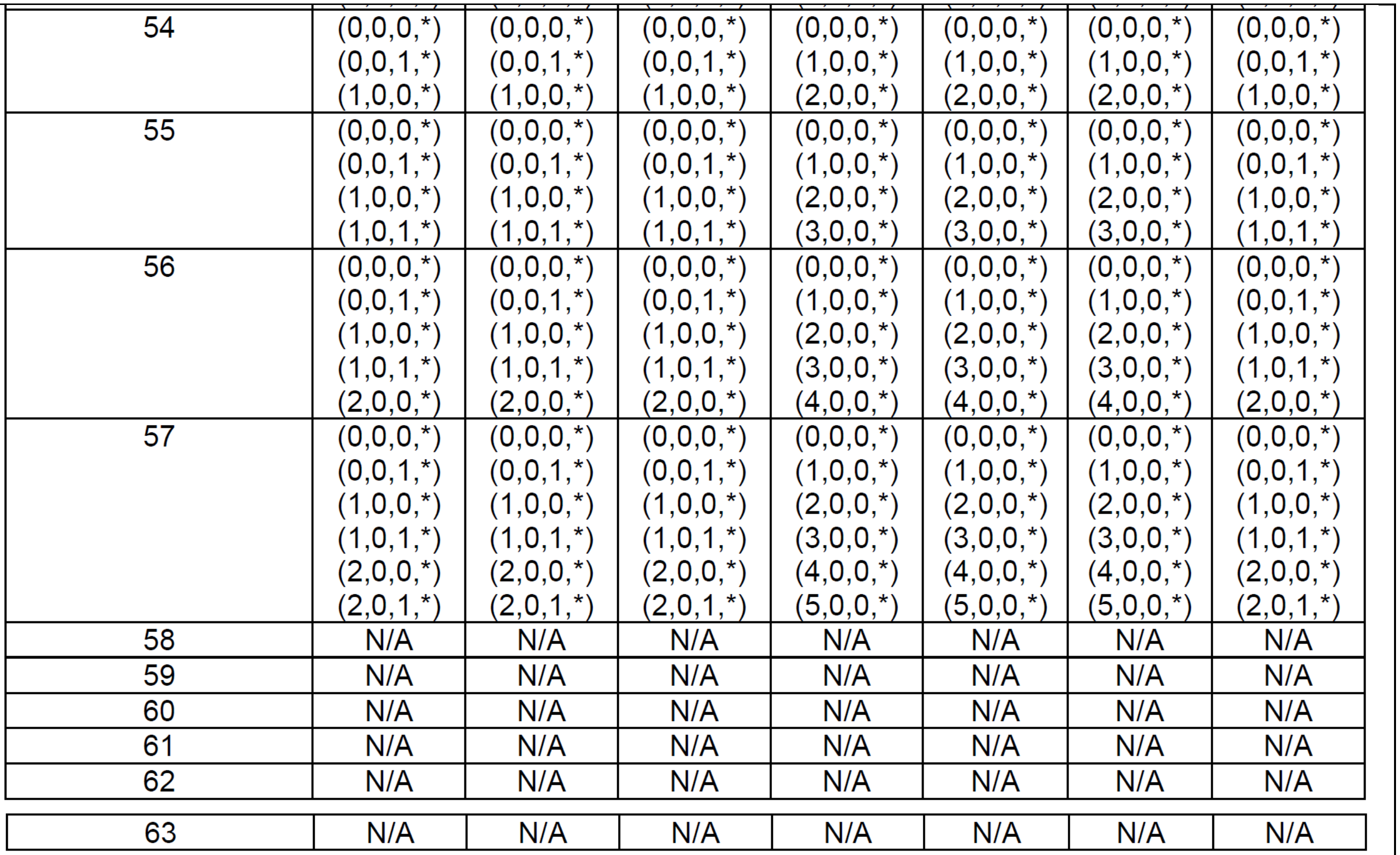
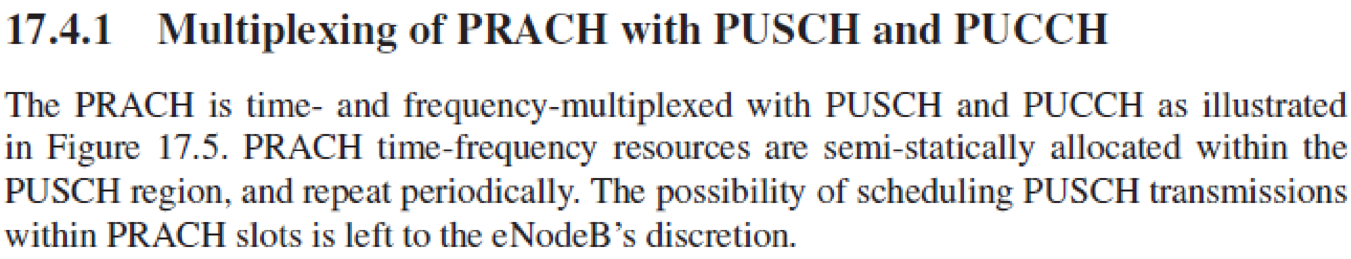


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

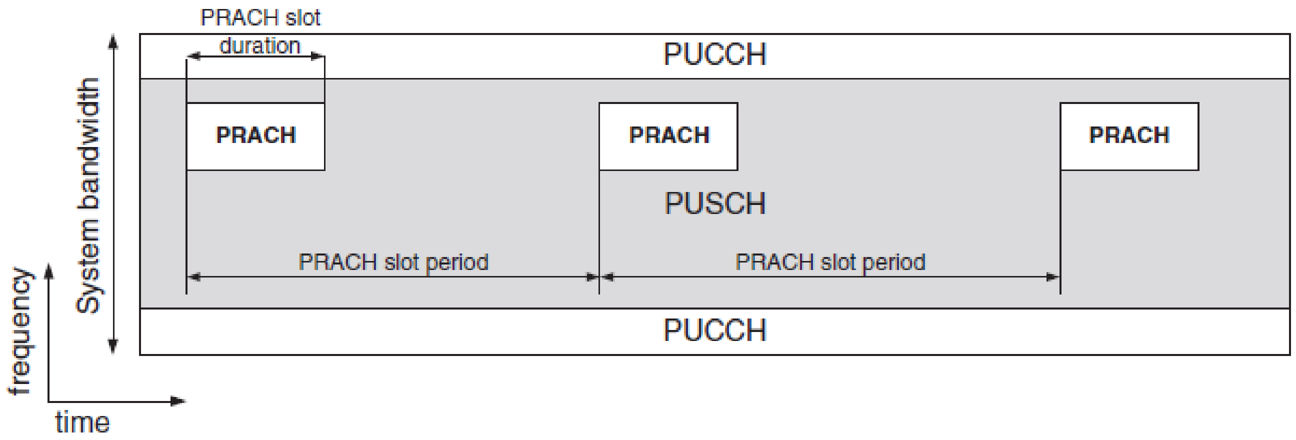


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

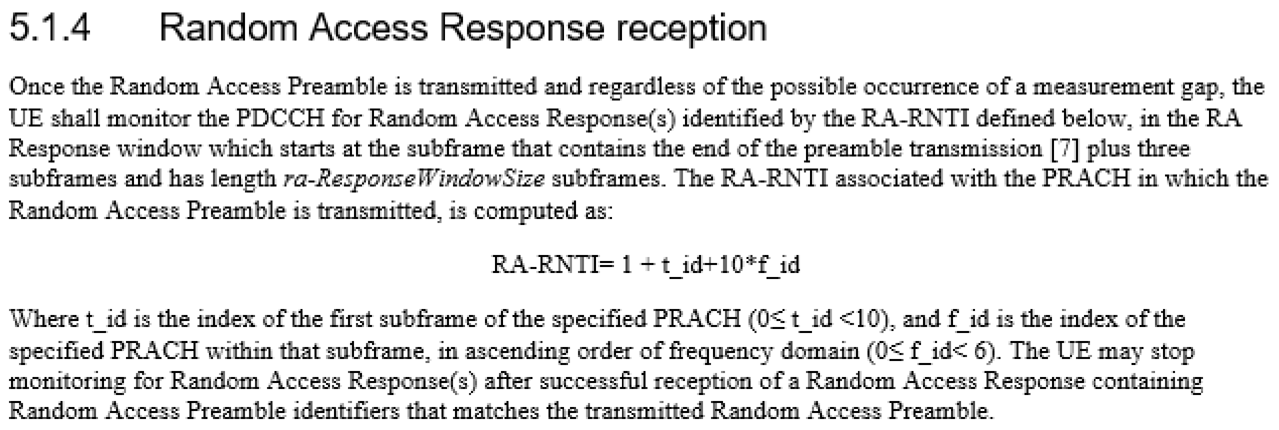
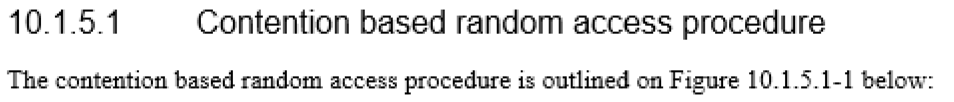
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 4

"The mobile station of claim 1, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5.

US Patent No. 10,833,908: Claim 5
"The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station."

5. The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of FCA's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

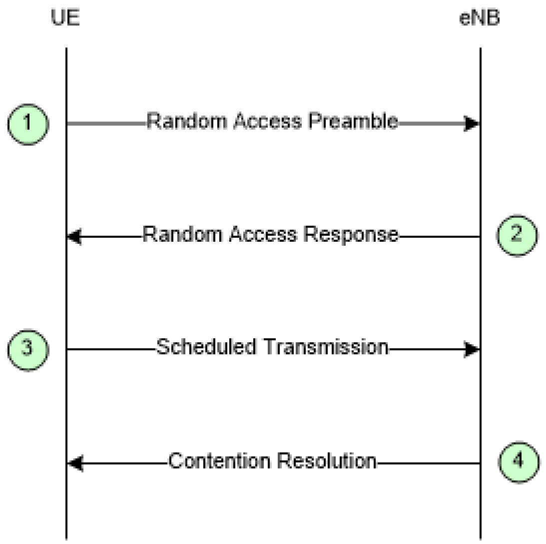


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

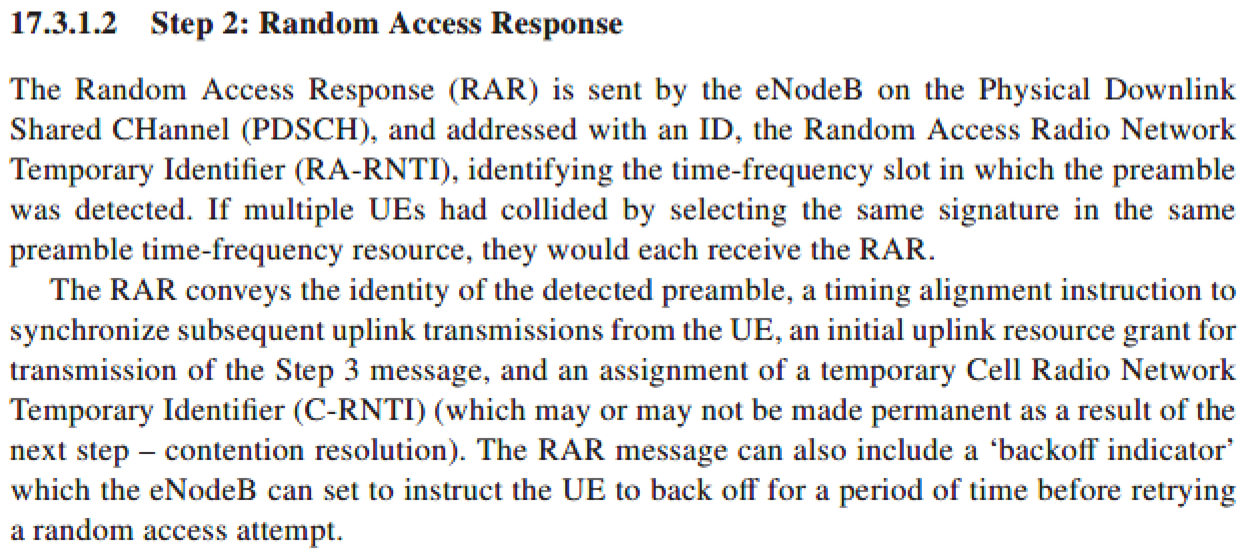
…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 5
“The mobile station of claim 1, wherein the response message includes a mobile station identifier assigned to the mobile station.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

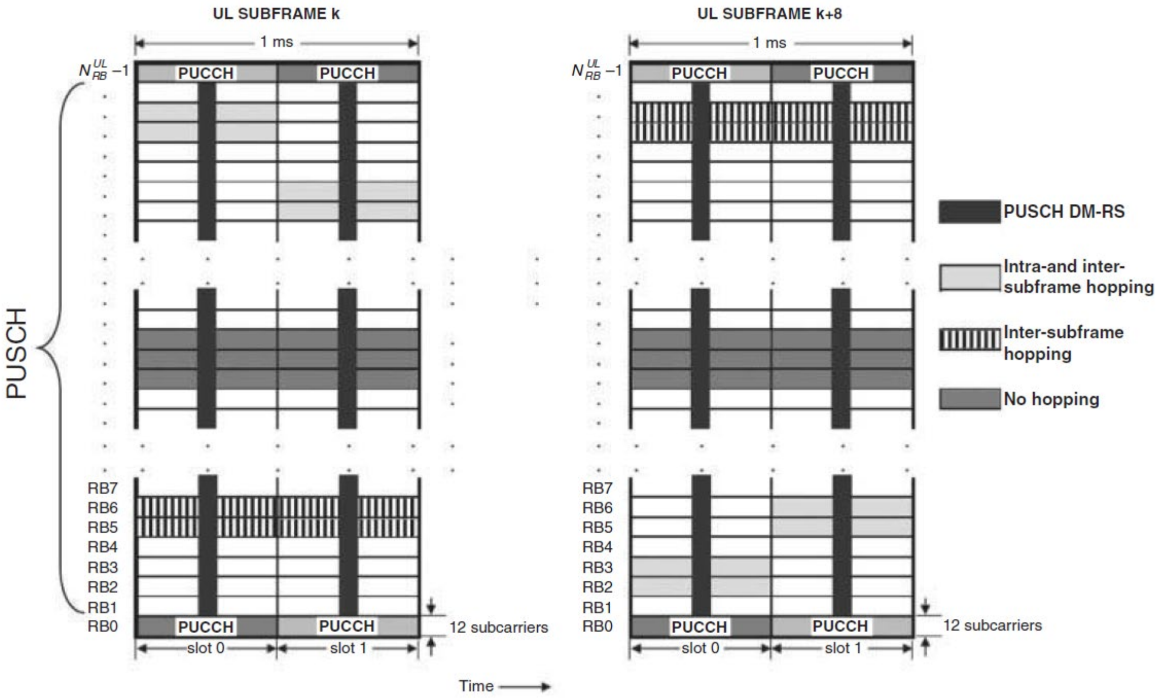
US Patent No. 10,833,908: Claim 6

"The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

6. The mobile station of claim 1, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with FCA's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 1. *See* element 1(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

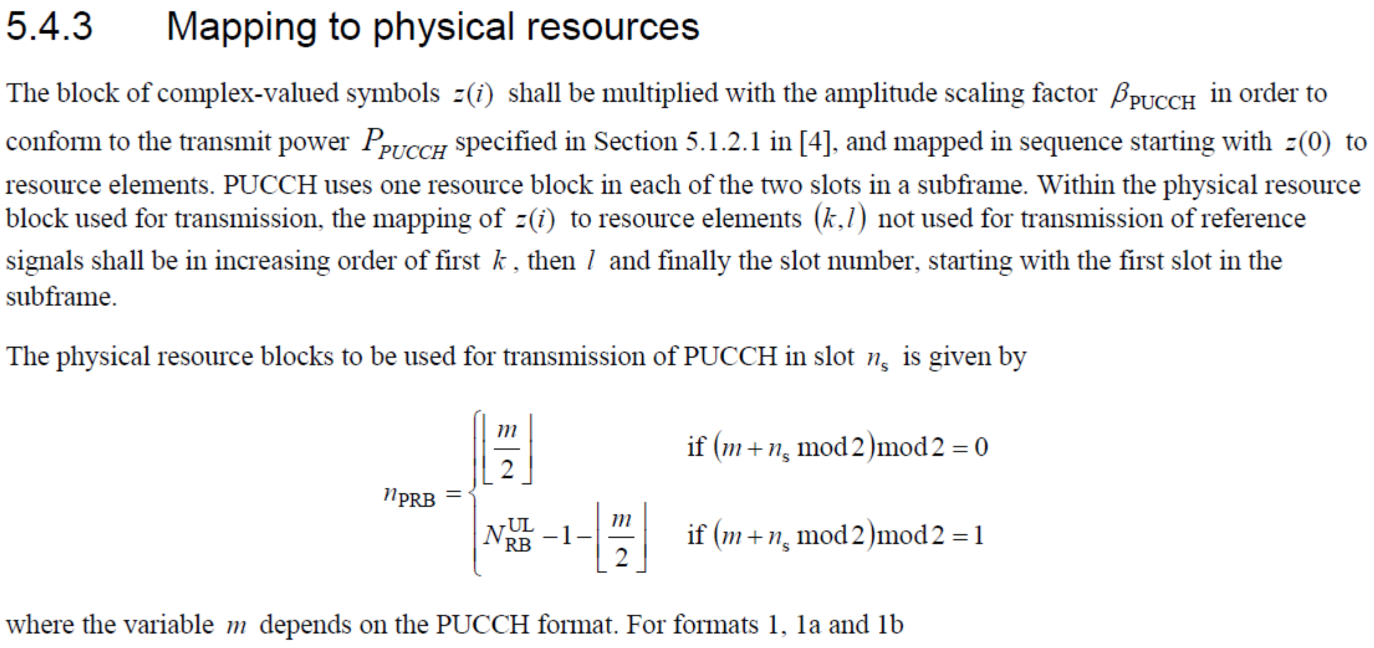
US Patent No. 10,833,908: Claim 7

“The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

7. The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with FCA’s Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 7
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

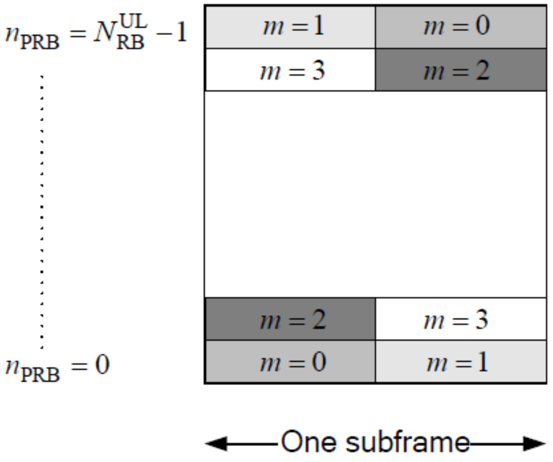


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

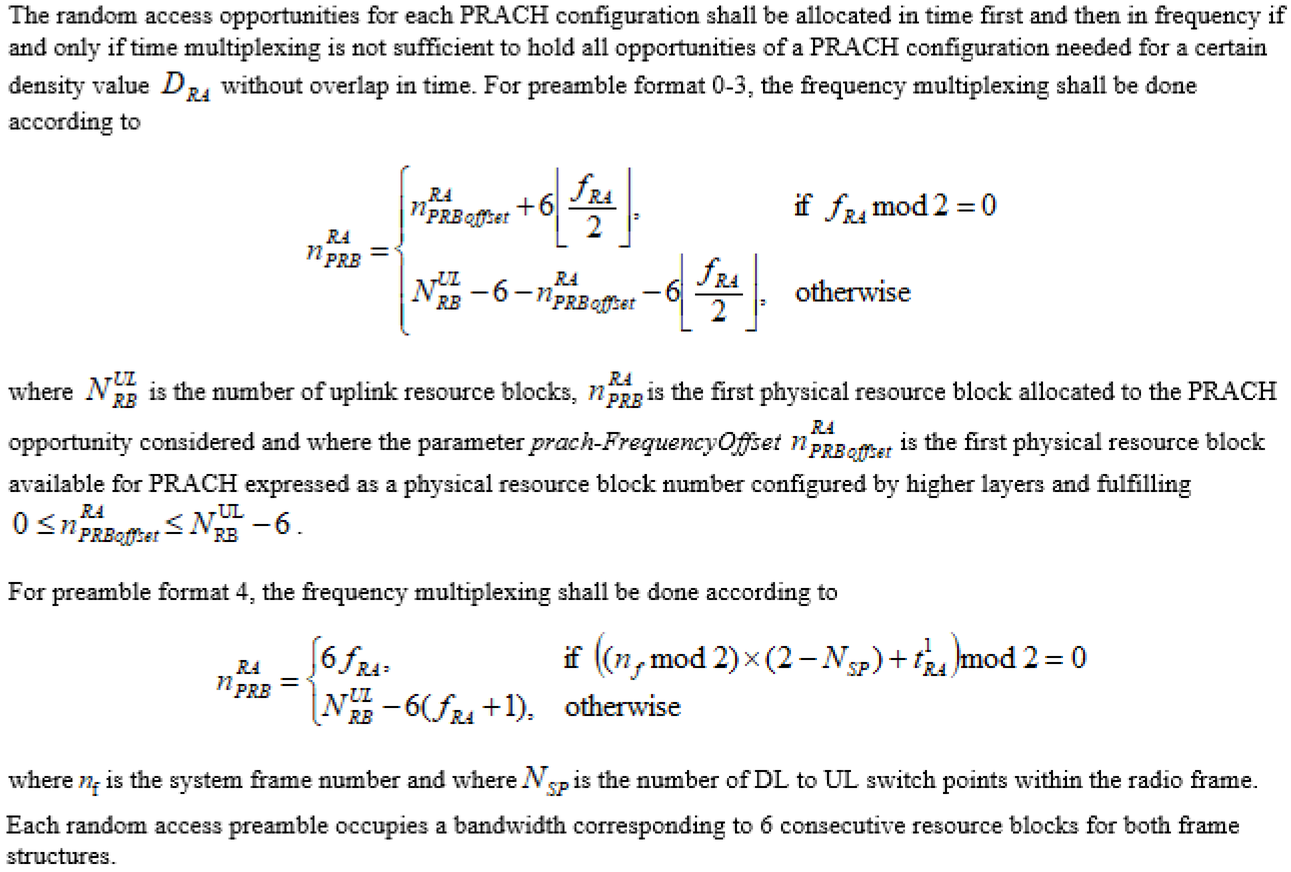
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

	determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH. **5.7 Physical random access channel** **5.7.1 Time and frequency structure** … For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$. …

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6f_{RA}, & \text{if } \left((n_f \bmod 2)\times(2-N_{SP})+t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA}+1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

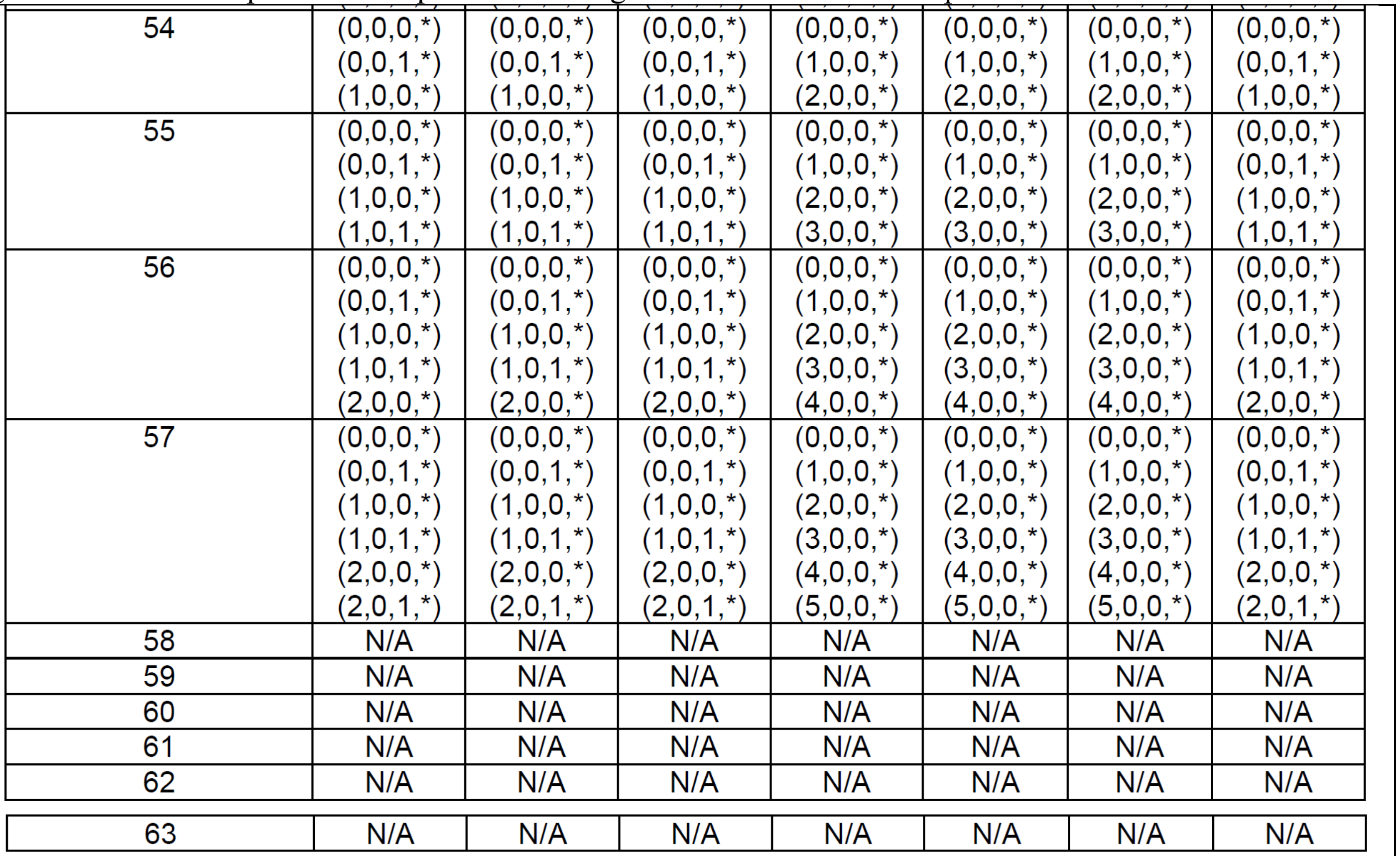
.

.

.

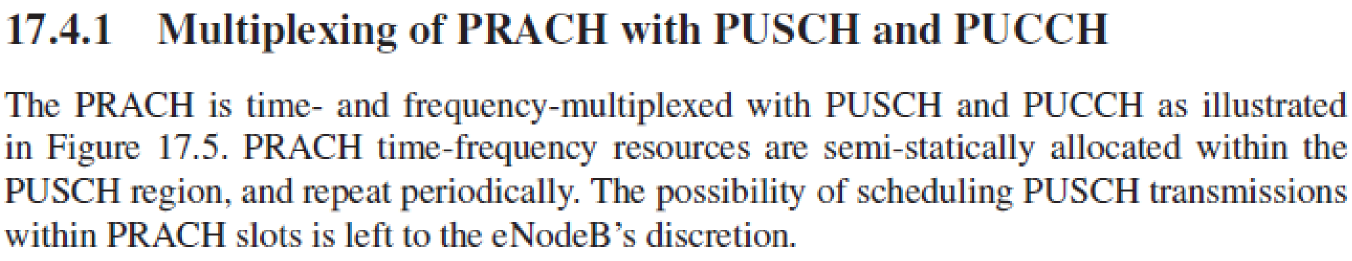
US Patent No. 10,833,908: Claim 7

"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

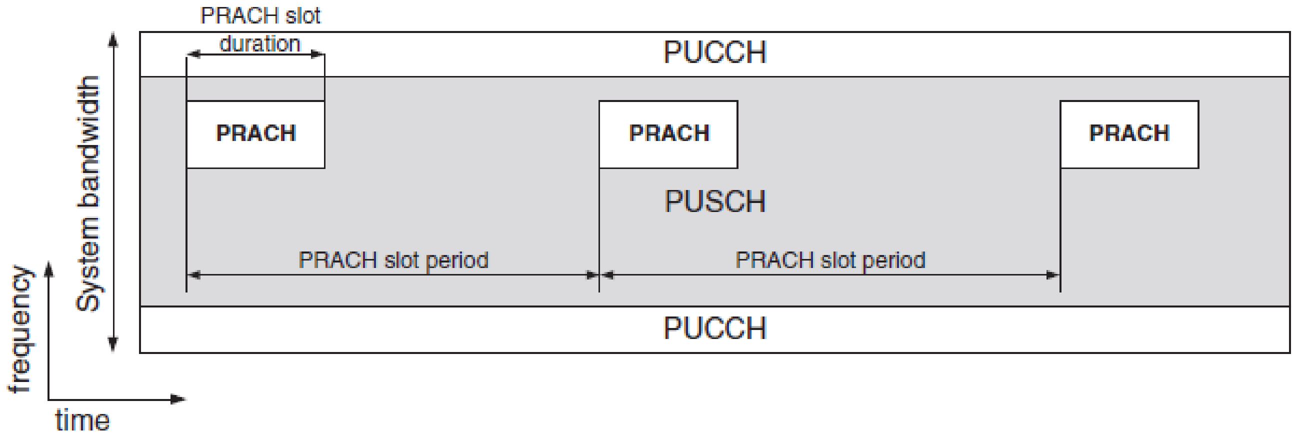


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

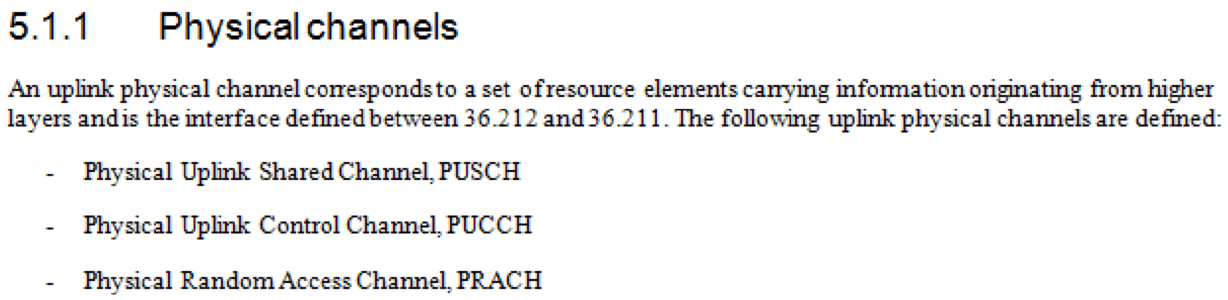
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 7

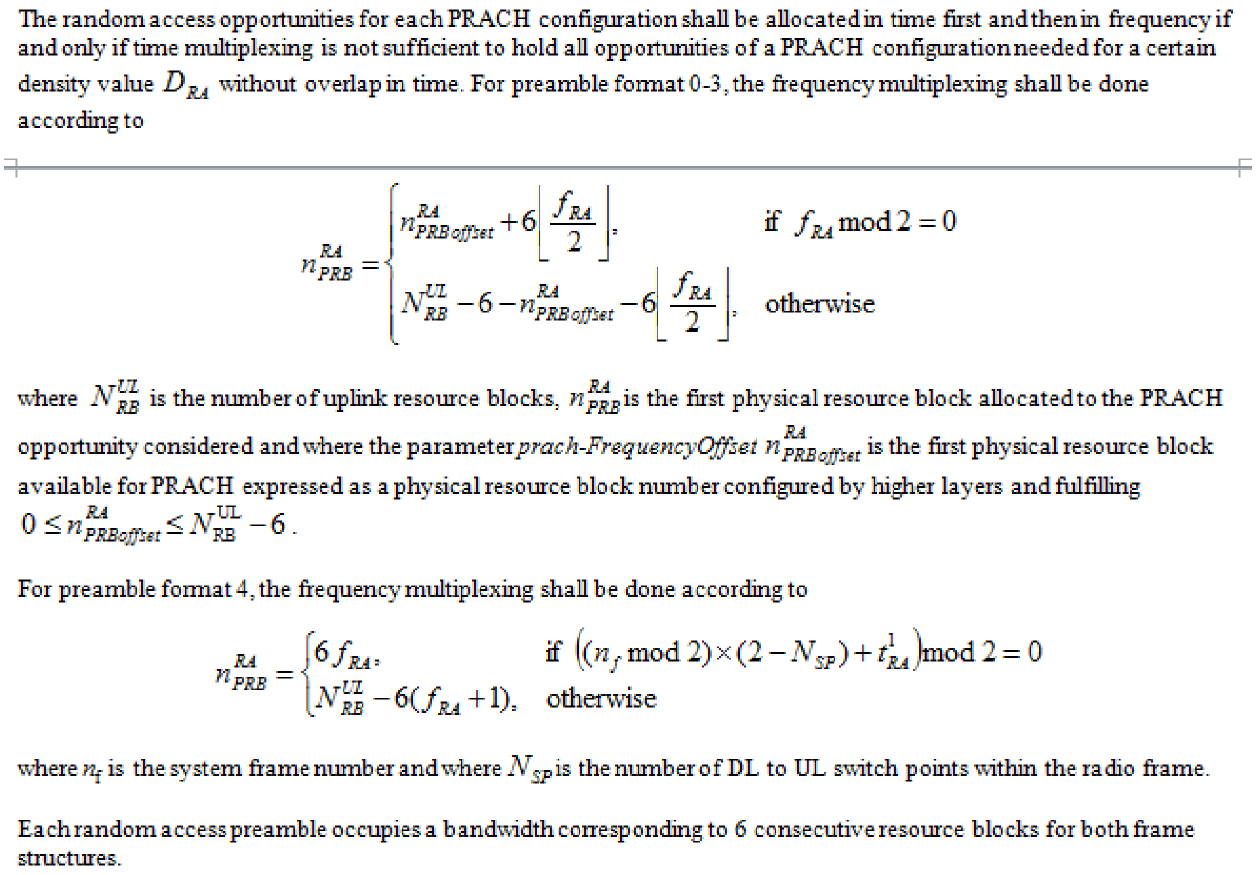
"The mobile station of claim 1, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."

8. The mobile station of claim 1, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with FCA's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 1. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB. 5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

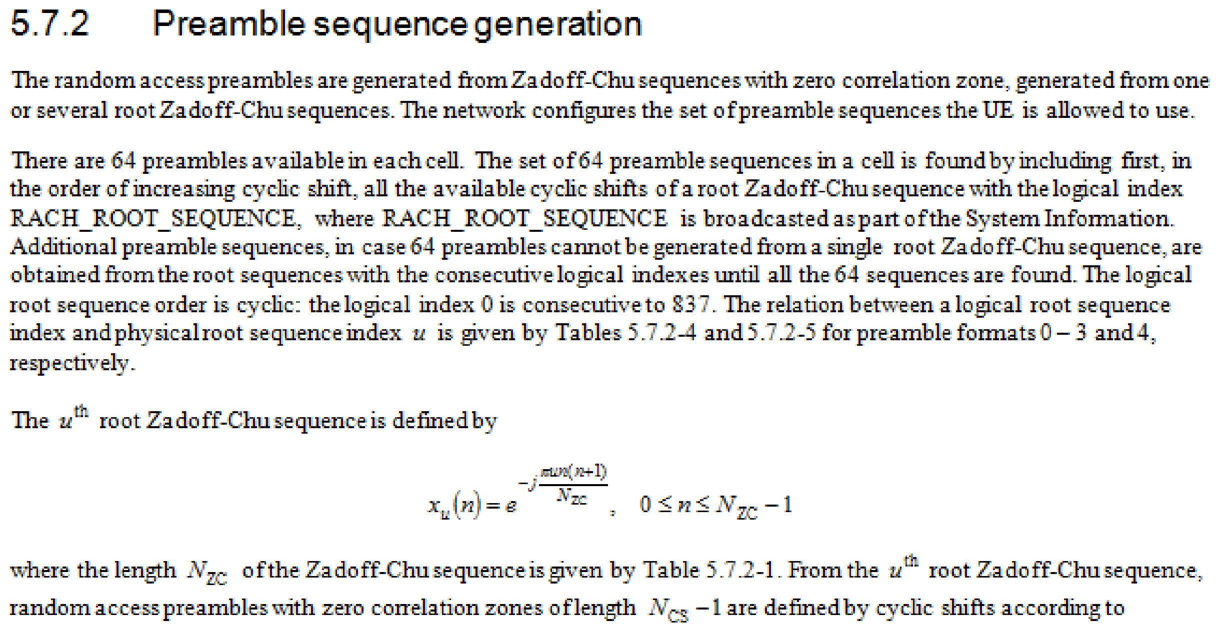
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 8
“The mobile station of claim 1, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

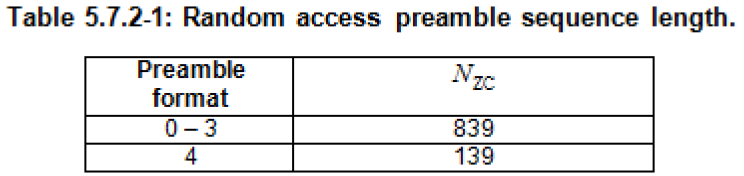
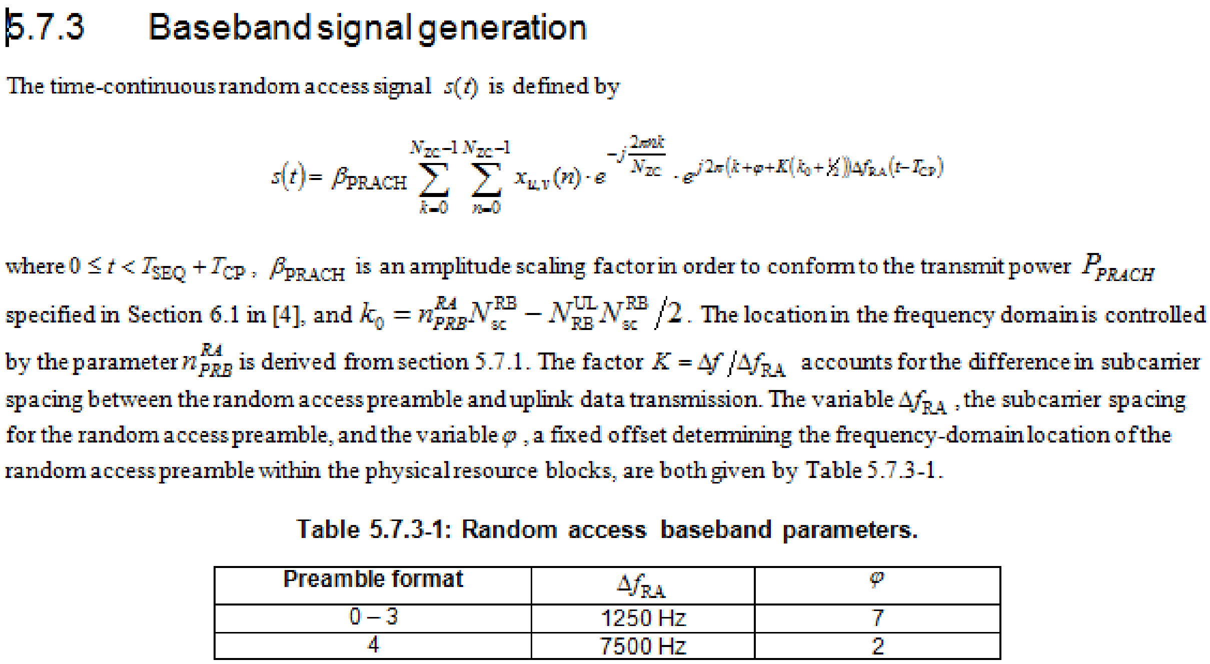


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 8
"The mobile station of claim 1, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

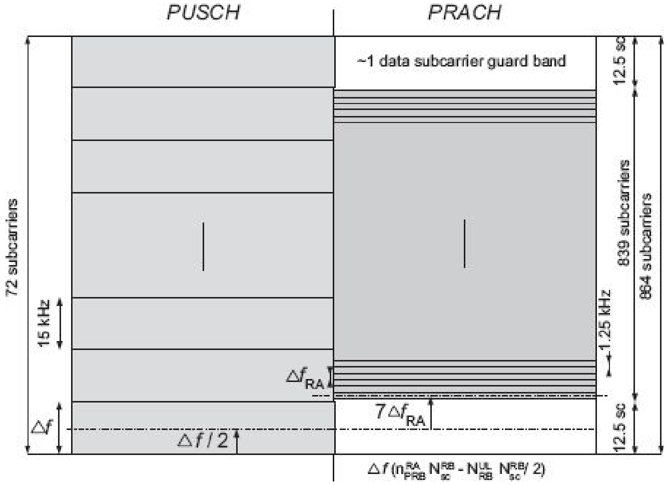
$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

where $0\leq t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

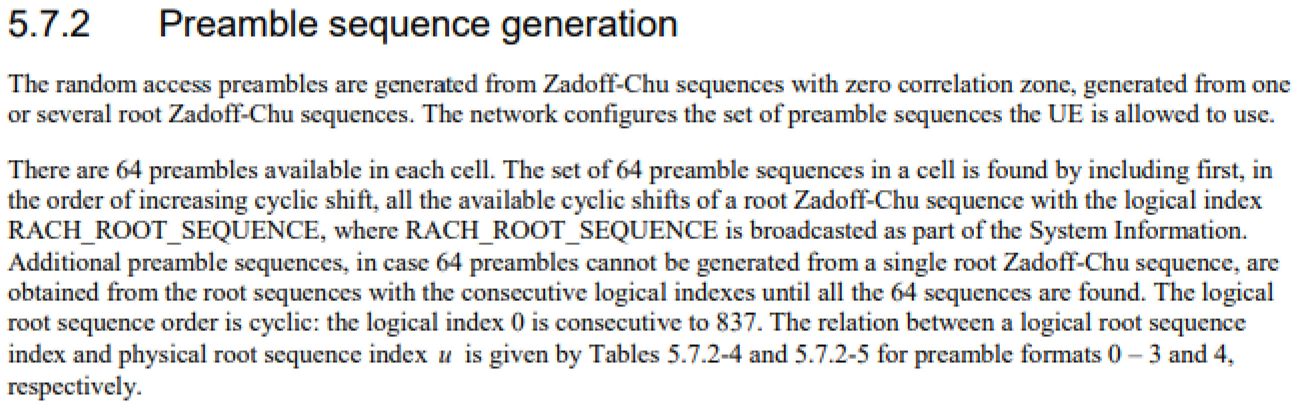
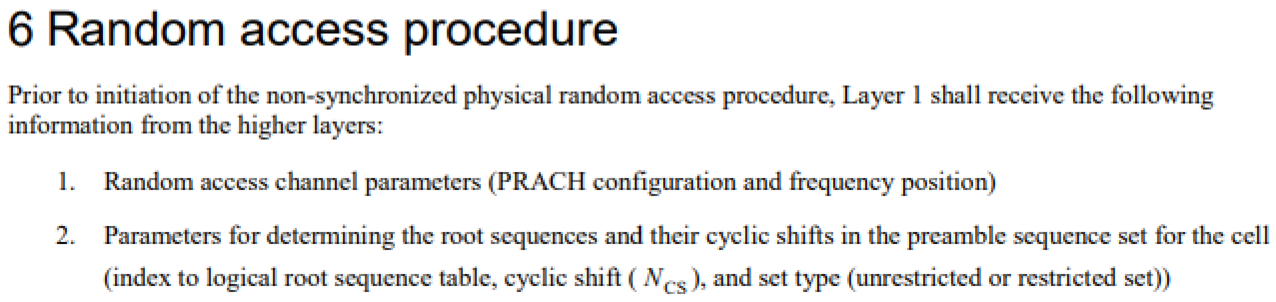
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 – 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers.  See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 9

"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

9. The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of FCA's Accused Instrumentalities is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 1, element 1(e). The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  **5.7.2 Preamble sequence generation** The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  **6 Random access procedure** Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16.

– RadioResourceConfigCommon

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}
```

US Patent No. 10,833,908: Claim 9
"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
```

US Patent No. 10,833,908: Claim 9
"The mobile station of claim 1, wherein: the receiver is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

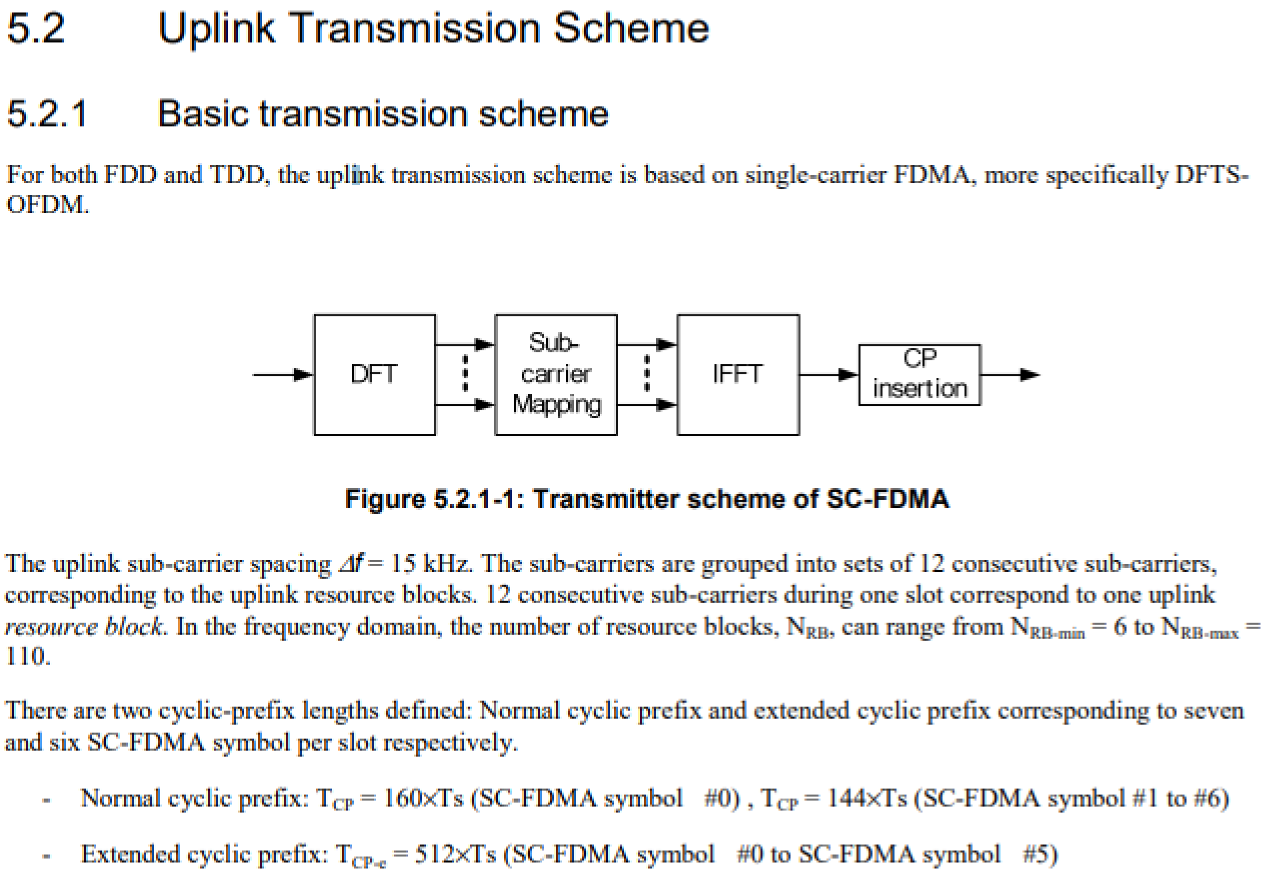
```
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

10. The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 1. FCA's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* FCA's Accused Instrumentalities implement these circuit elements for transmitting the uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 10

"The mobile station of claim 1, wherein the transmitter includes an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

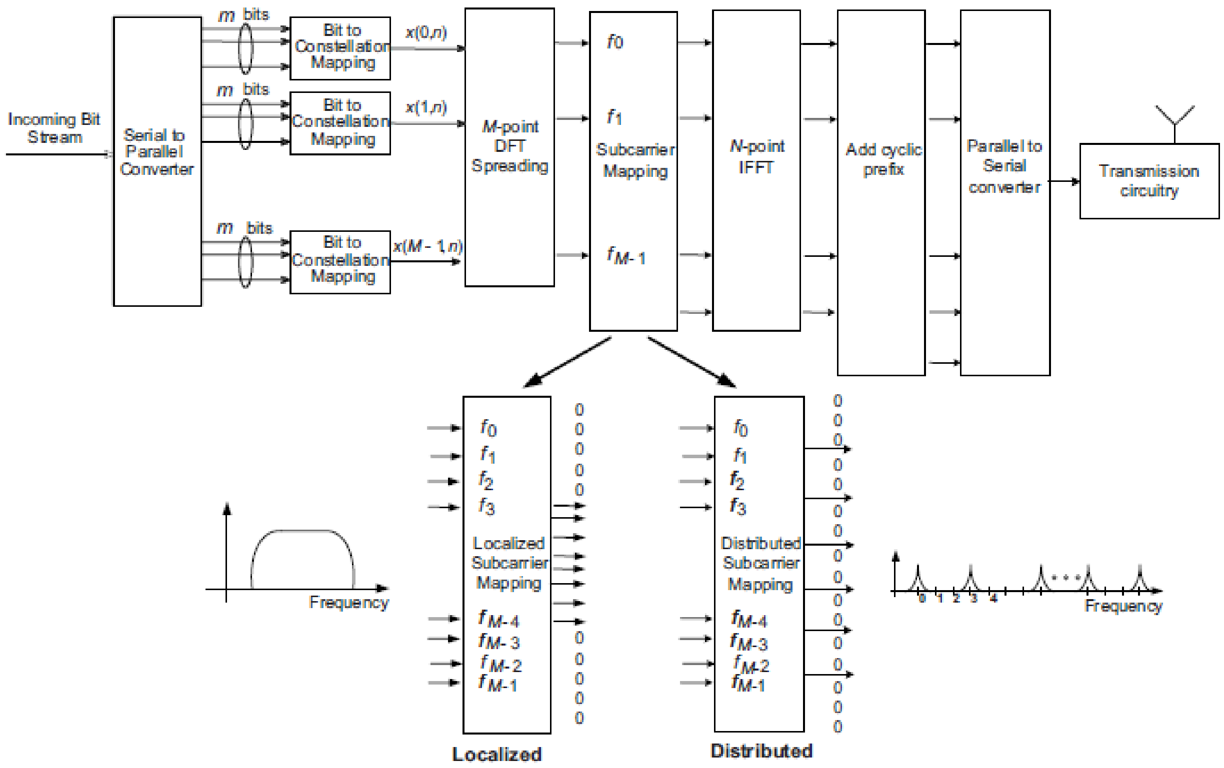
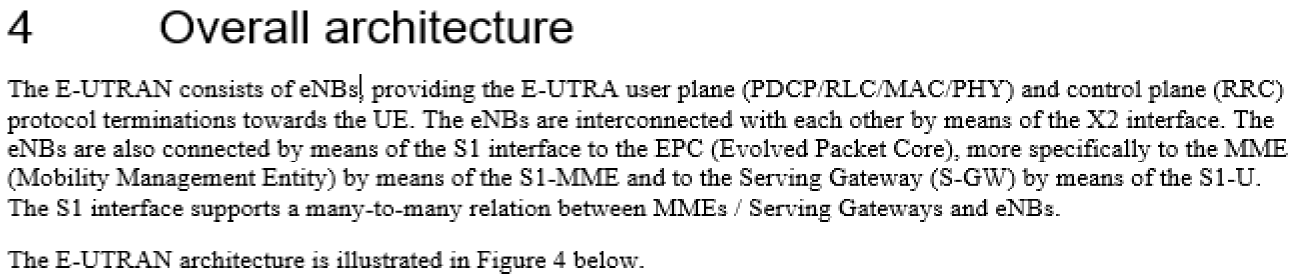


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:”

11. A method performed by a mobile station, the method comprising:	To the extent the preamble is considered a limitation, FCA’s Accused Instrumentalities meet the preamble of claim 11 of the ’908 patent. *E.g.,* FCA’s Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, FCA offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff’s Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

US Patent No. 10,833,908: Claim 11(a)
"11. A method performed by a mobile station, the method comprising:"

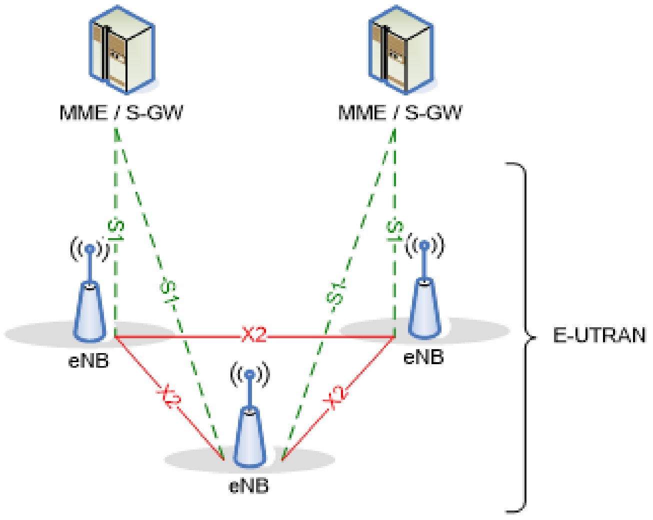


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.

4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

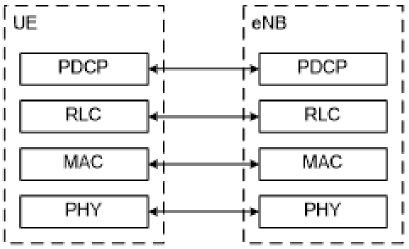


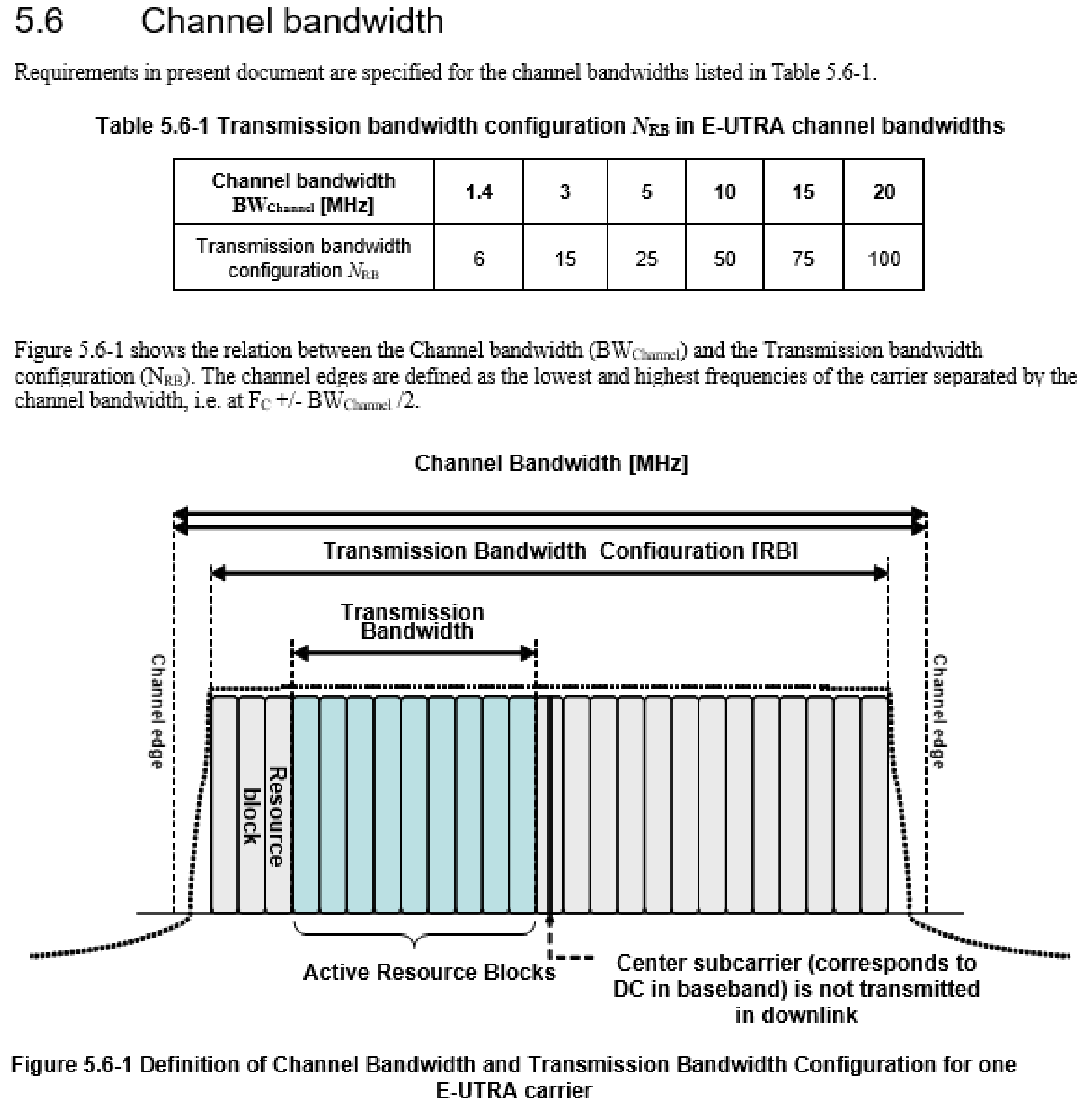
Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

transmitting, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols;	FCA's Accused Instrumentalities transmit, to a base station, a first uplink signal within a frequency band, wherein the first uplink signal is an OFDM signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

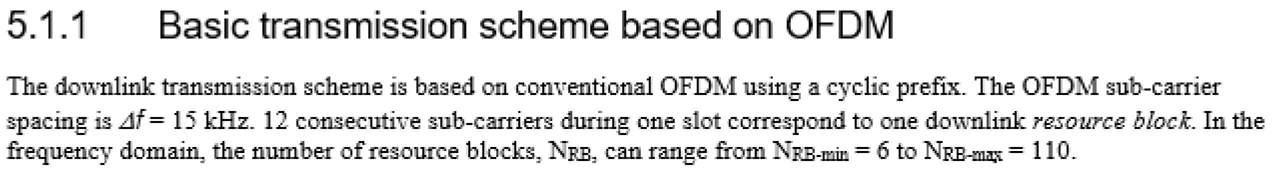
Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

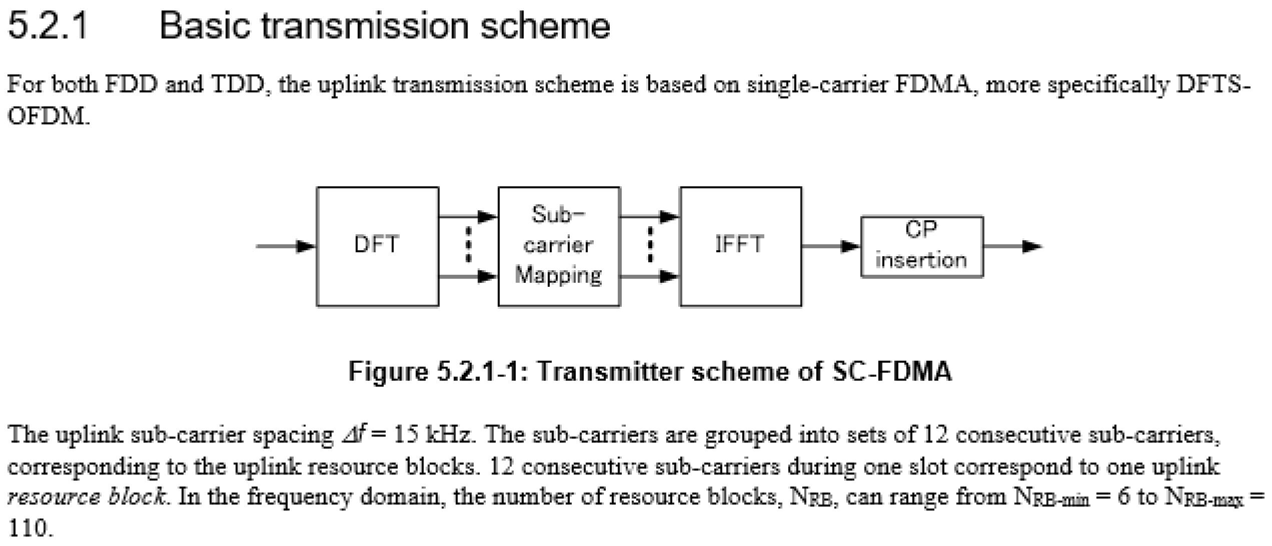
For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

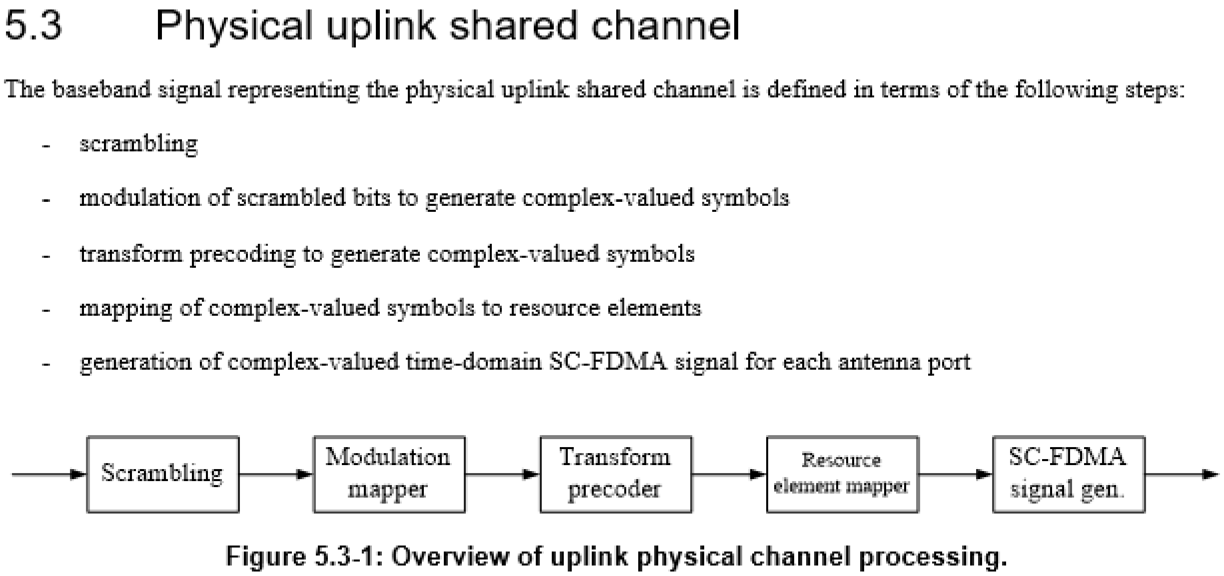
The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.3 Physical uplink shared channel

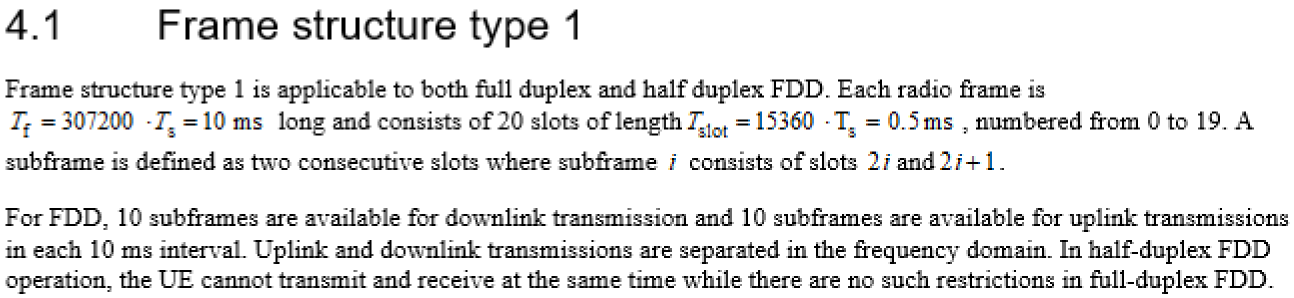
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\ \text{ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\ \text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

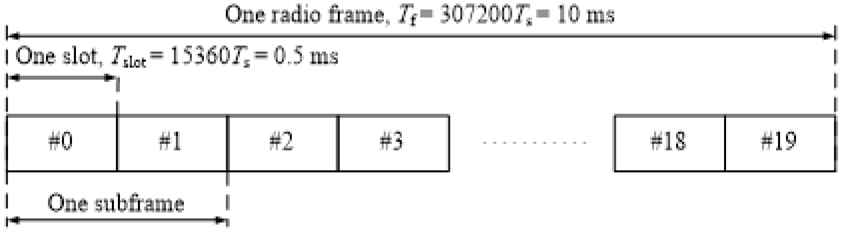


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.

4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 11(b)

"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

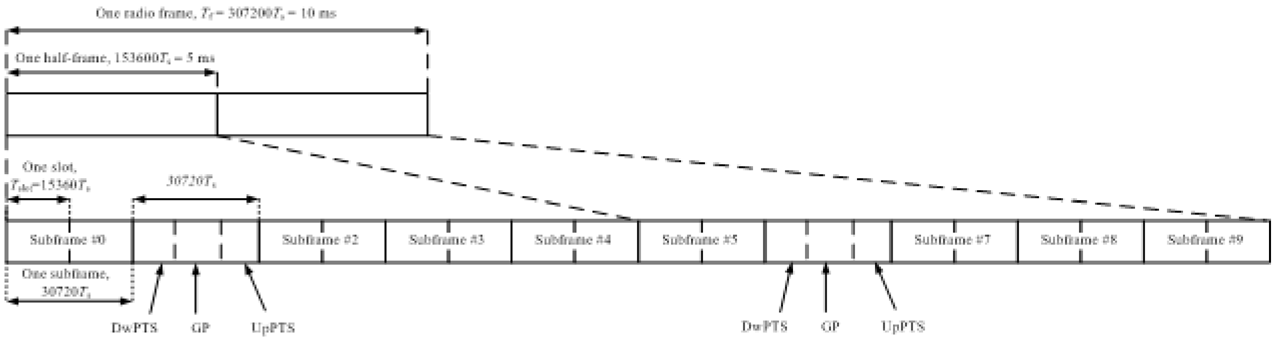
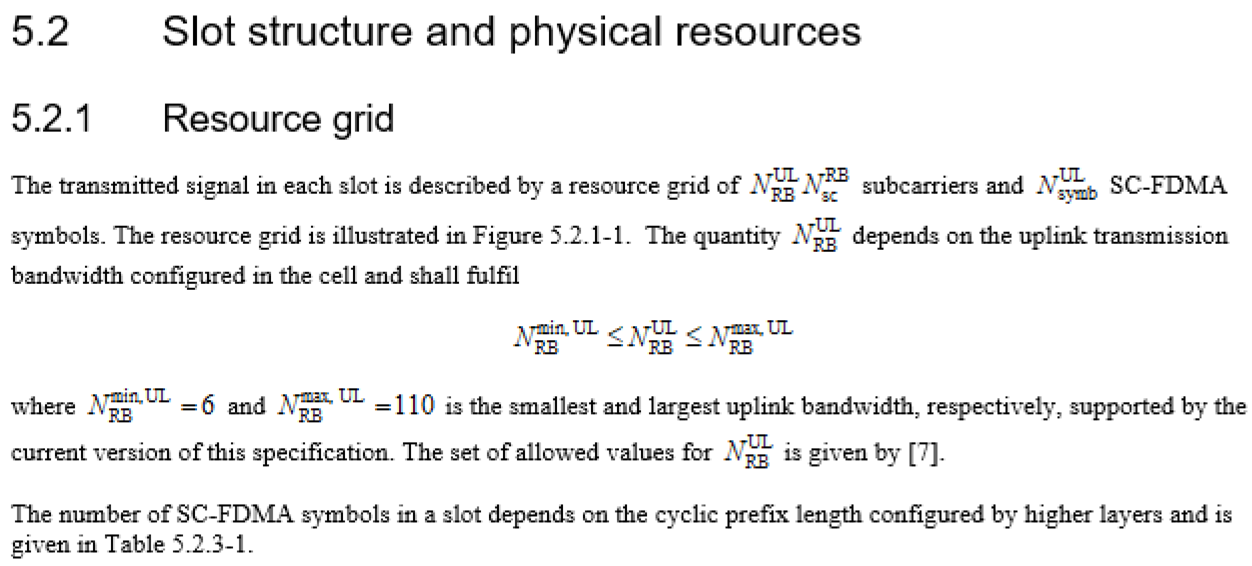


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

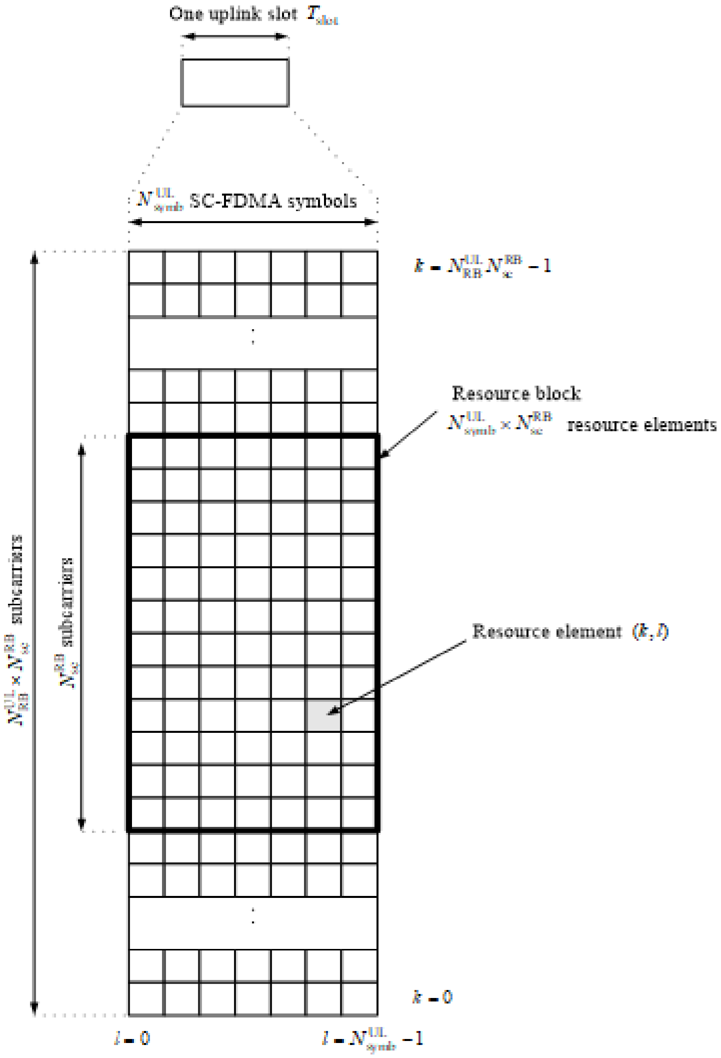
$$N_{\mathrm{RB}}^{\min,\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$$

where $N_{\mathrm{RB}}^{\min,\mathrm{UL}} = 6$ and $N_{\mathrm{RB}}^{\max,\mathrm{UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

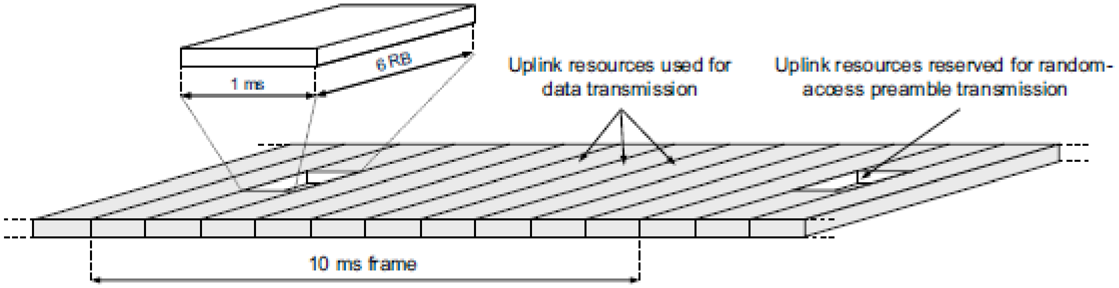
The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 11(b)

“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

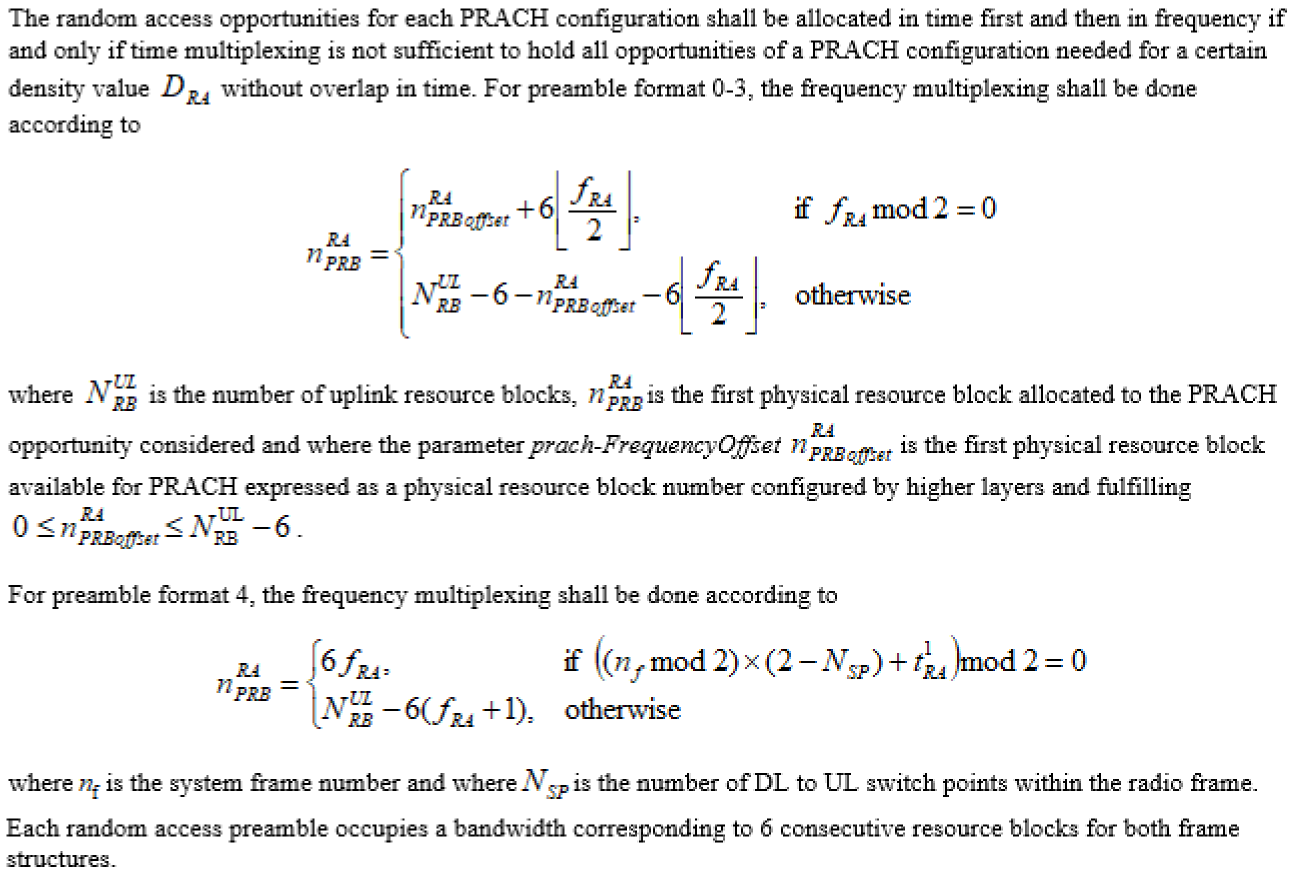
US Patent No. 10,833,908: Claim 11(b)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,	FCA's Accused Instrumentalities transmit, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure ...

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

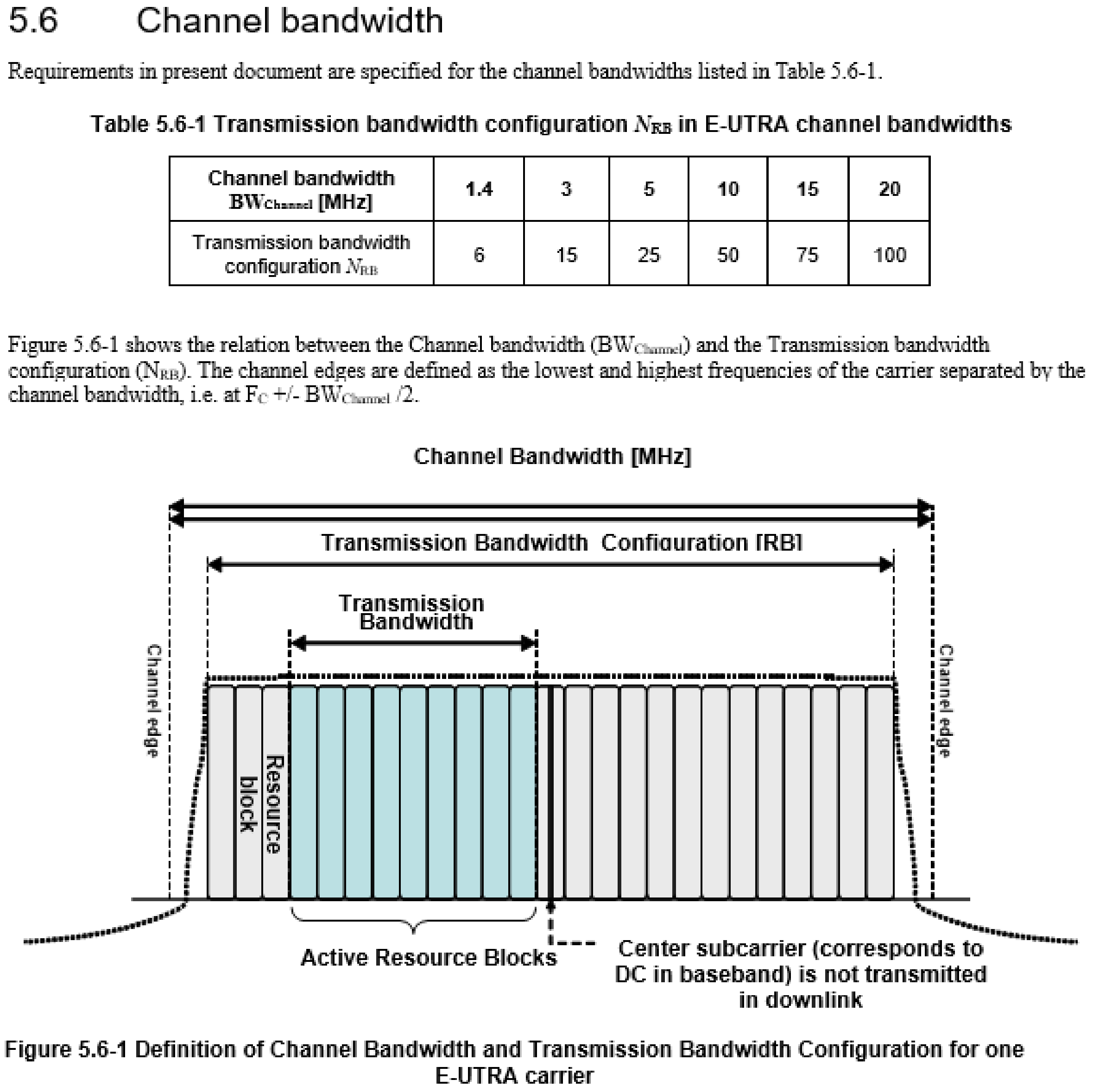
$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

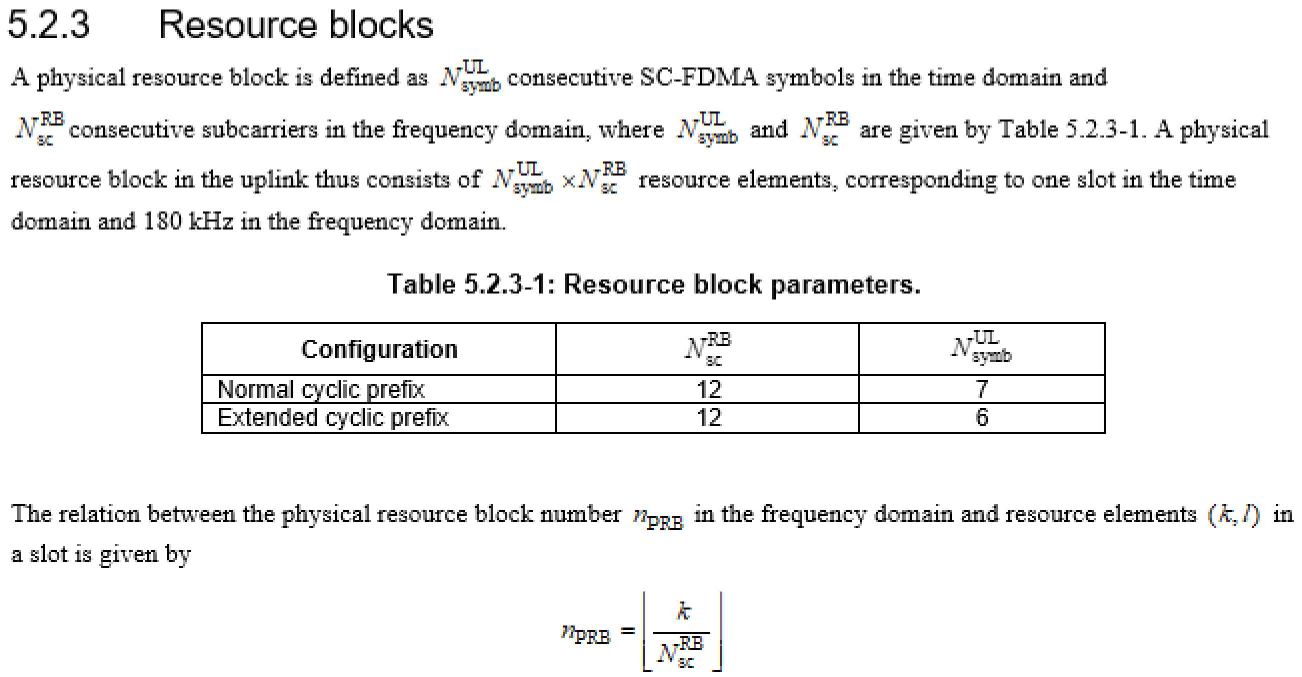
Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 11(c)
“transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,”



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

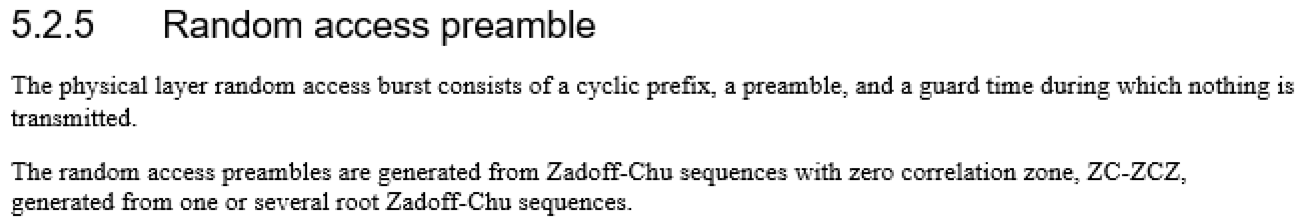
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

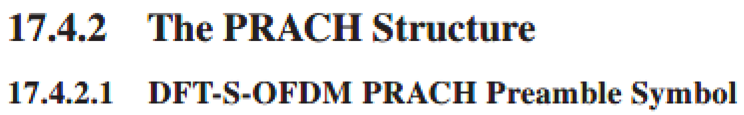


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

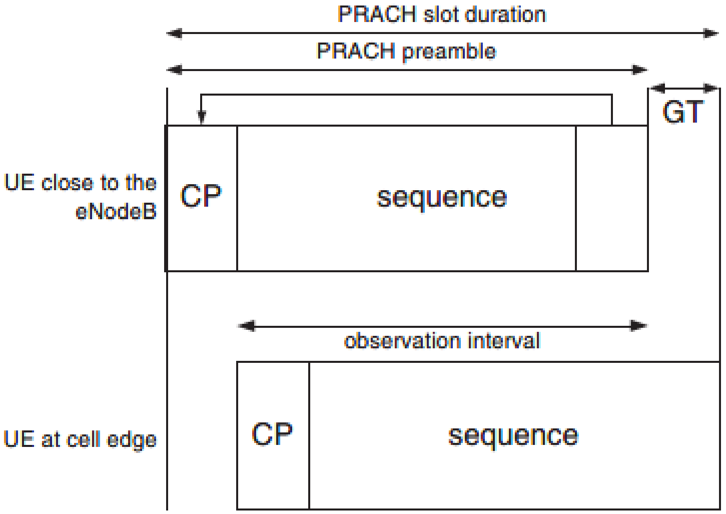


17.4.2 The PRACH Structure

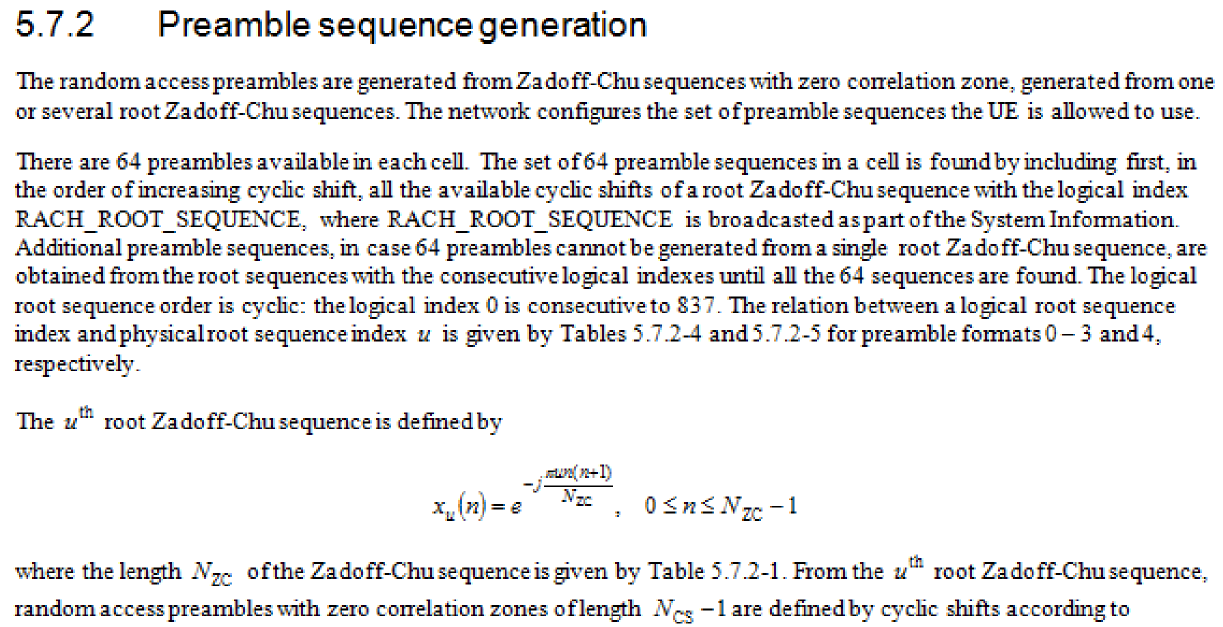
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

…

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"

	The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional  Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE's delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 11(c)
"transmitting, to the base station, an random access signal followed by a guard period in only a portion of the frequency band, wherein the random access signal includes a sequence associated with the base station,"



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

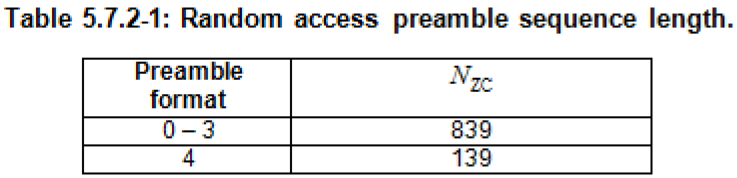
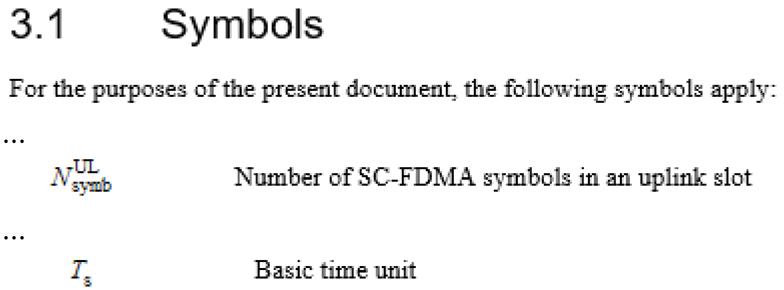
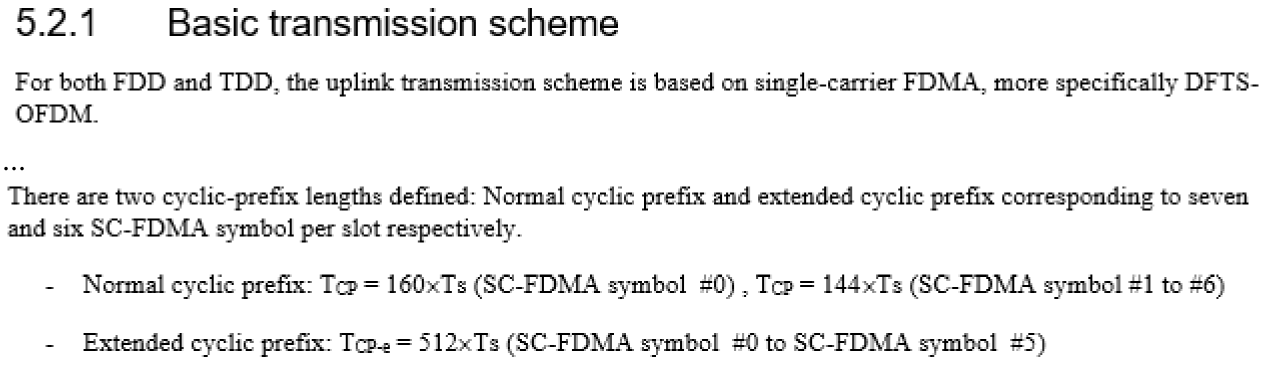


Table 5.7.2-1: Random access preamble sequence length.

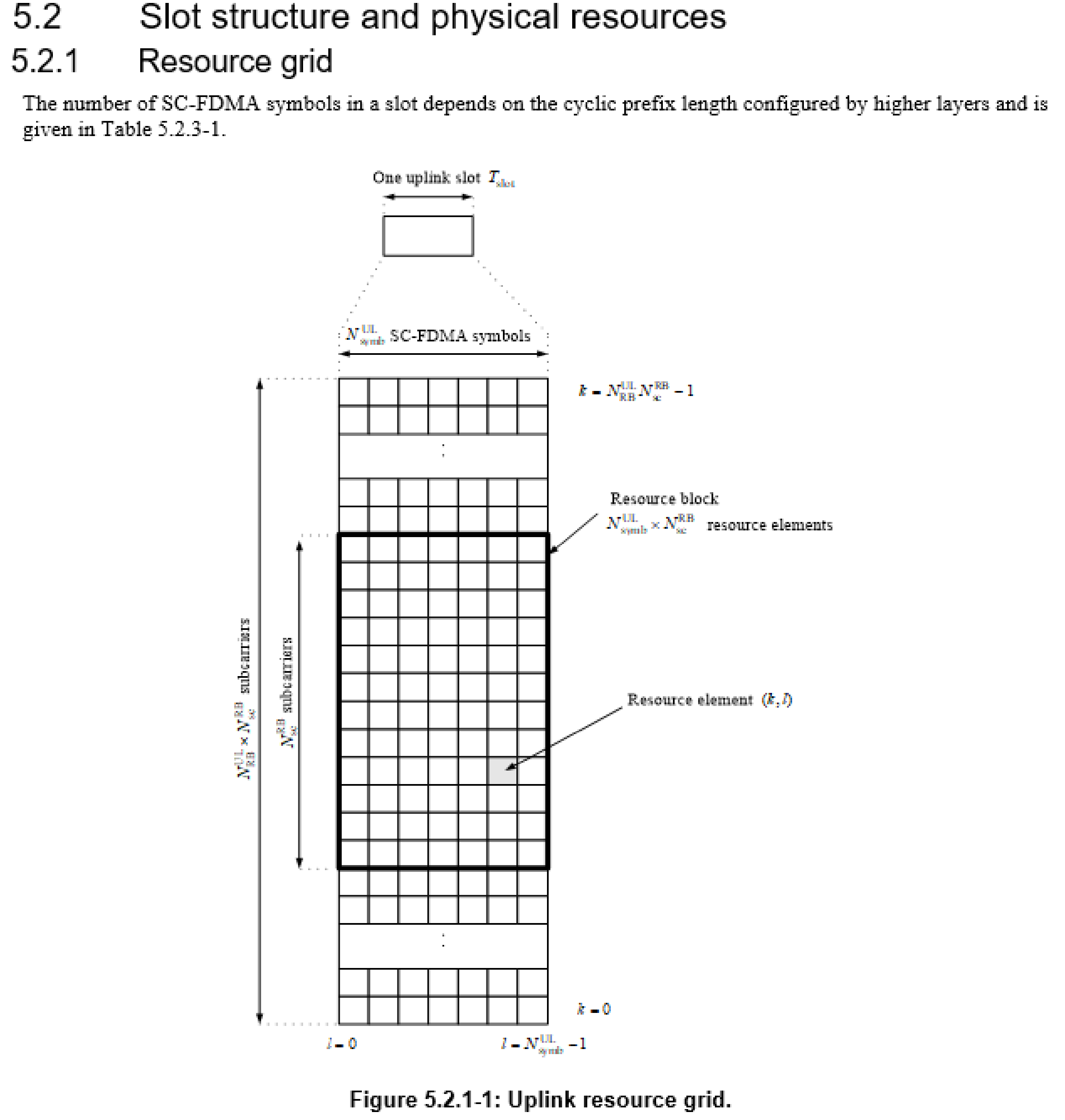
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using FCA's Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs.  3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals.  5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (SC-FDMA symbol #0) , T_{CP} = 144×Ts (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 11(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"



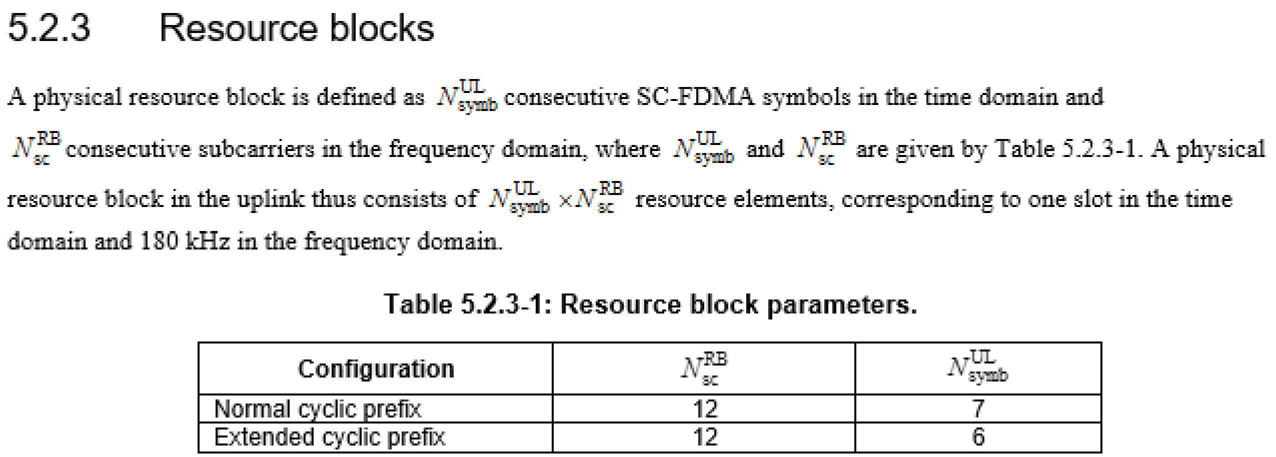
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

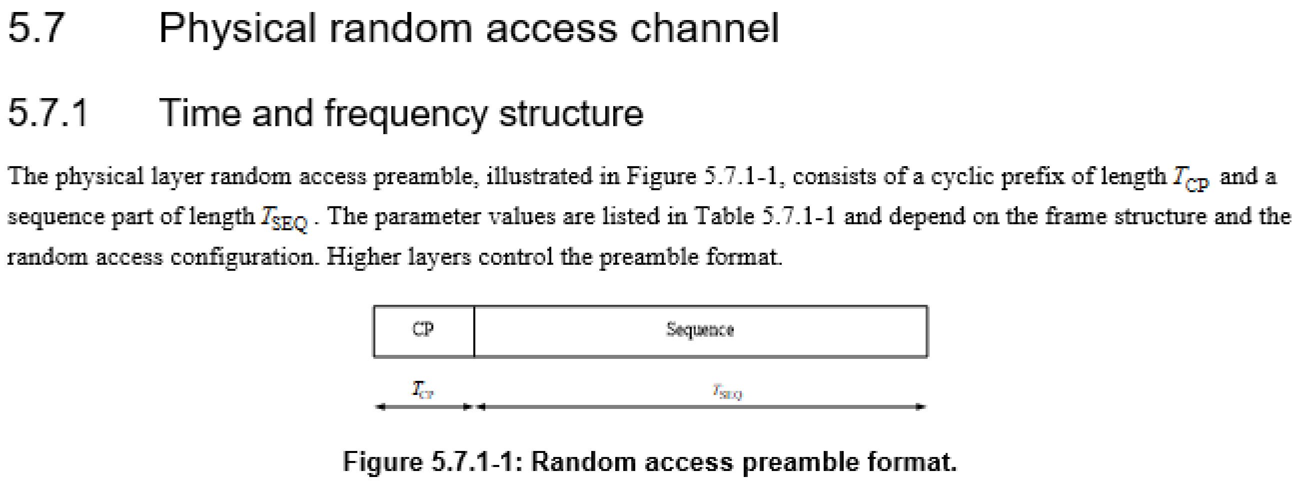
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 11(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

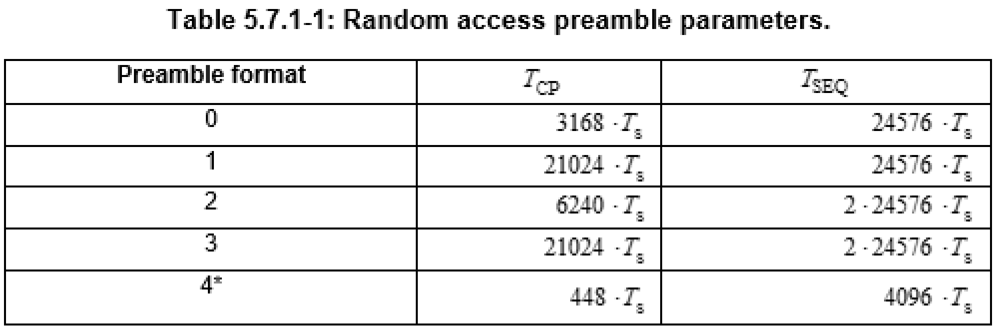
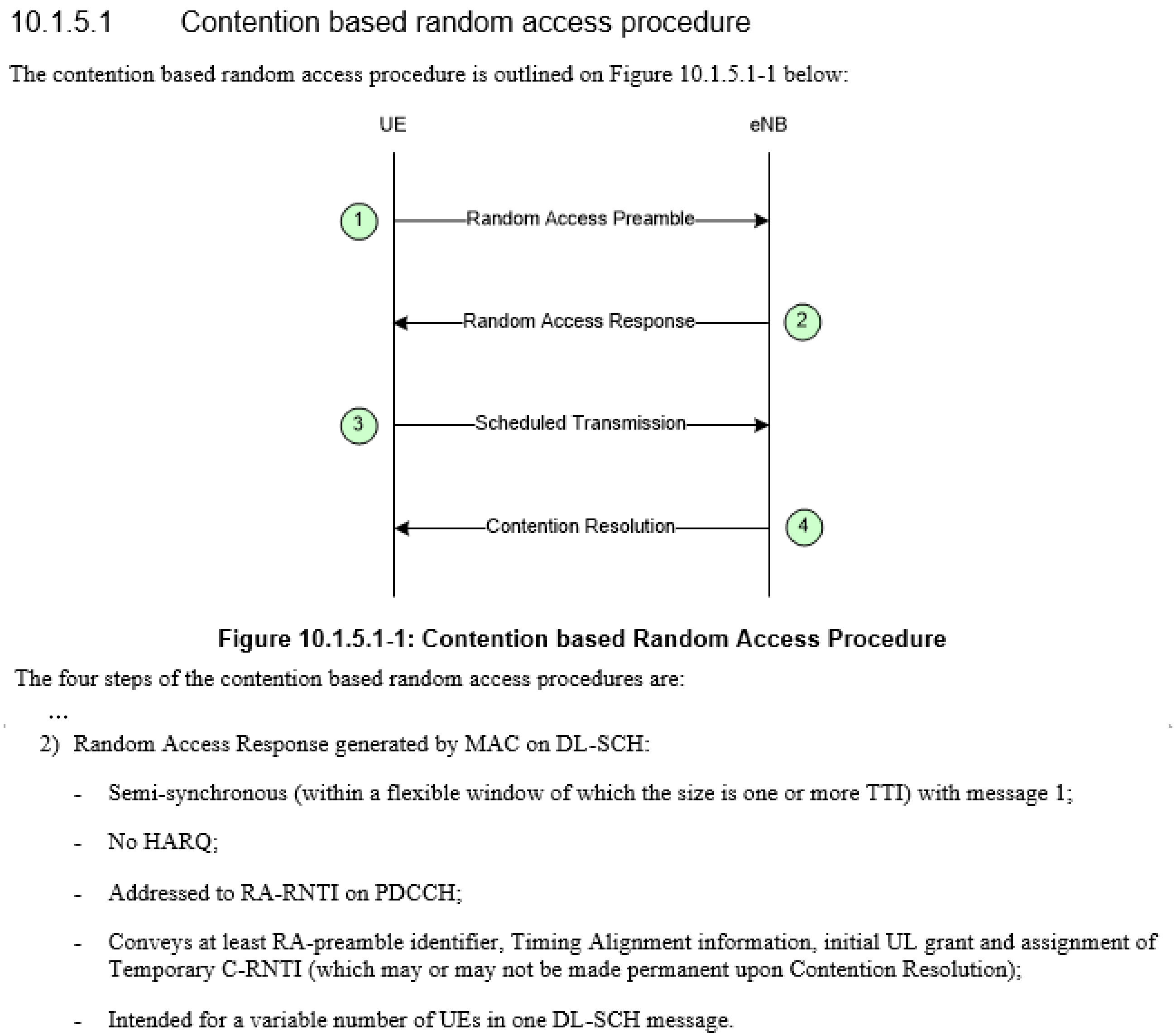


Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

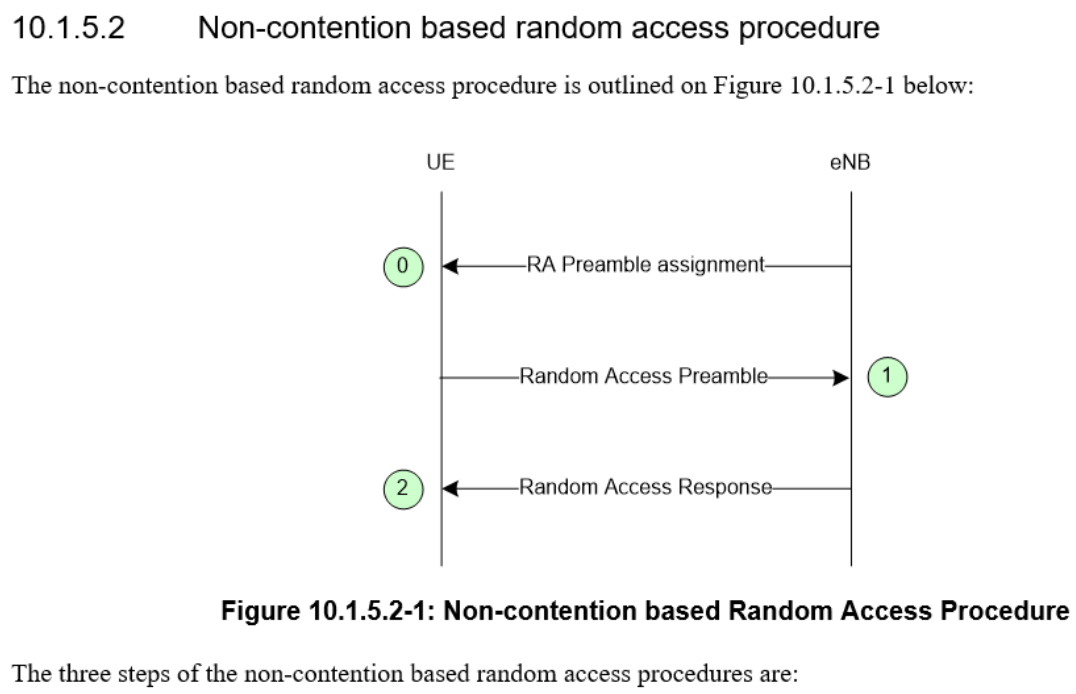
See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

receiving, from the base station, a response message. ;	FCA's Accused Instrumentalities receive, from the base station, a response message. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



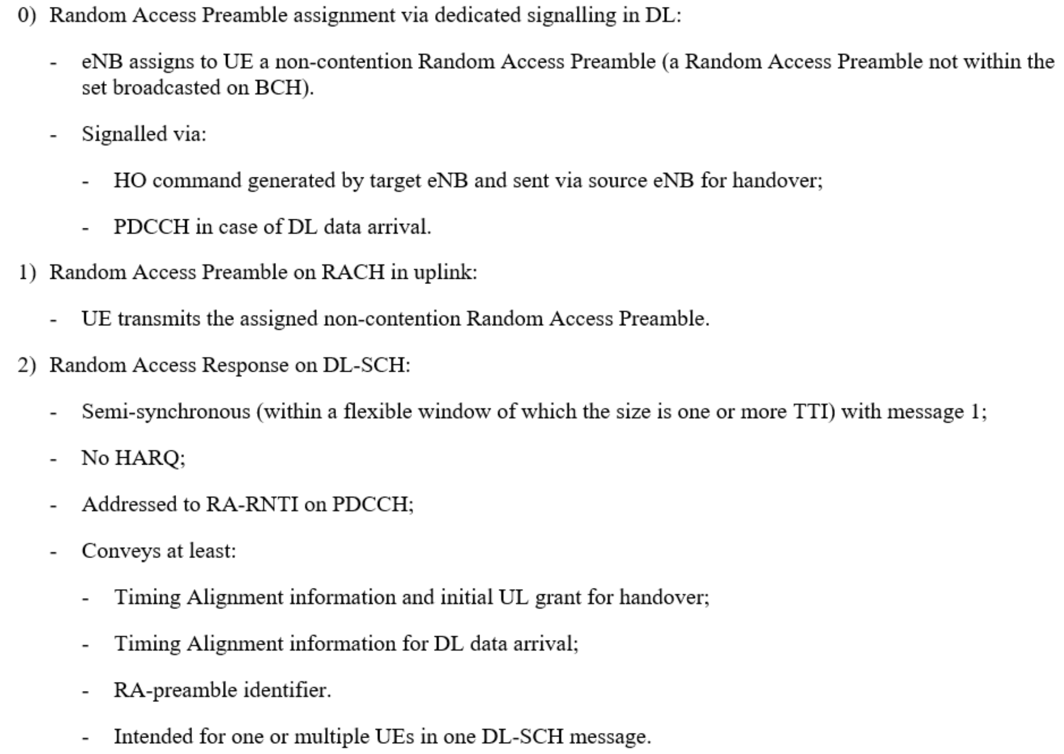
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

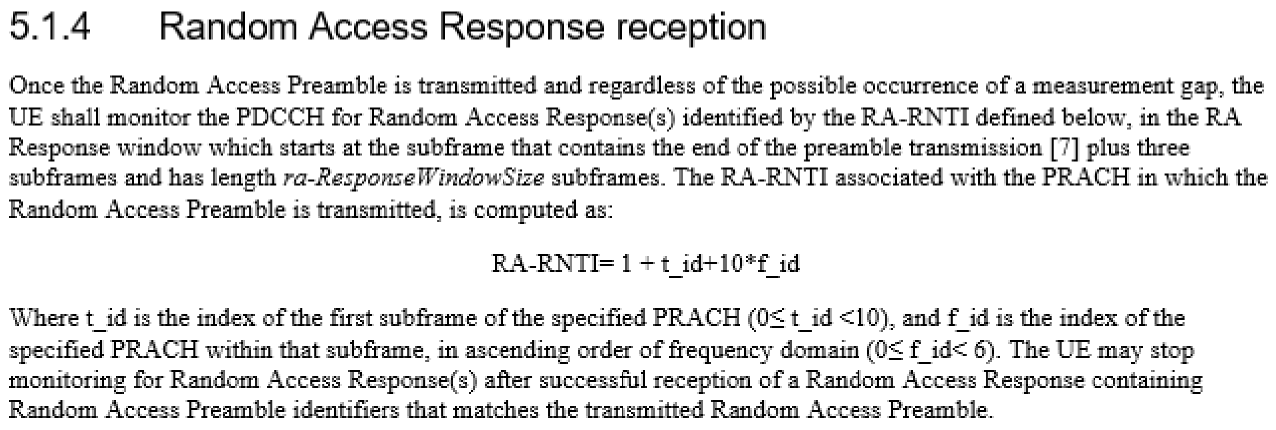
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

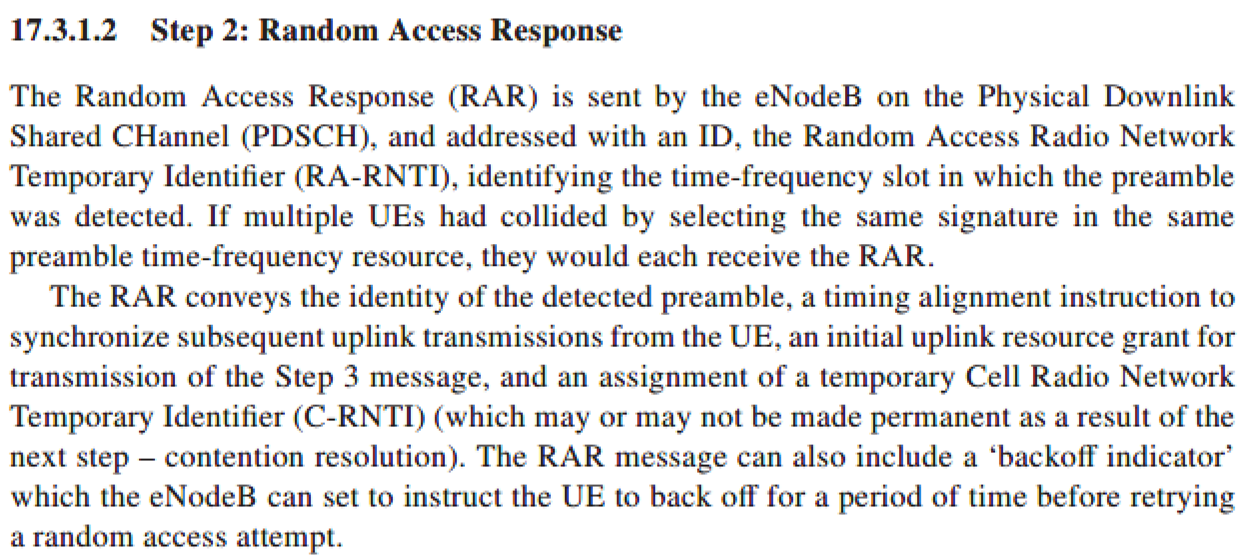
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 11(e)
"receiving, from the base station, a response message."

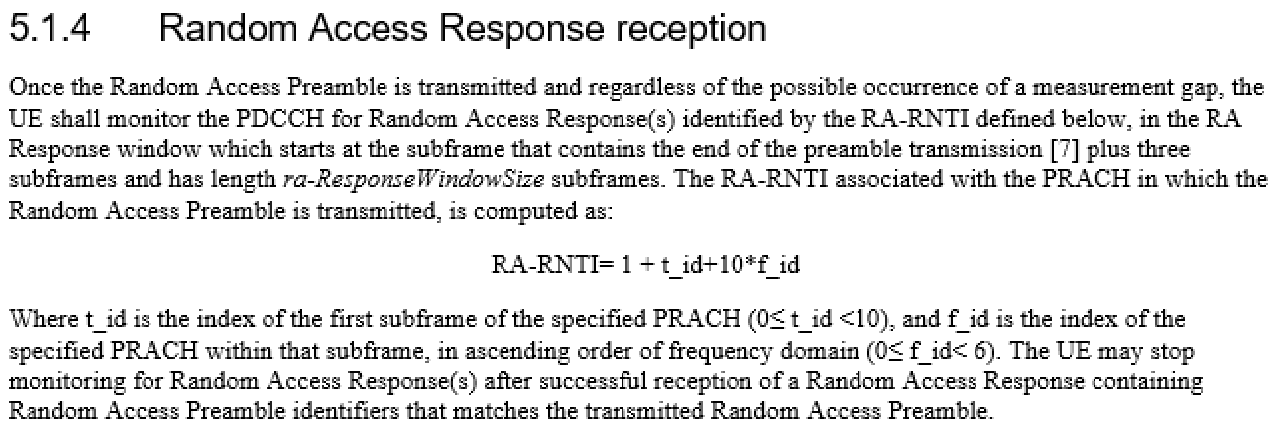
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 12(a)
"The method claim 11, further comprising:"

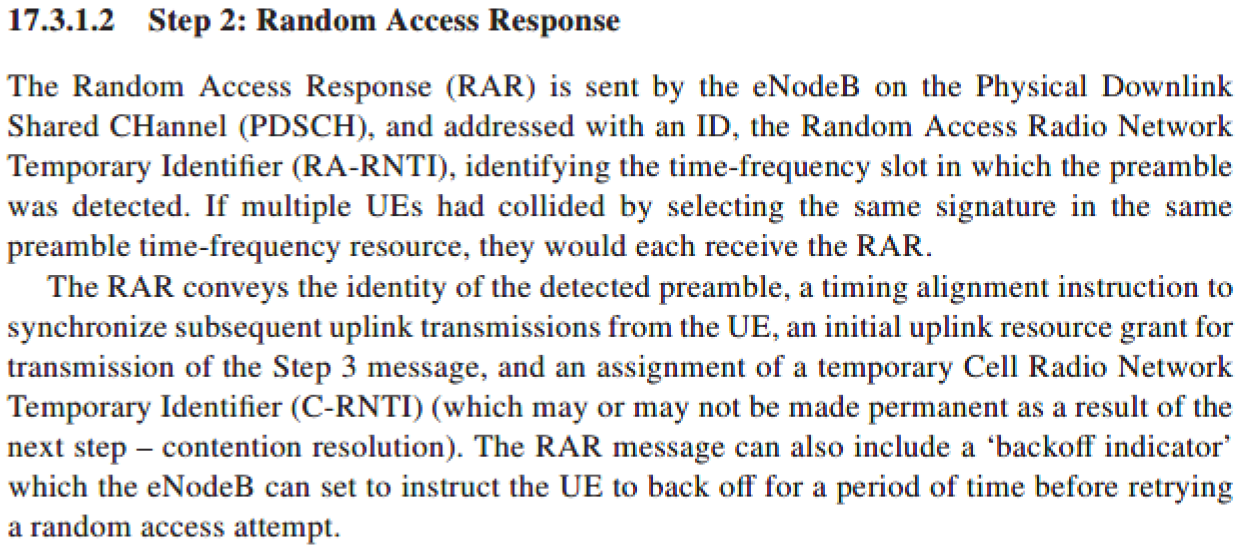
12. The method claim 11, further comprising:	*See* Claim 11.

US Patent No. 10,833,908: Claim 12(b)

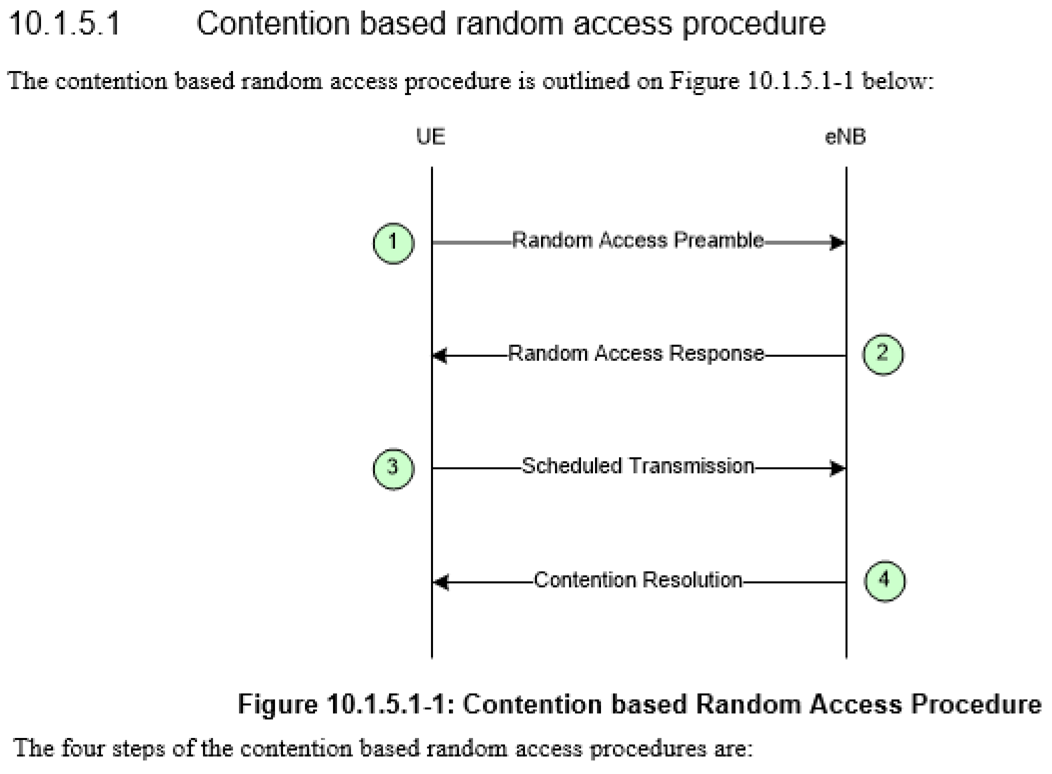
"determining if the response message identifies the sequence associated with the base station in the random access signal; and"

determining if the response message identifies the sequence associated with the base station in the random access signal; and	FCA's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $\text{RA-RNTI}= 1 + \text{t\_id}+10*\text{f\_id}$ Where t_id is the index of the first subframe of the specified PRACH ($0\leq \text{t\_id} <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq \text{f\_id}< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 12(b)
“determining if the response message identifies the sequence associated with the base station in the random access signal; and”

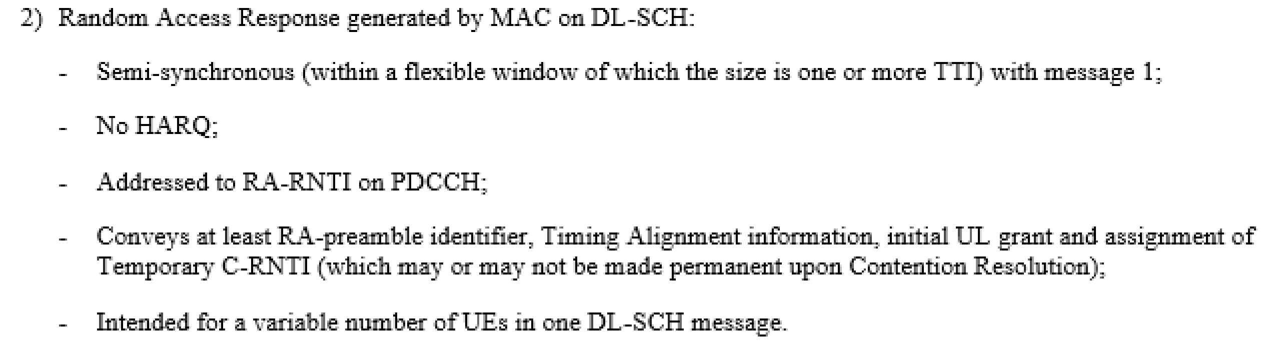
	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 12(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, FCA's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: ...

US Patent No. 10,833,908: Claim 12(c)

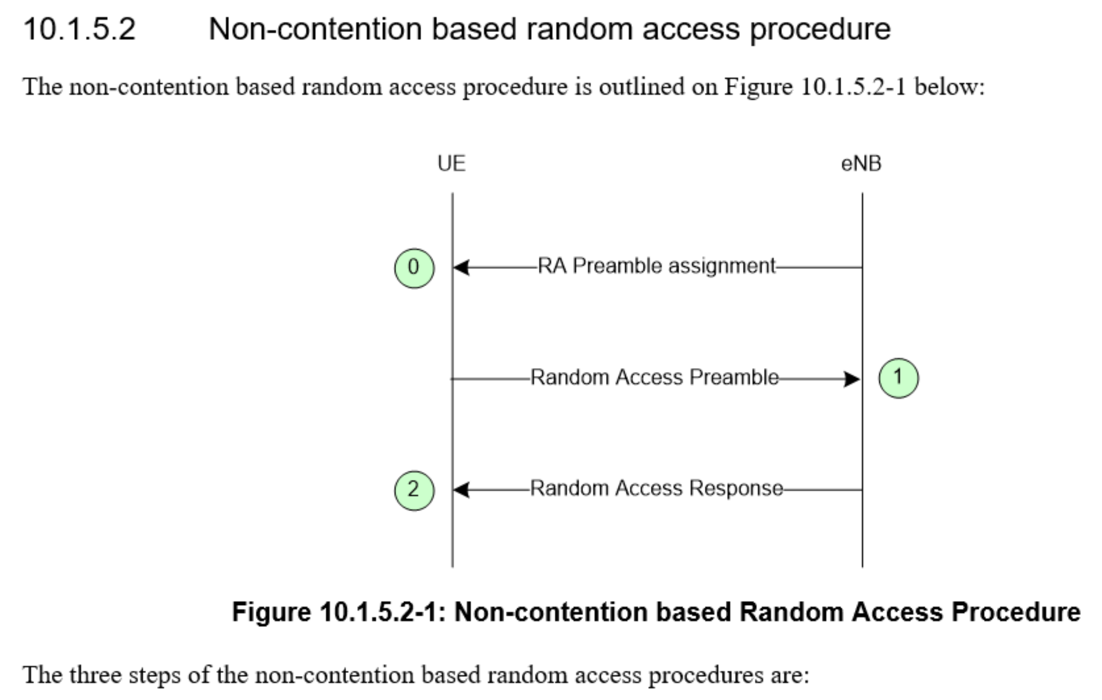
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



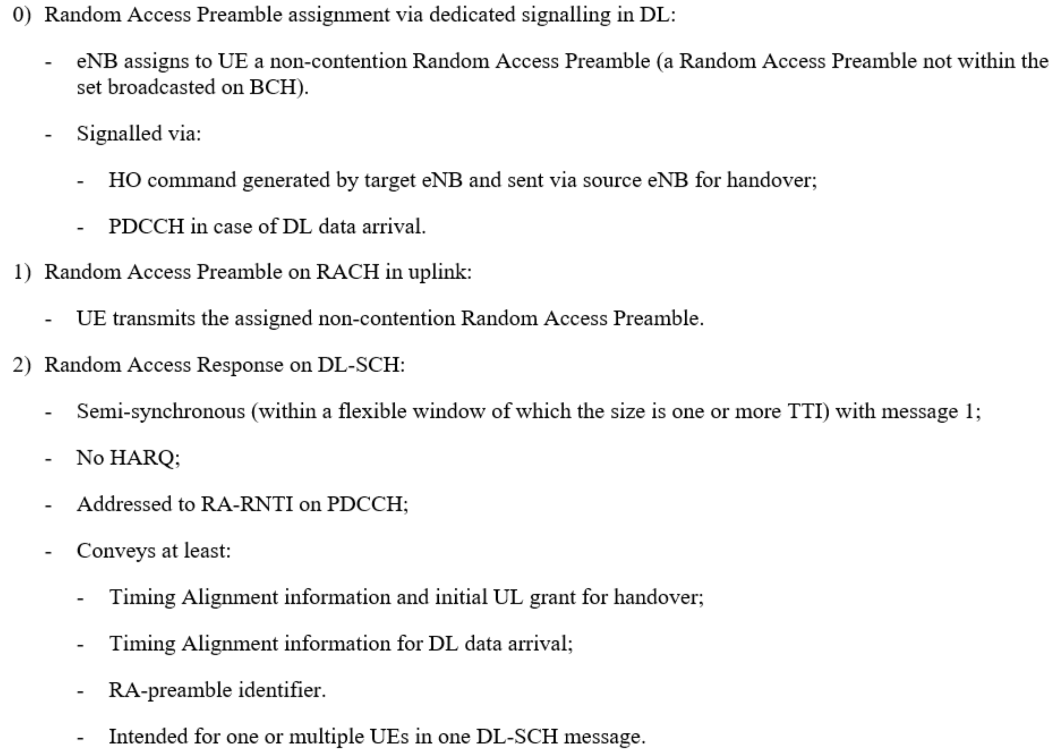
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

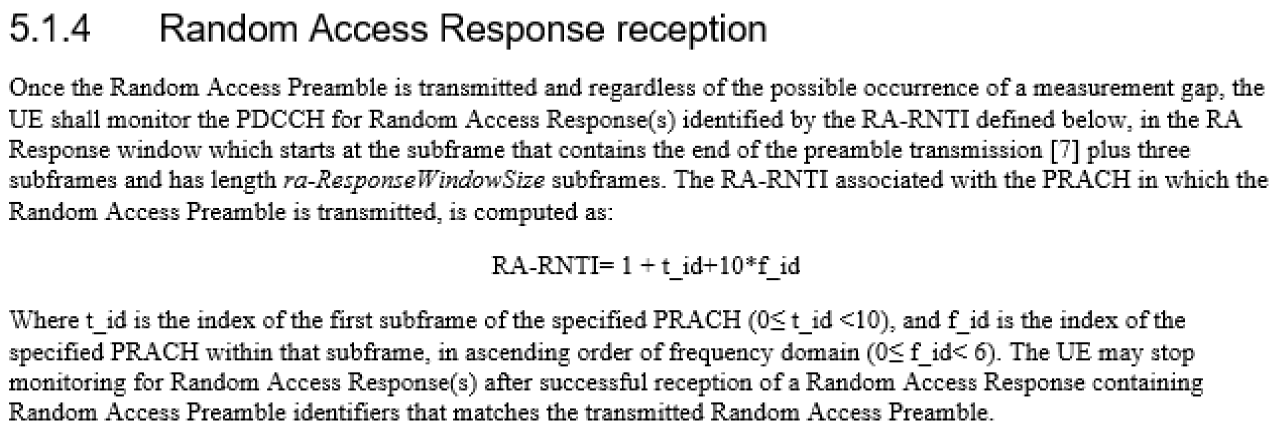
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

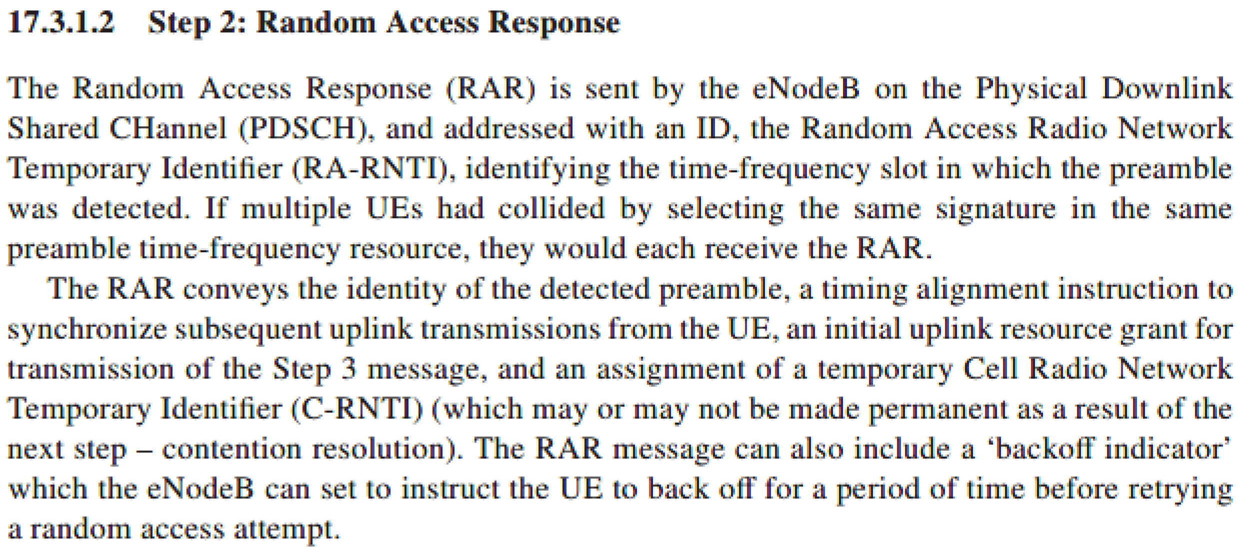
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

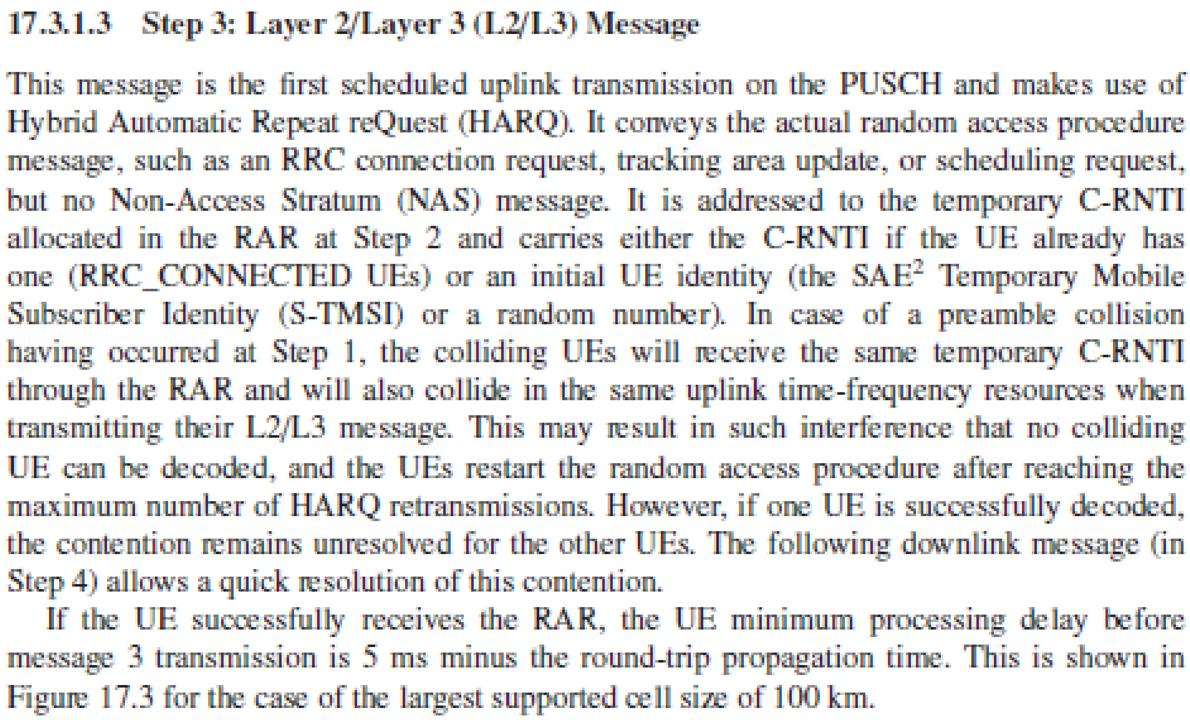
Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

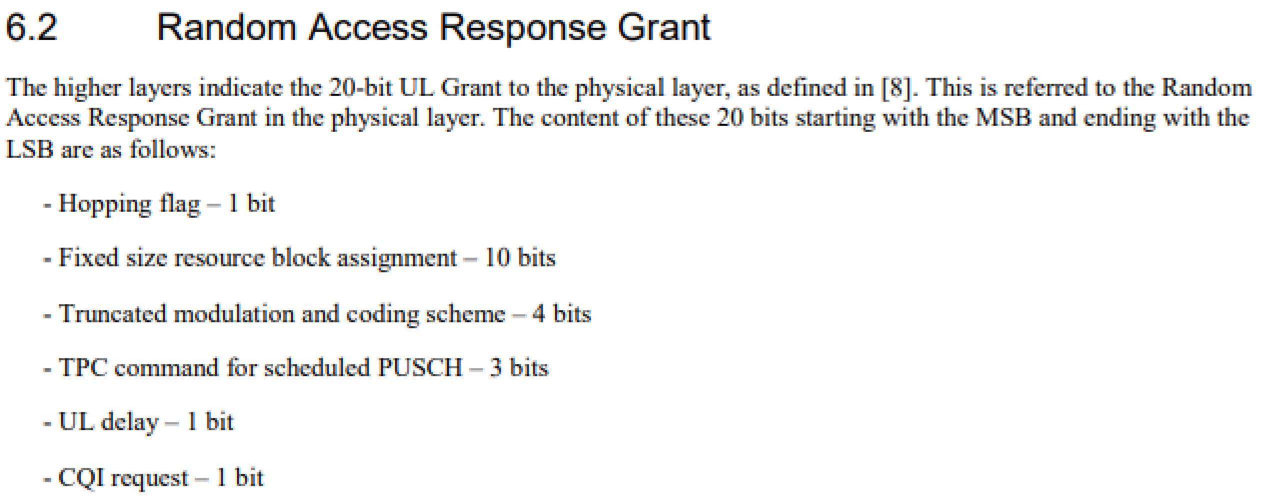
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

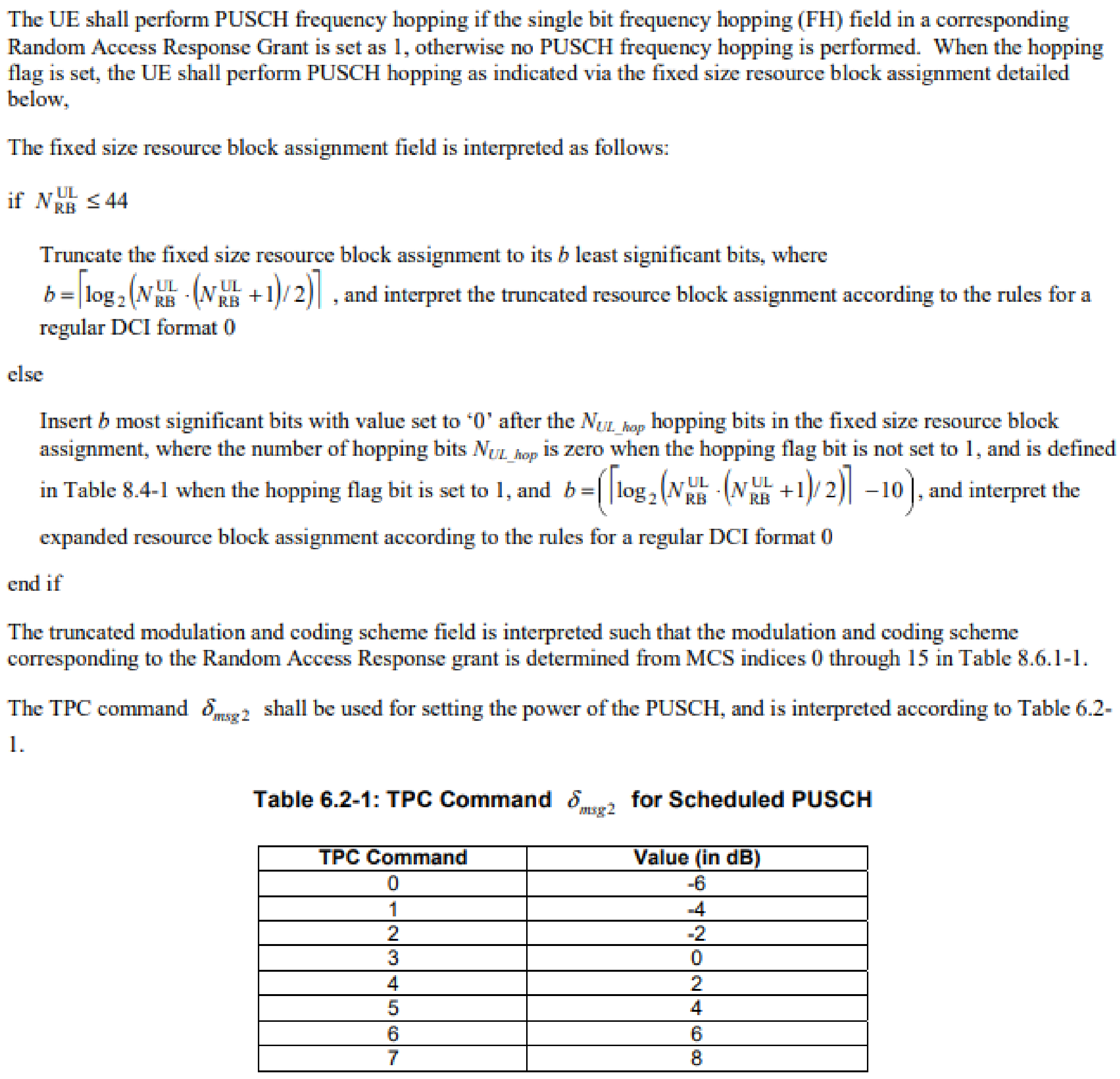
US Patent No. 10,833,908: Claim 12(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 13(a)
"The method of claim 12, wherein the response message includes power adjustment information and"

13. The method of claim 12, wherein the response message includes power adjustment information and	The response message received by FCA's Accused Instrumentalities includes power adjustment information. *E.g.*, The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(a)
“The method of claim 12, wherein the response message includes power adjustment information and”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

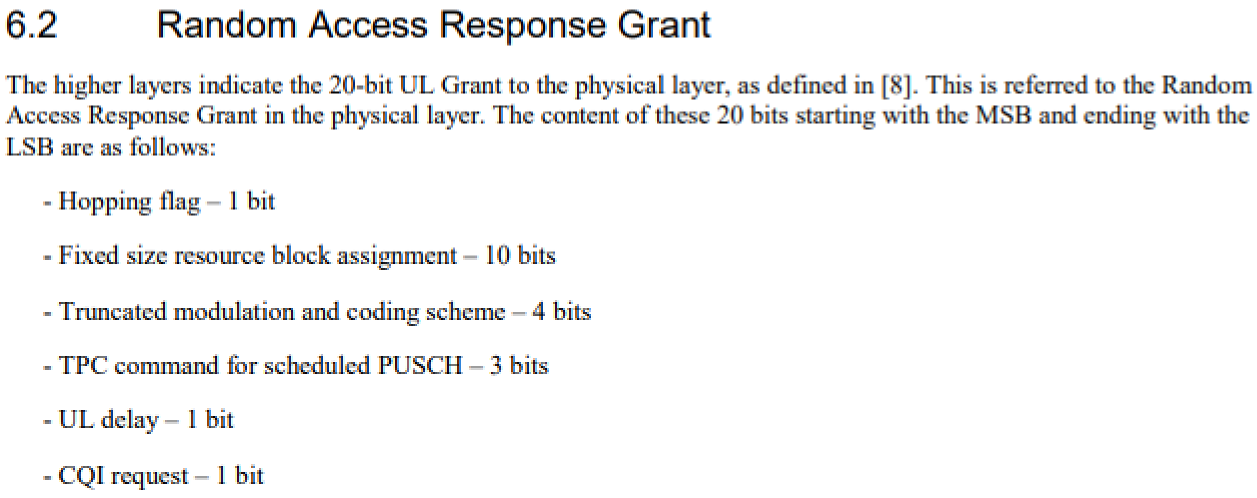
The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

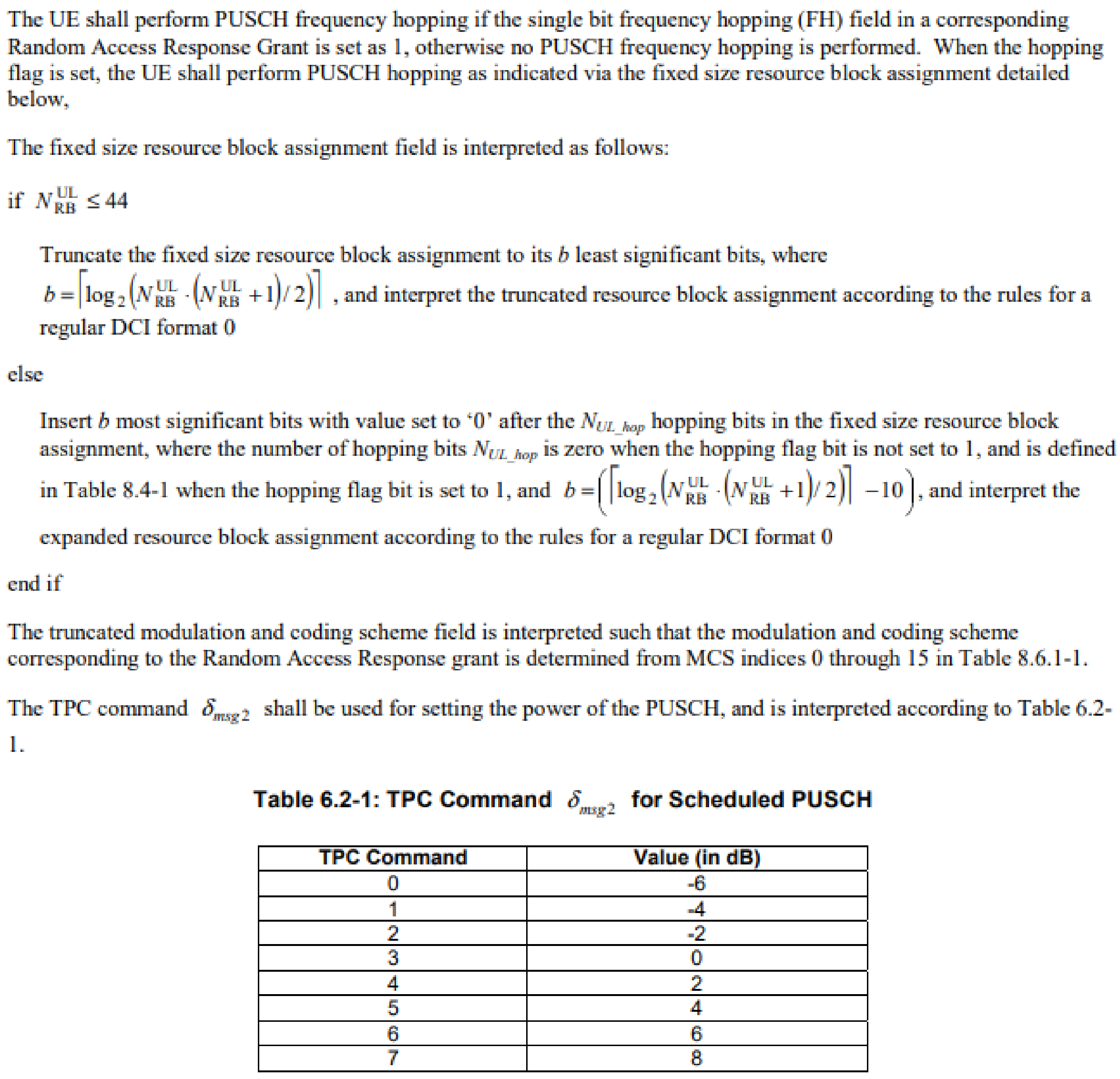
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

wherein the second uplink signal is transmitted according to the power adjustment information.	FCA's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 13(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to '0' after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}}+1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

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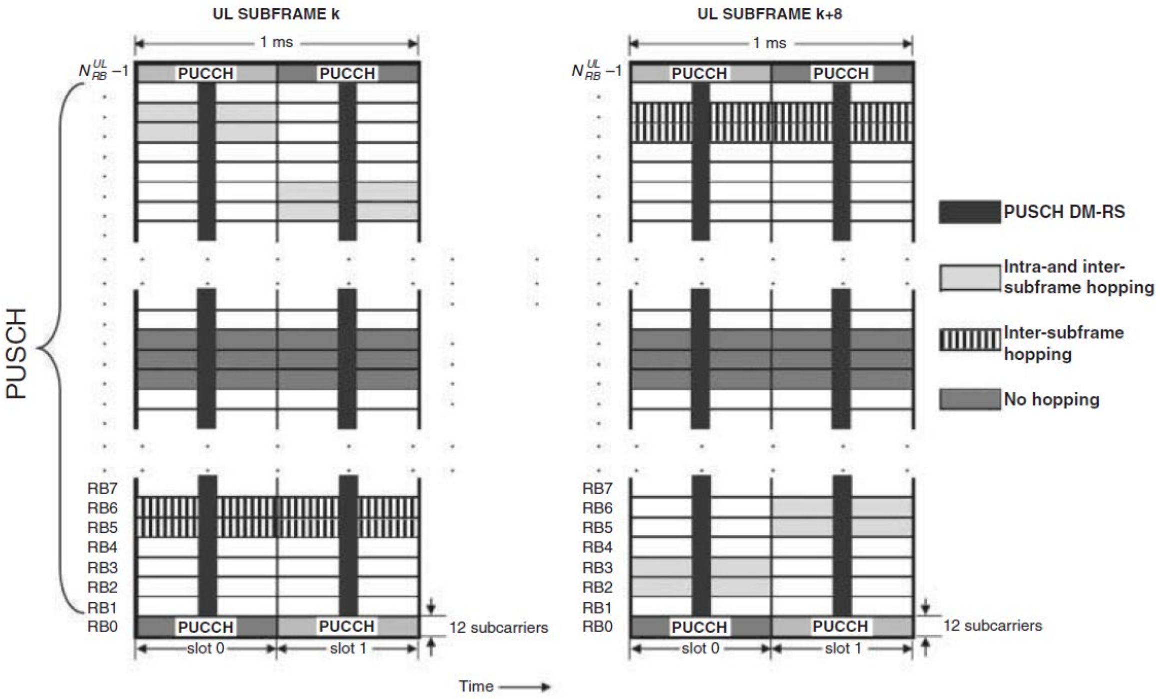
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

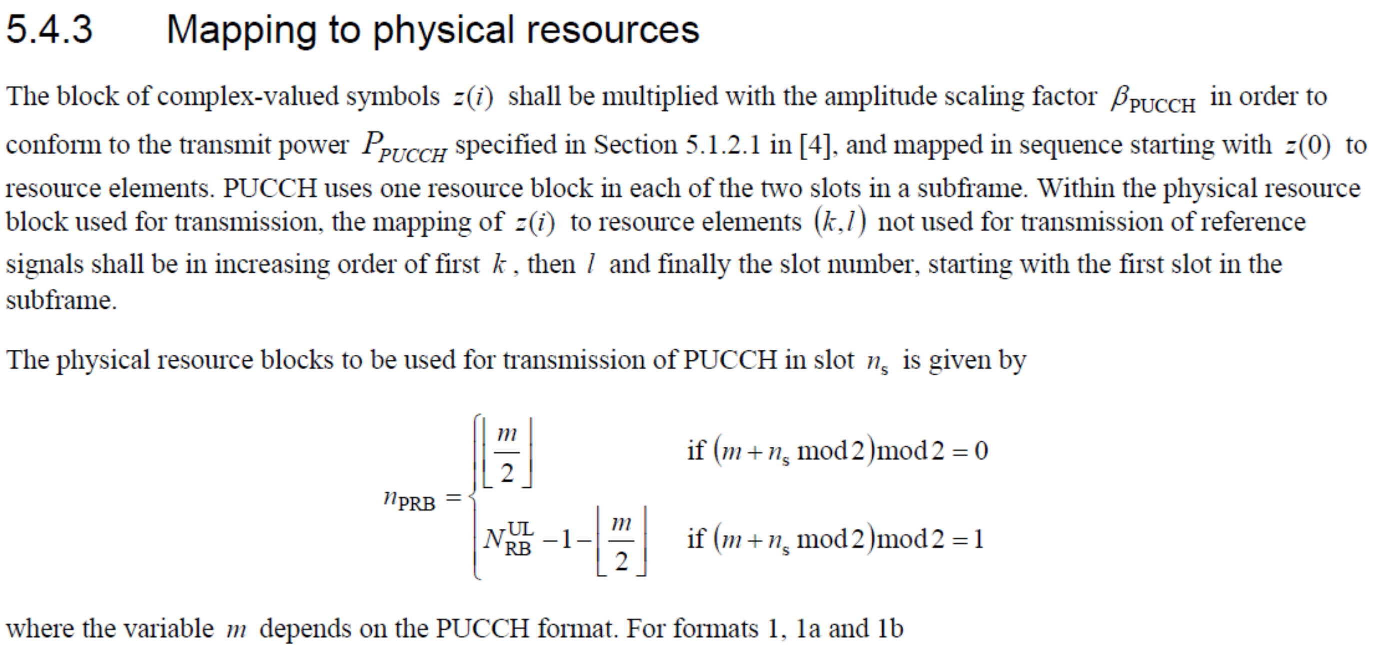
US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

14. The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by FCA's Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 11. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_s is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_s \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

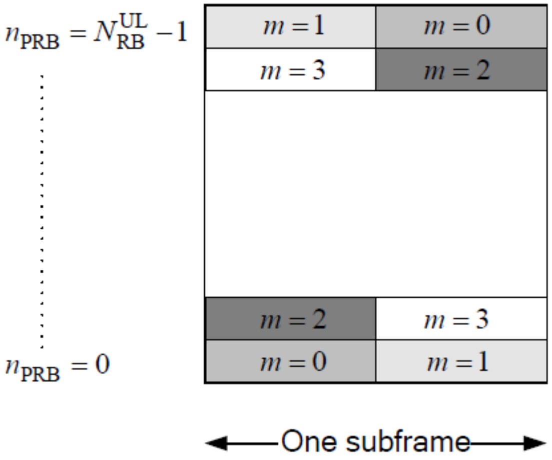


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is determined by the parameter prach-FrequencyOffset $n^{\mathrm{RA}}_{\mathrm{PRBoffset}}$. For FDD, the parameter directly determines

US Patent No. 10,833,908: Claim 14

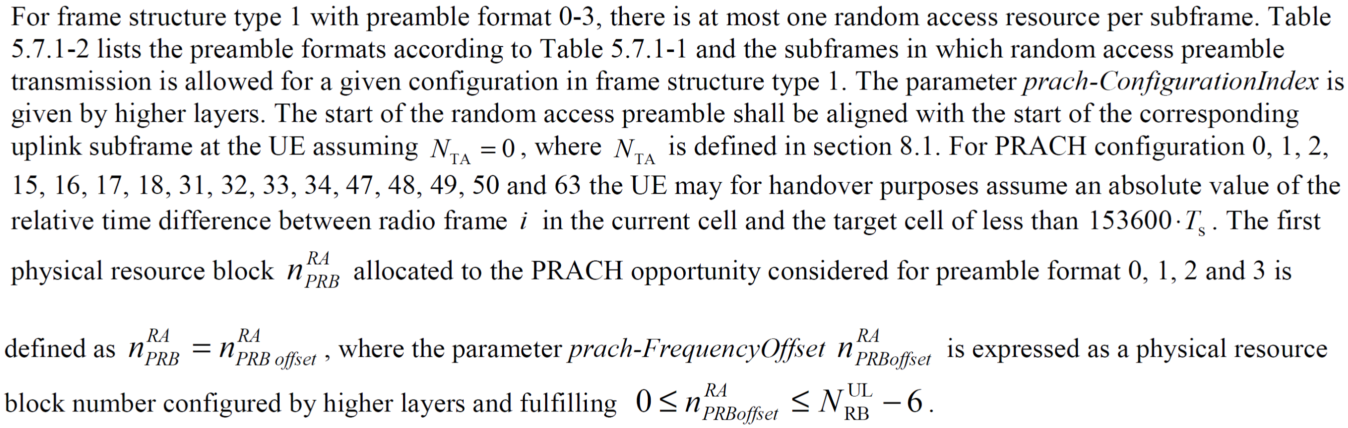
“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.

5.7 Physical random access channel

5.7.1 Time and frequency structure

…



For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n_{PRB}^{RA} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n_{PRB}^{RA} = n_{PRB\ offset}^{RA}$, where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

…

US Patent No. 10,833,908: Claim 14

"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

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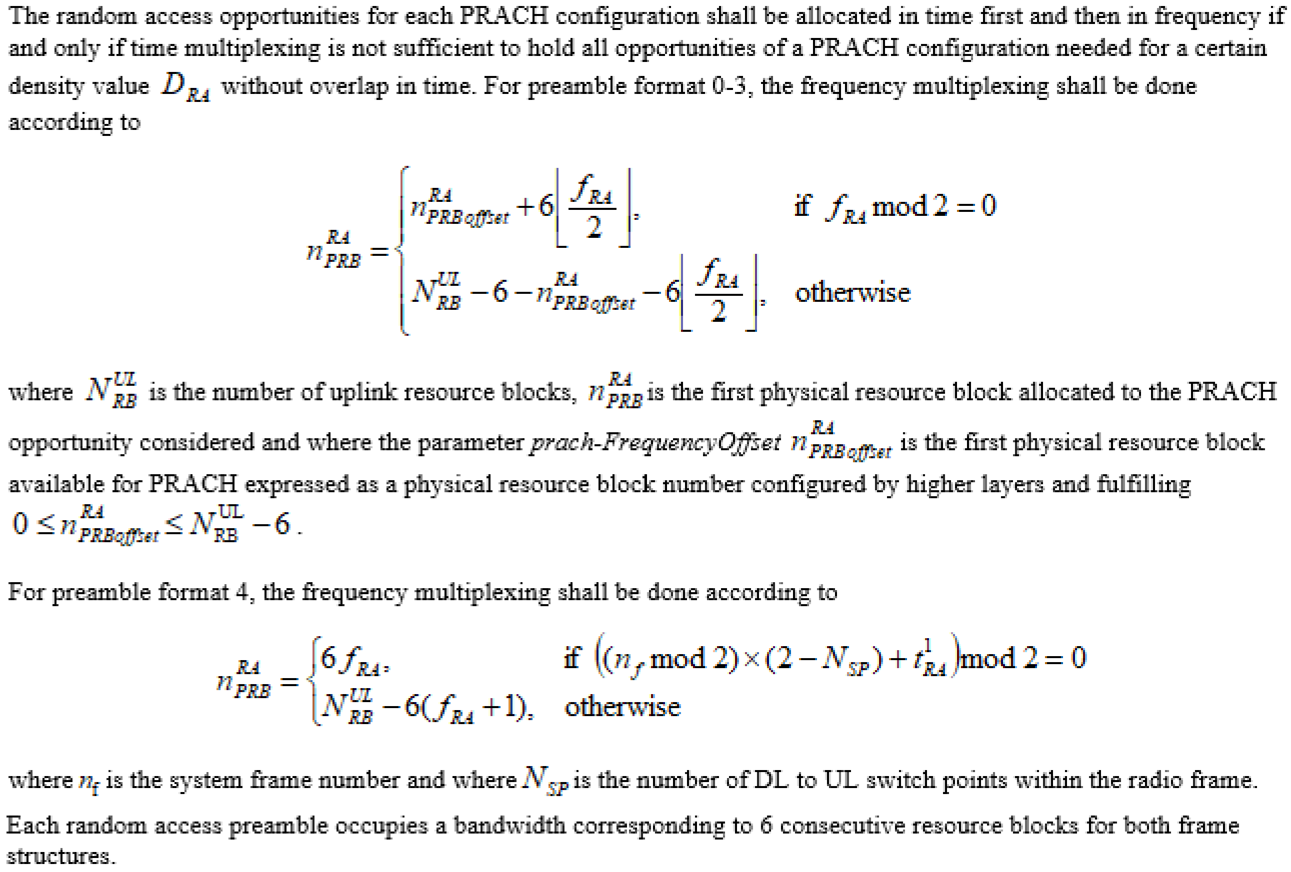

The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

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</table>

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{\mathrm{s}}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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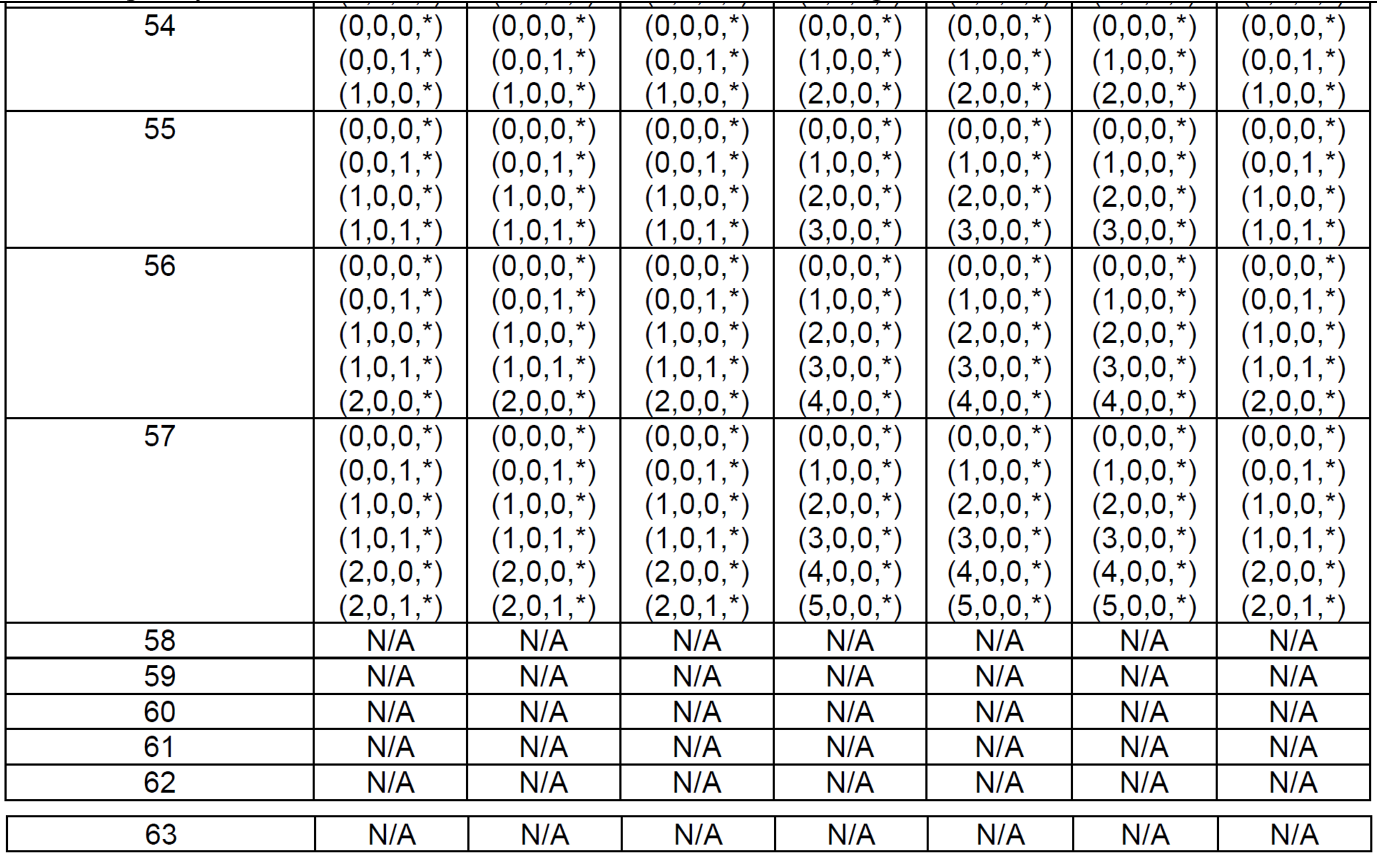
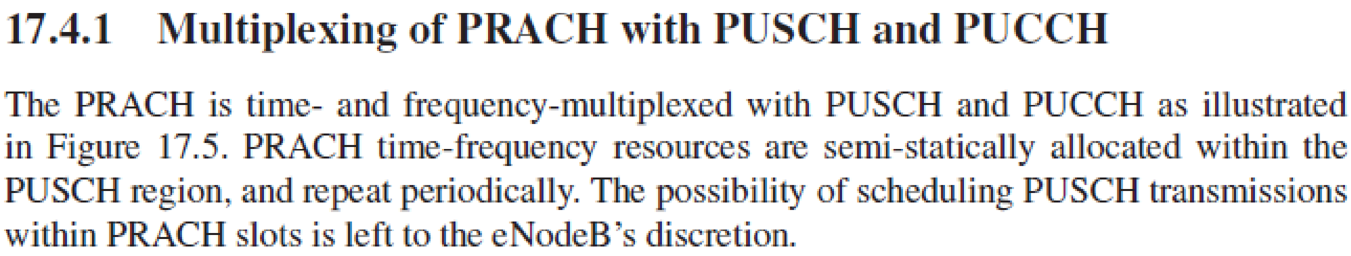
US Patent No. 10,833,908: Claim 14
"The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

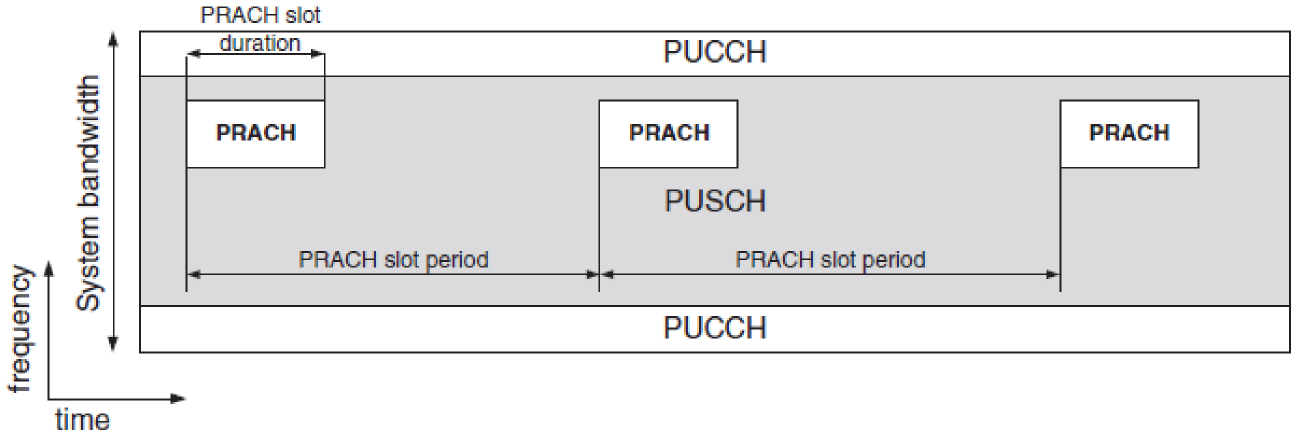


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

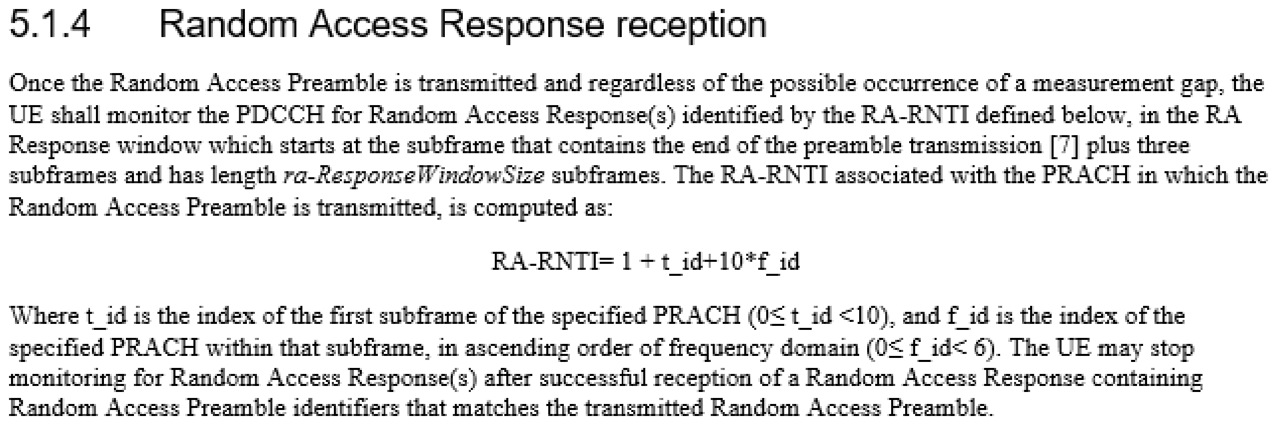
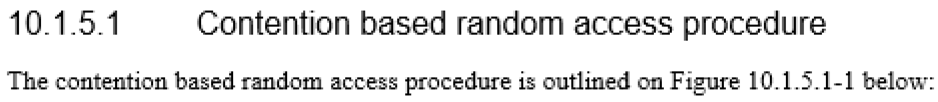
US Patent No. 10,833,908: Claim 14

“The method of claim 11, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

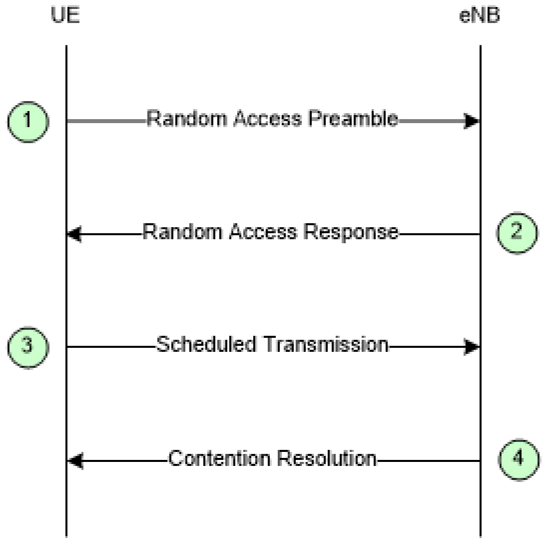
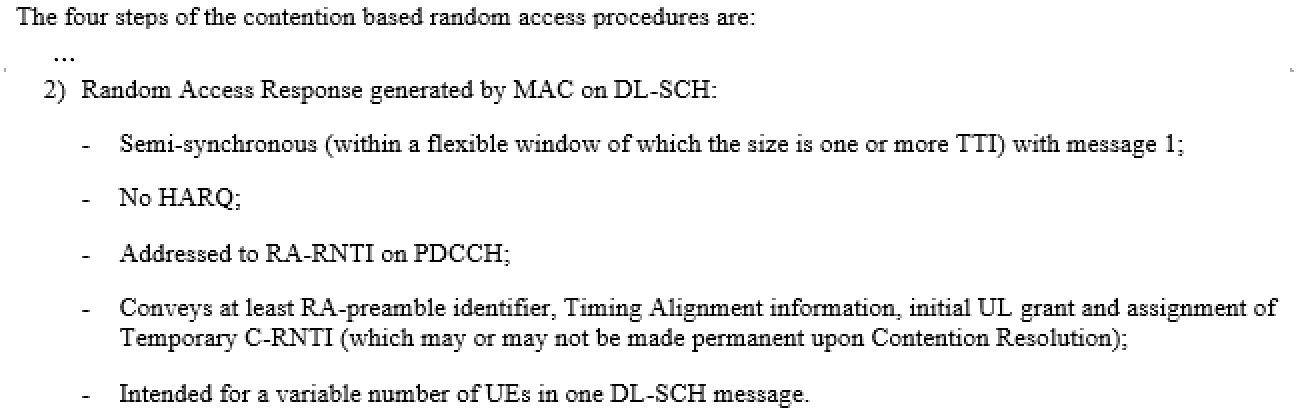
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice,” Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 15

"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

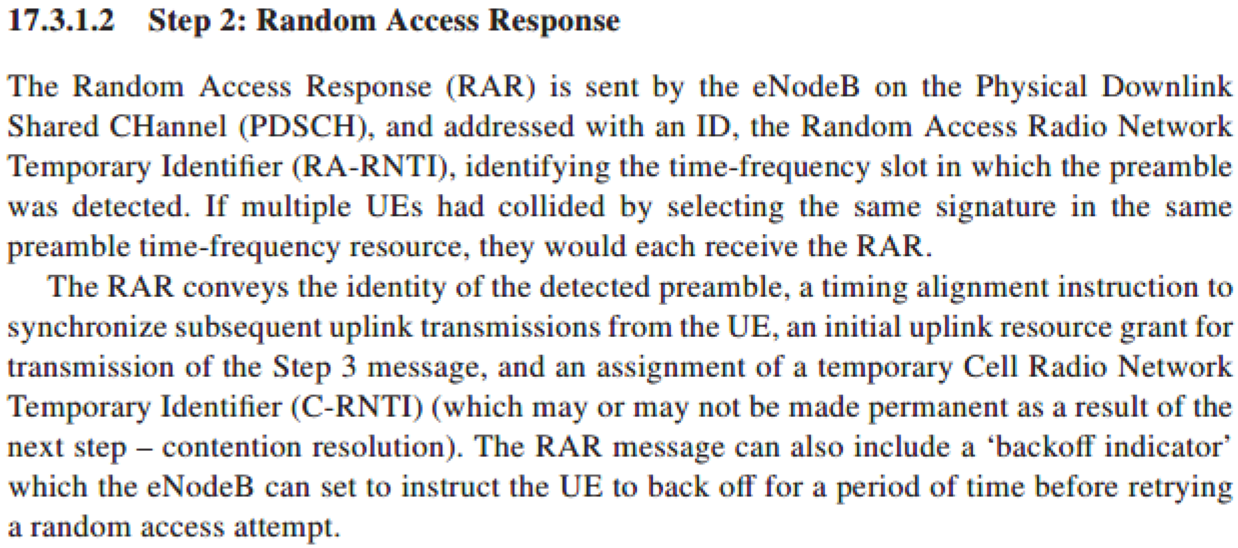
15. The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of FCA's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 11. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 15
"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **Figure 10.1.5.1-1: Contention based Random Access Procedure**  The four steps of the contention based random access procedures are: ... 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message. See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 15

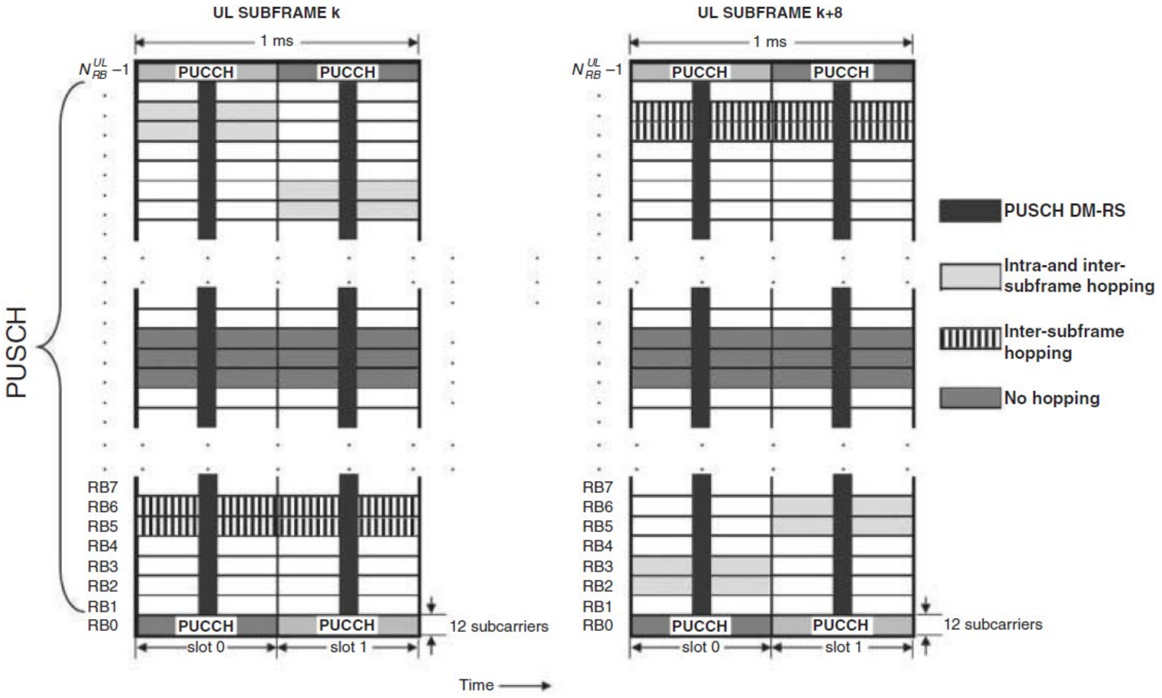
"The method of claim 11, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

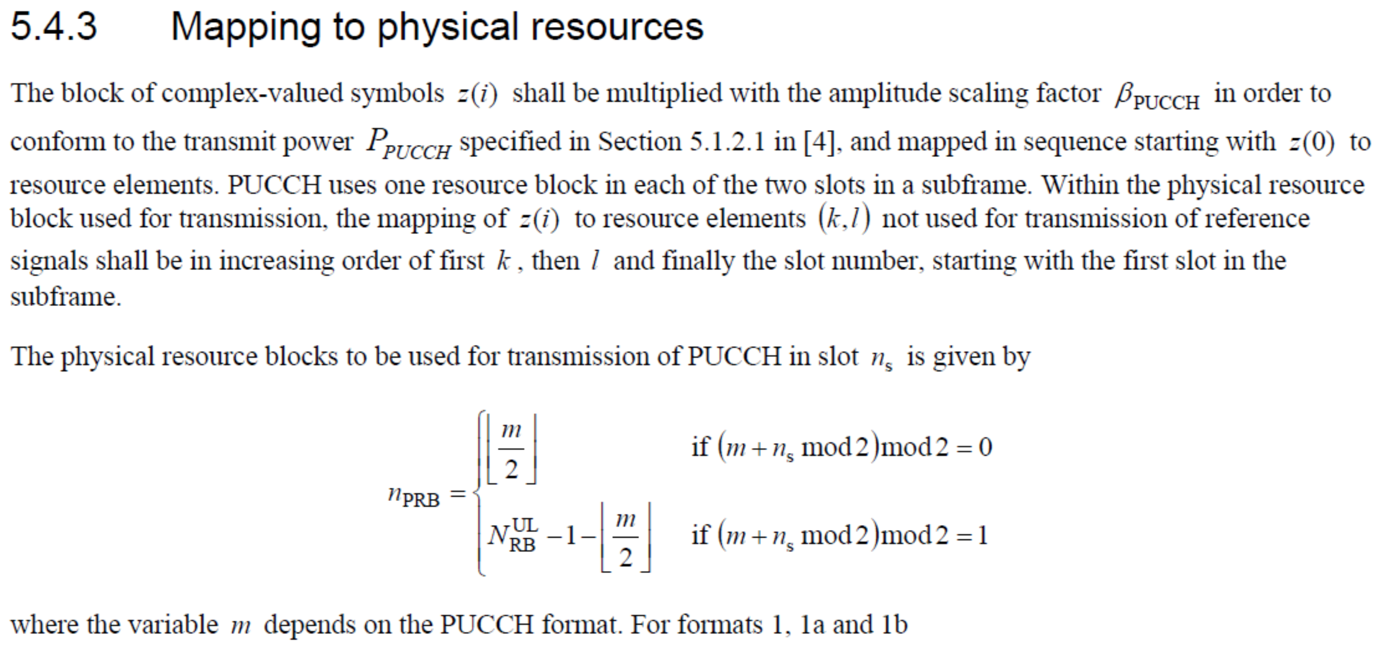
US Patent No. 10,833,908: Claim 16
"The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

16. The method of claim 11, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with FCA's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.*, *See* Claim 11. *See* element 11(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols.

US Patent No. 10,833,908: Claim 17
"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

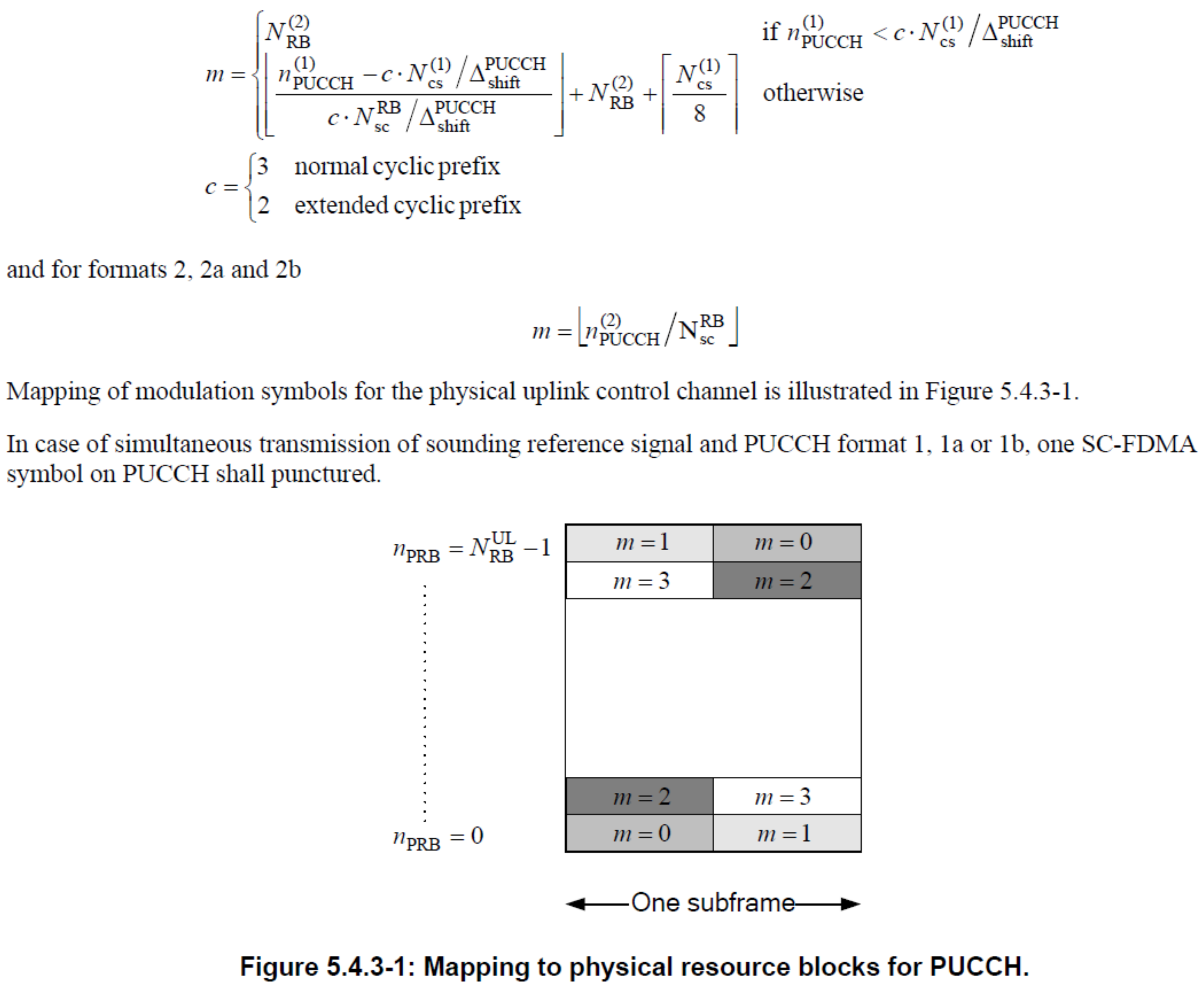
17. The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with FCA's Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

US Patent No. 10,833,908: Claim 17
“The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

	For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.  5.4.3 Mapping to physical resources The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe. The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by $n_{\text{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\text{s}} \bmod 2) \bmod 2 = 0 \\ N_{\text{RB}}^{\text{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\text{s}} \bmod 2) \bmod 2 = 1 \end{cases}$ where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

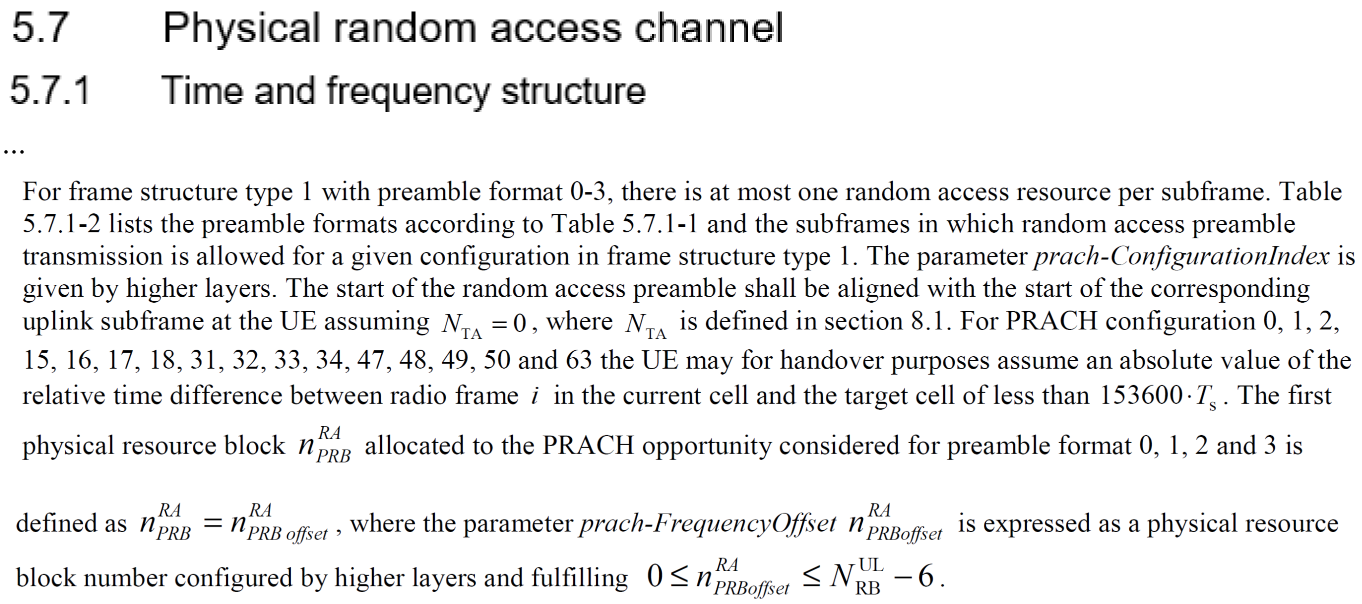
In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

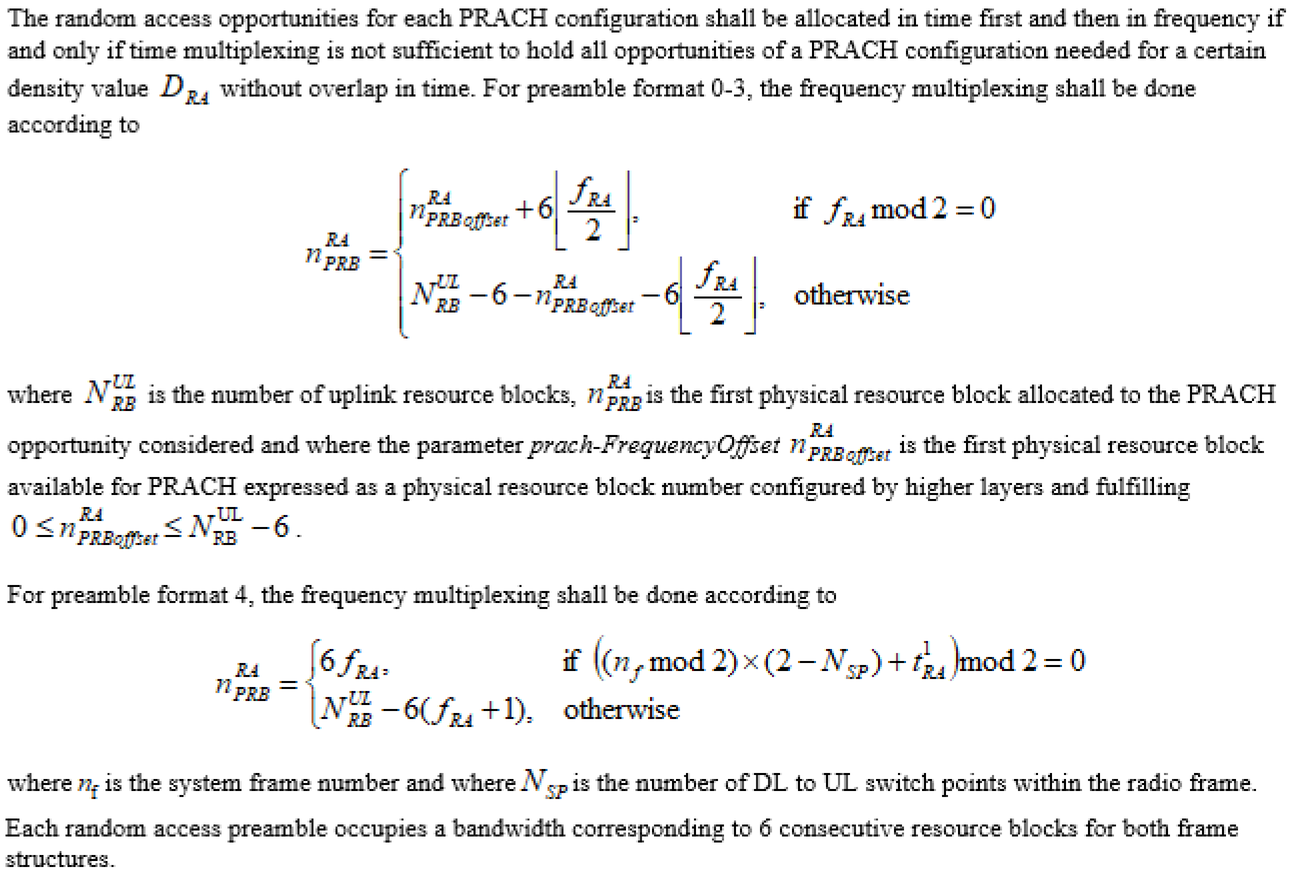
…

For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

.

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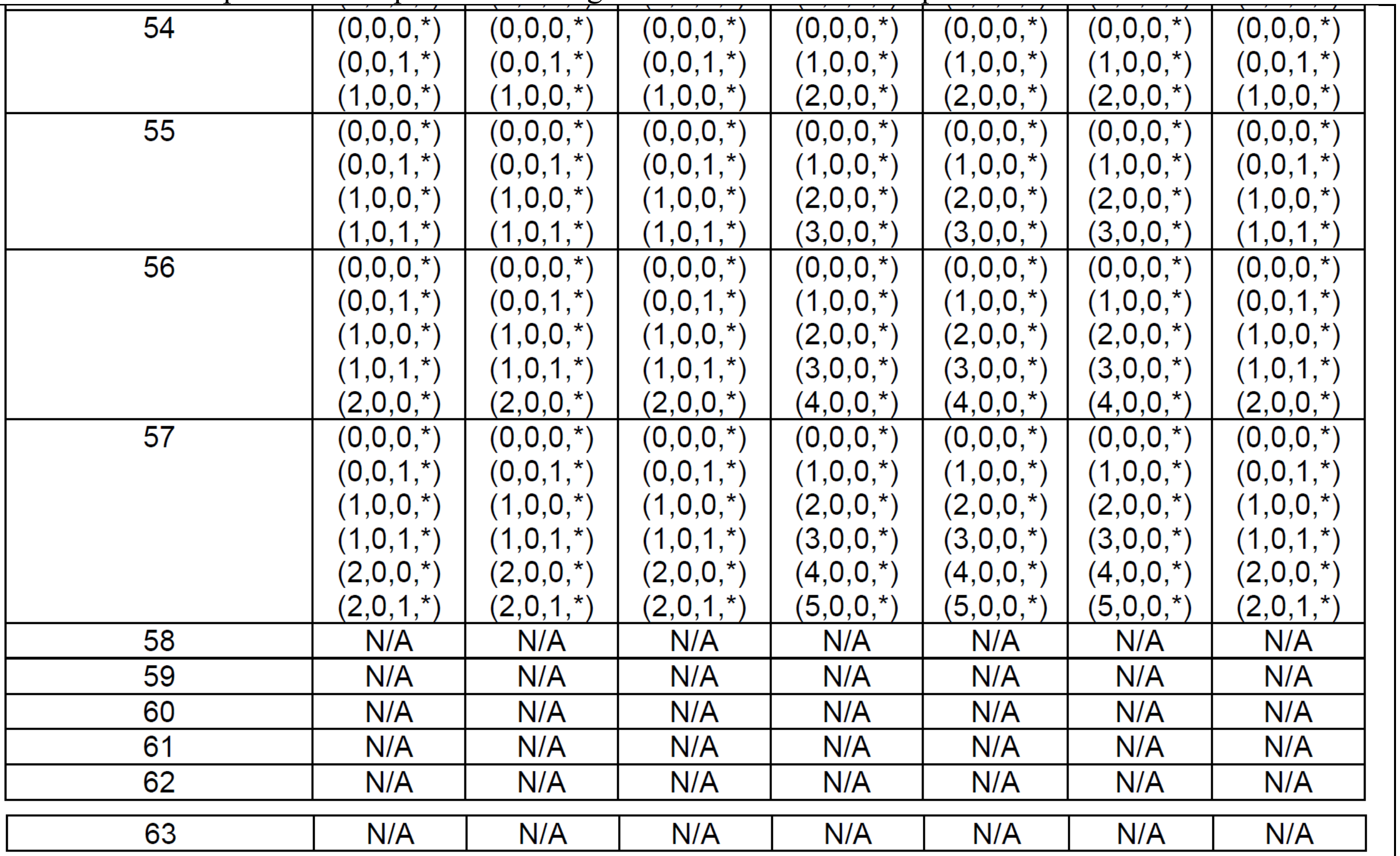
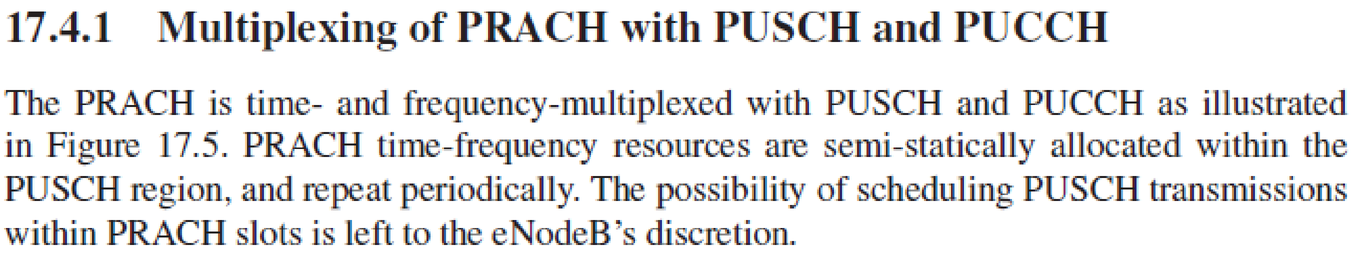


54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

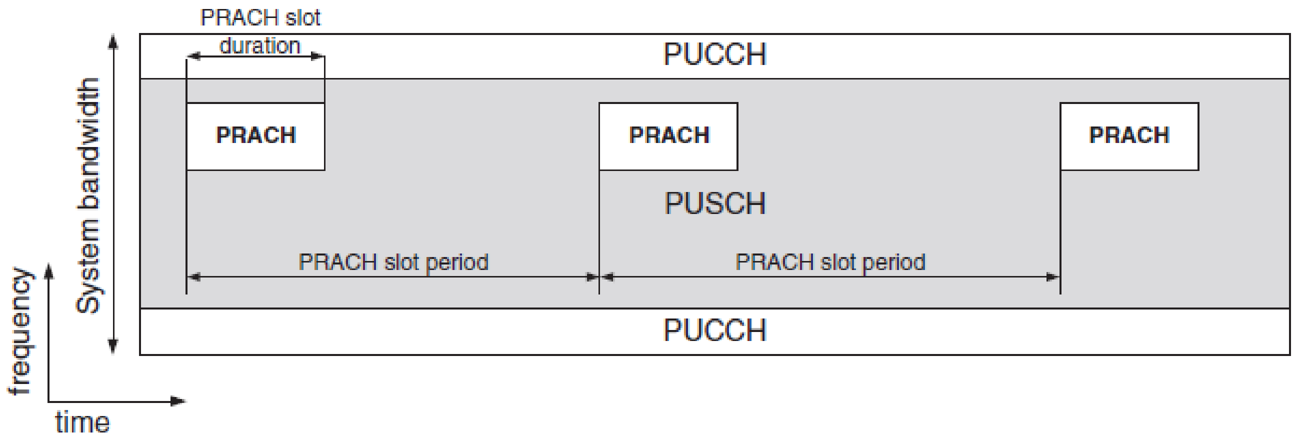


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

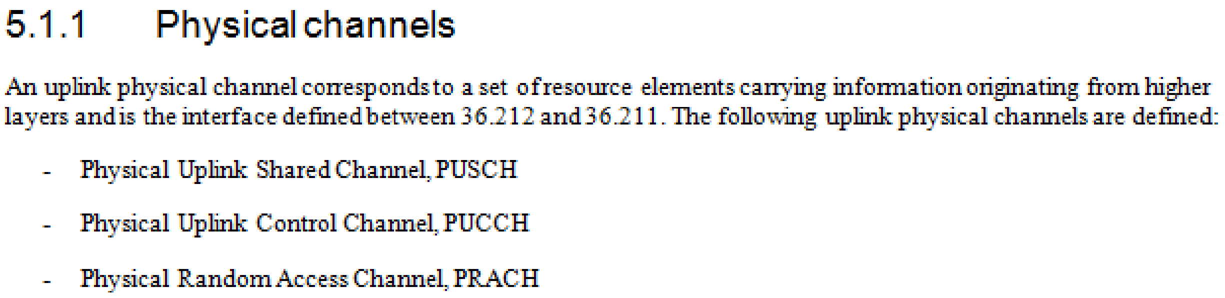
US Patent No. 10,833,908: Claim 17

"The method of claim 11, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

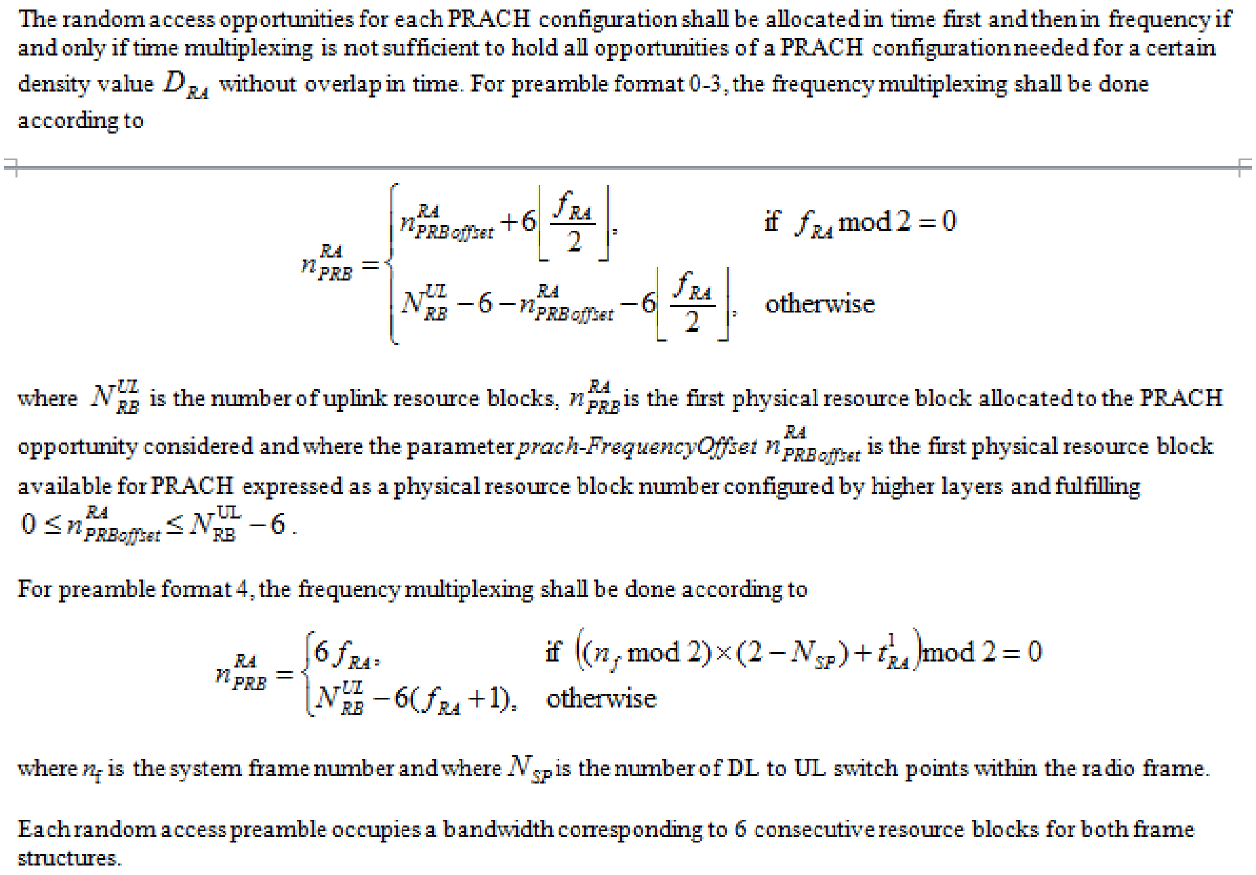
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 14.

US Patent No. 10,833,908: Claim 18

"The method of claim 11, wherein the random access signal is a spread spectrum signal."

18. The method of claim 11, wherein the random access signal is a spread spectrum signal	The receiver random access signal used with FCA's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 11. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

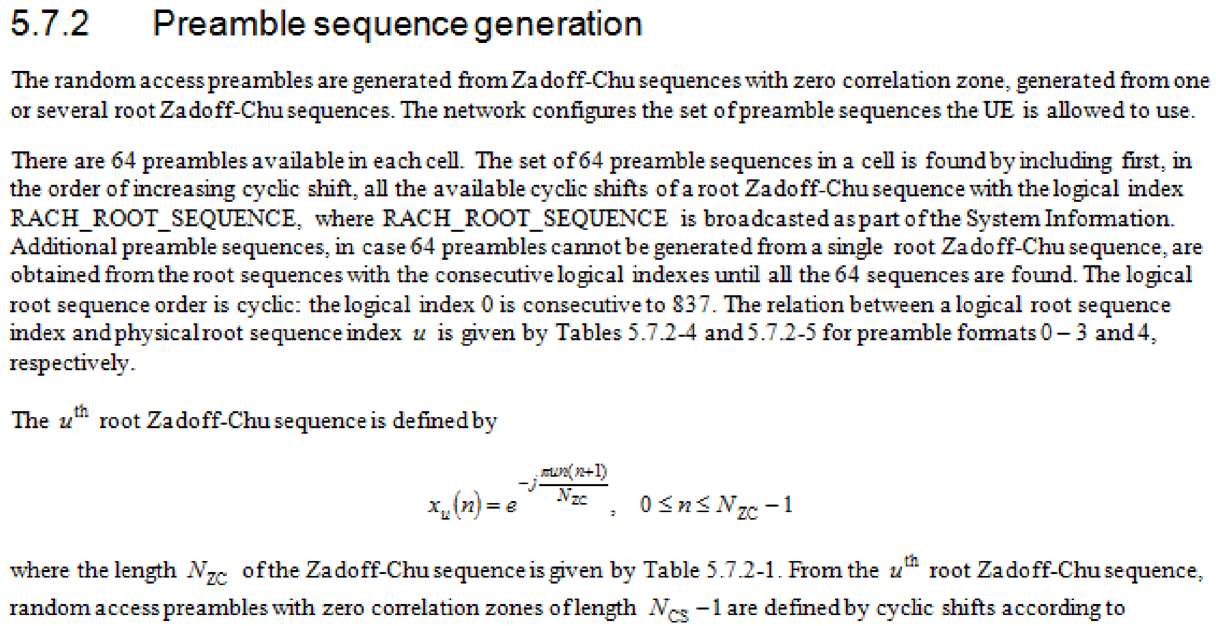
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 18
“The method of claim 11, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

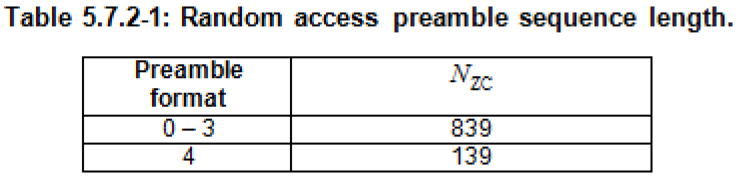
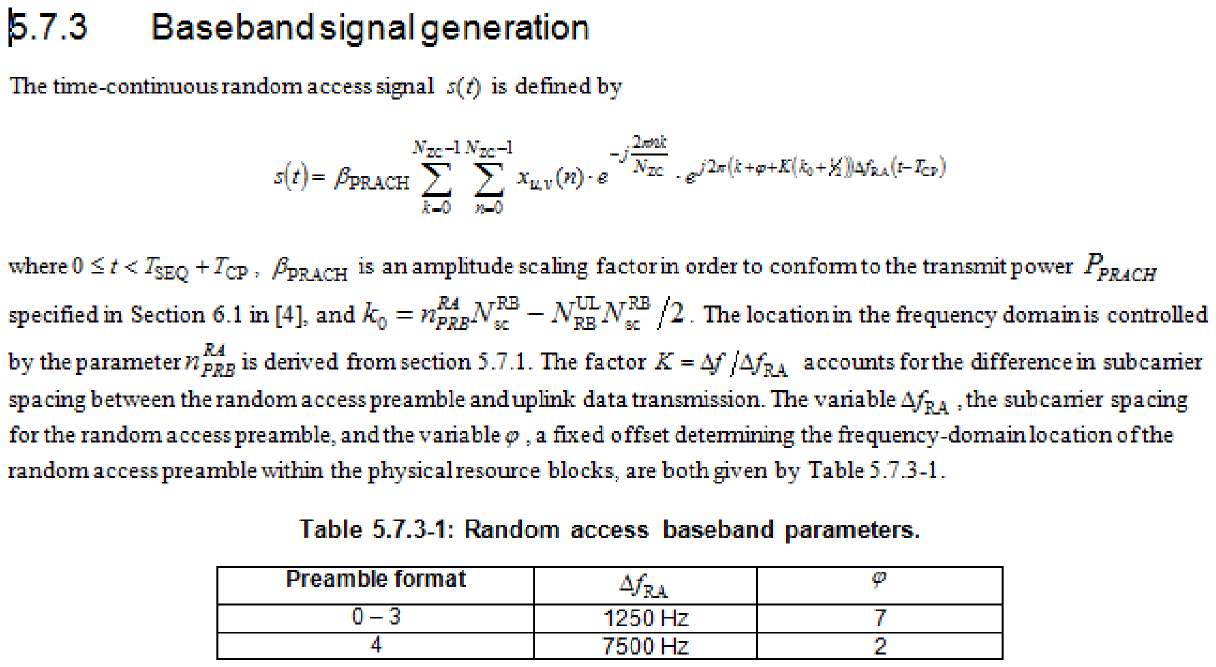


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 18
"The method of claim 11, wherein the random access signal is a spread spectrum signal."



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

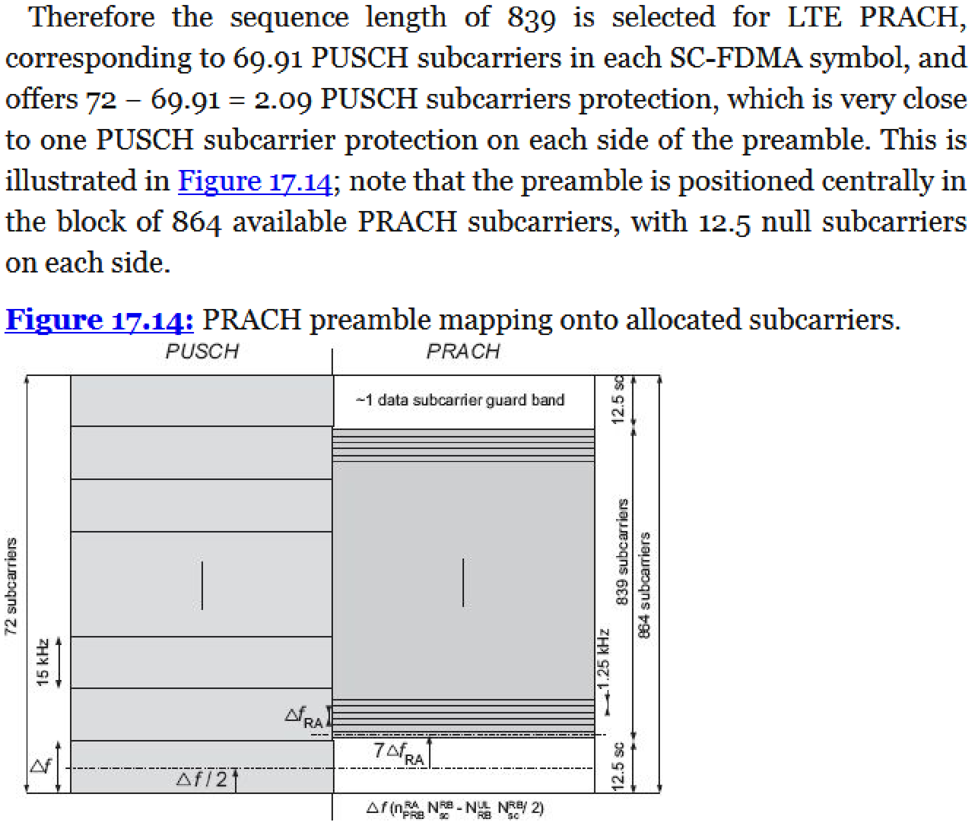
$$s(t)=\beta_{\mathrm{PRACH}}\sum_{k=0}^{N_{\mathrm{ZC}}-1}\sum_{n=0}^{N_{\mathrm{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\mathrm{ZC}}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\mathrm{RA}}\left(t-T_{\mathrm{CP}}\right)}$$

where $0\le t<T_{\mathrm{SEQ}}+T_{\mathrm{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\mathrm{sc}}^{\mathrm{RB}}-N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\mathrm{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

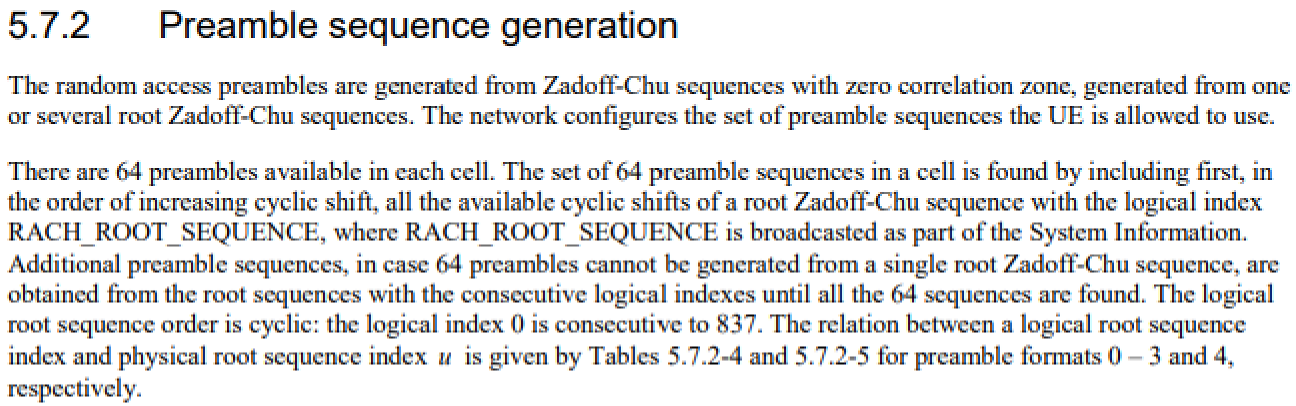
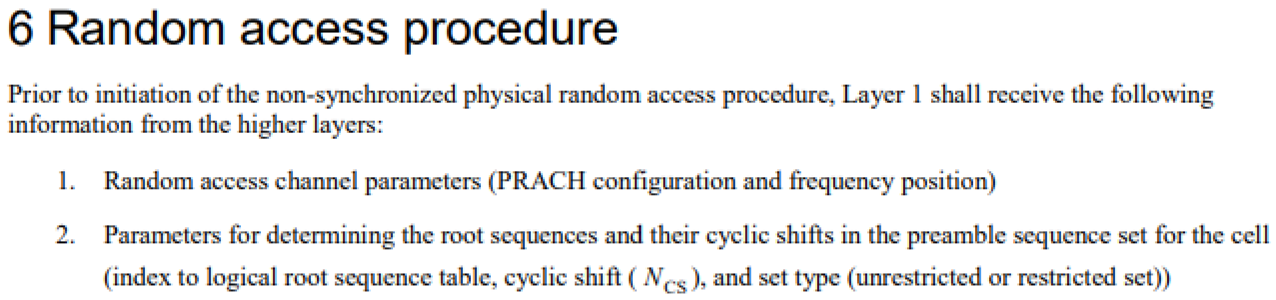
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

	Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side. **Figure 17.14:** PRACH preamble mapping onto allocated subcarriers. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at p. 387.

US Patent No. 10,833,908: Claim 19

"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

19. The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of FCA's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the system information.  **5.7.2 Preamble sequence generation** The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  **6 Random access procedure** Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 19
"The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 19

“The method of claim 11, further comprising: receiving broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

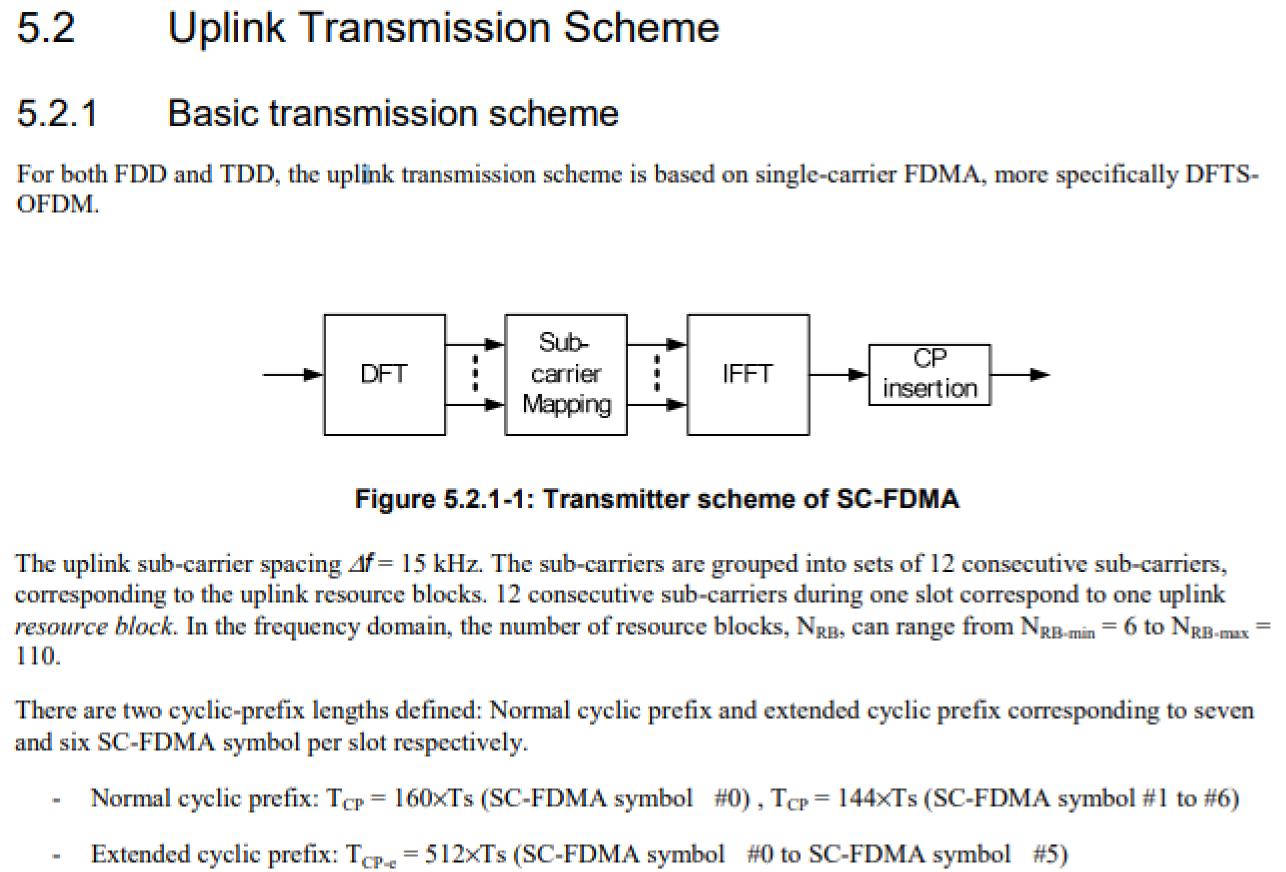
```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }       OPTIONAL                                                        -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}

-- ASN1STOP
```

RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

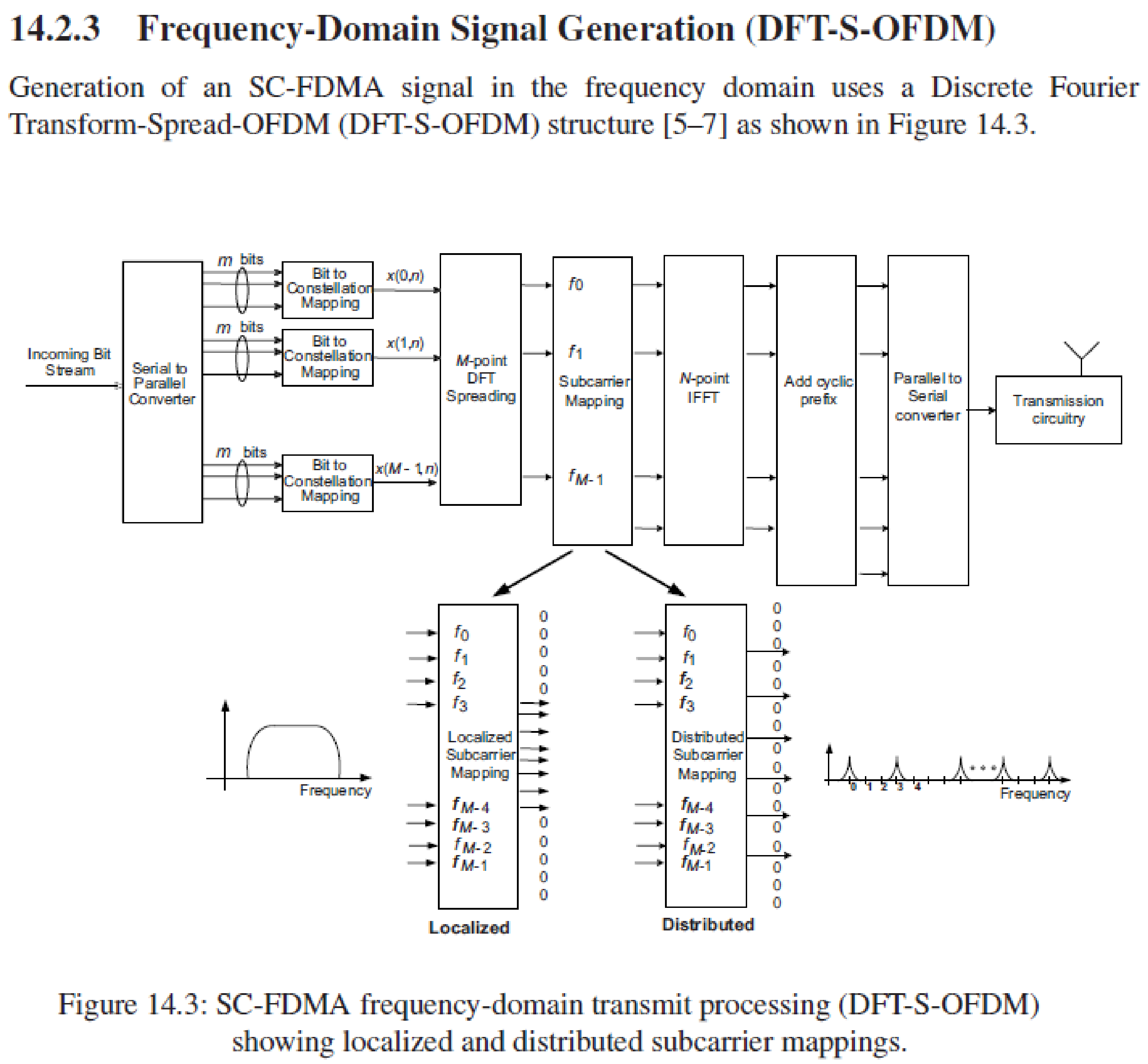
US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

20. The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit.	*See* Claim 11. FCA's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that provides the first uplink signal. *E.g.,* FCA's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  **5.2 Uplink Transmission Scheme** **5.2.1 Basic transmission scheme** For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

US Patent No. 10,833,908: Claim 20

"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

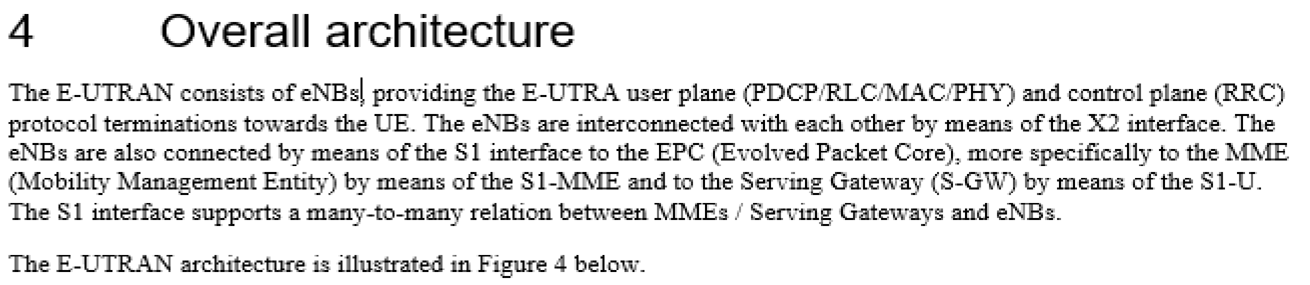
Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

US Patent No. 10,833,908: Claim 20
"The method of claim 11, wherein the first uplink signal is provided by an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit."

	See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320. *See also* Claim 10.

US Patent No. 10,833,908: Claim 21(a)
"A mobile station comprising:"

21. A mobile station comprising:	To the extent the preamble is considered a limitation, FCA's Accused Instrumentalities meet the preamble of claim 21 of the '908 patent. *E.g.,* FCA's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at Release 8. For example, FCA offers for sale, sells, and/or imports various vehicle models that are marketed and released with LTE cellular functionality and perform methods thereof, including but not limited to the models listed in the Plaintiff's Disclosure Of Asserted Claims And Infringement Contentions. The LTE specification (Series 36, Release 8) supports user equipment (UE) to perform a random access (RACH) procedure. For clarity, Release 8 of the 36 series 3GPP specifications was frozen in December of 2008 and that release was used as the basis for the first wave of LTE equipment. The LTE marketplace currently supports a mix of releases from Release 8 through Release 17. Though for ease of review Release 8 of the LTE specification is cited below, the same or functionally identical content exists in each corresponding release on the market. An LTE communication system provides access to multiple users (user equipments (UEs)) through multiple cells associated with multiple eNodeBs.  4 Overall architecture The E-UTRAN consists of eNBs providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME and to the Serving Gateway (S-GW) by means of the S1-U. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs. The E-UTRAN architecture is illustrated in Figure 4 below.

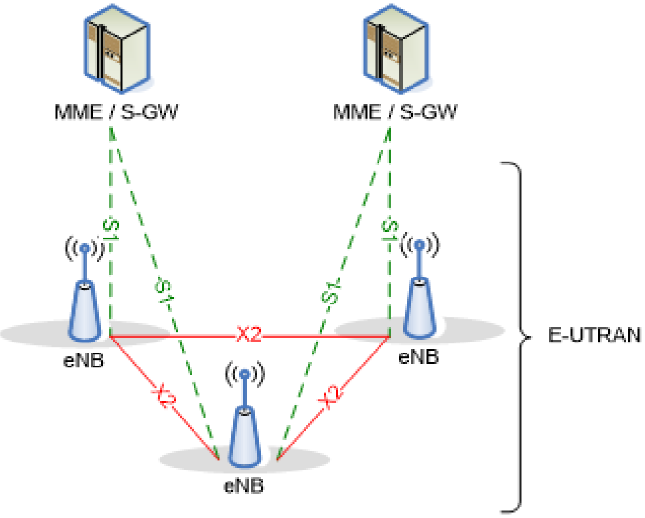
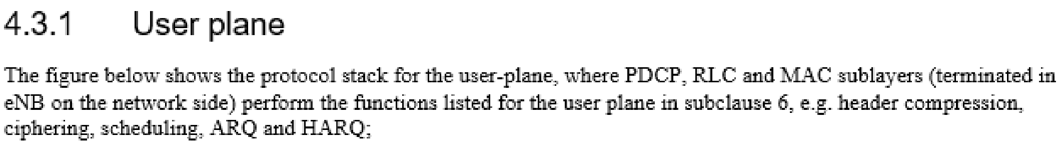


Figure 4-1: Overall Architecture

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 15.



4.3.1 User plane

The figure below shows the protocol stack for the user-plane, where PDCP, RLC and MAC sublayers (terminated in eNB on the network side) perform the functions listed for the user plane in subclause 6, e.g. header compression, ciphering, scheduling, ARQ and HARQ;

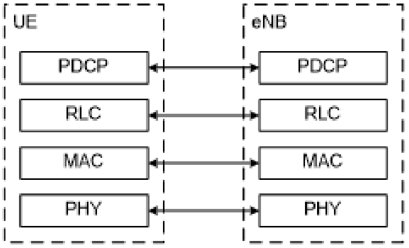


Figure 4.3.1-1: User-plane protocol stack

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 18.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

a first type of transmitter signal processing circuit configured to: generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers	FCA's Accused Instrumentalities include a first type of transmitter signal processing circuit configured to generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols. *E.g.*, The FCA Accused Instrumentalities include circuitry to use the frequency bands for the LTE network. A frequency band used for LTE communication has an associated channel bandwidth over which uplink and downlink communication is transmitted between the UEs and the eNodeBs.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

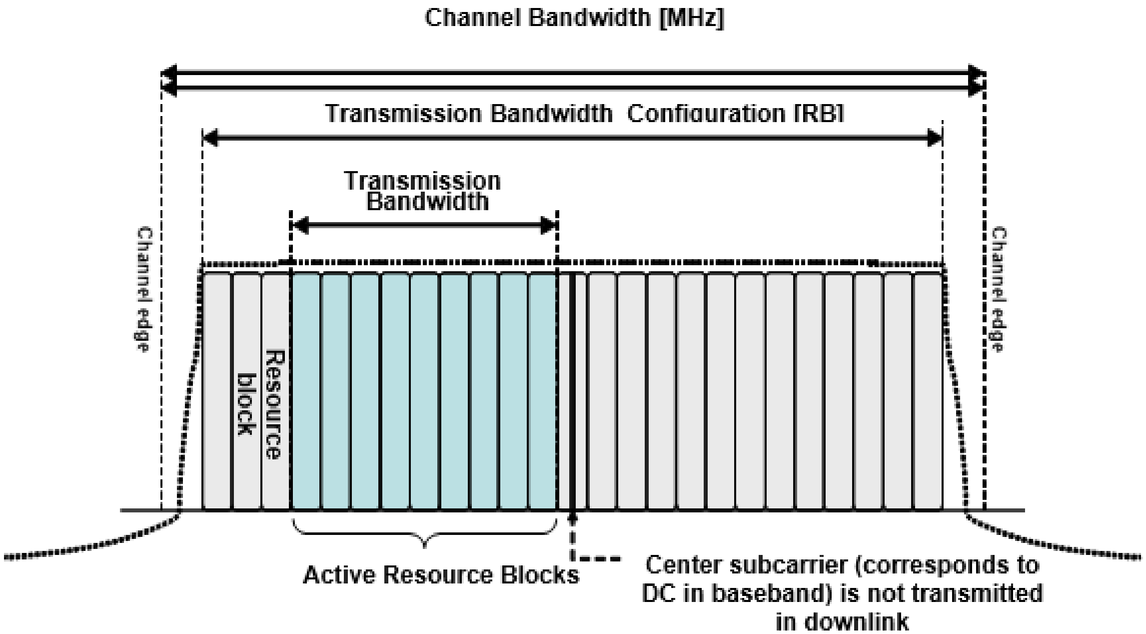
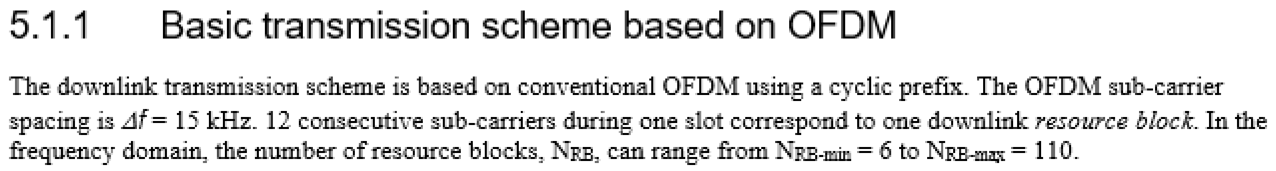


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15.

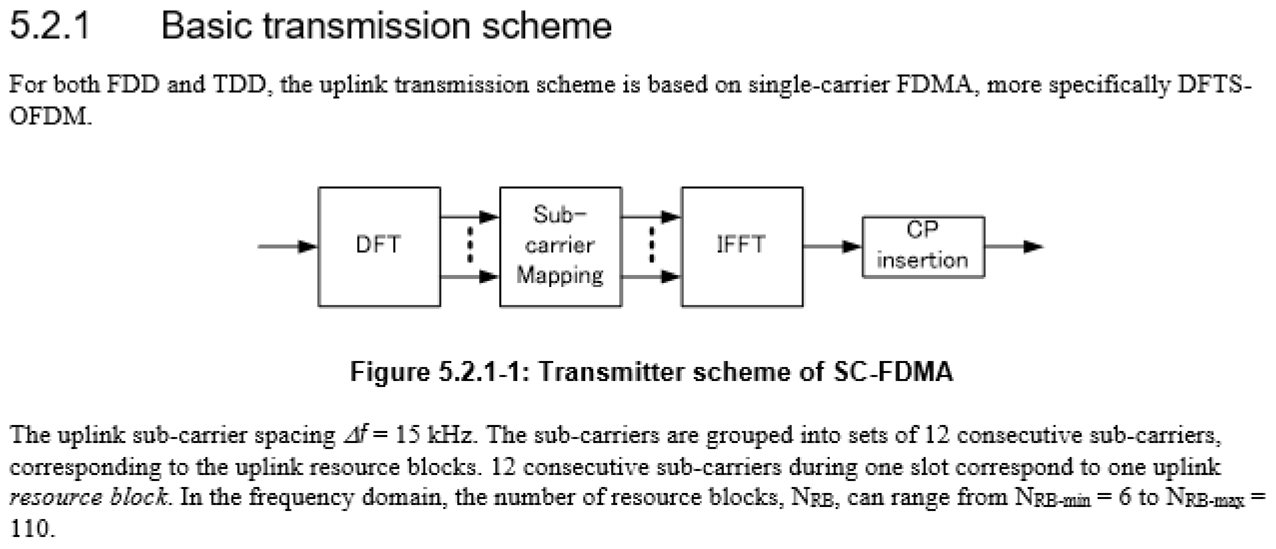
The mobile station modulates the first uplink signal onto a set of OFDM subcarriers. For the uplink, LTE uses a specific type of OFDMA (Orthogonal Frequency Division Multiple Access) referred to as either discrete Fourier Transform Spread (DFTS)-OFDM, or as SC-FDMA (Single Carrier – Frequency Division Multiple Access).



5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is $\Delta f = 15$ kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.



5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

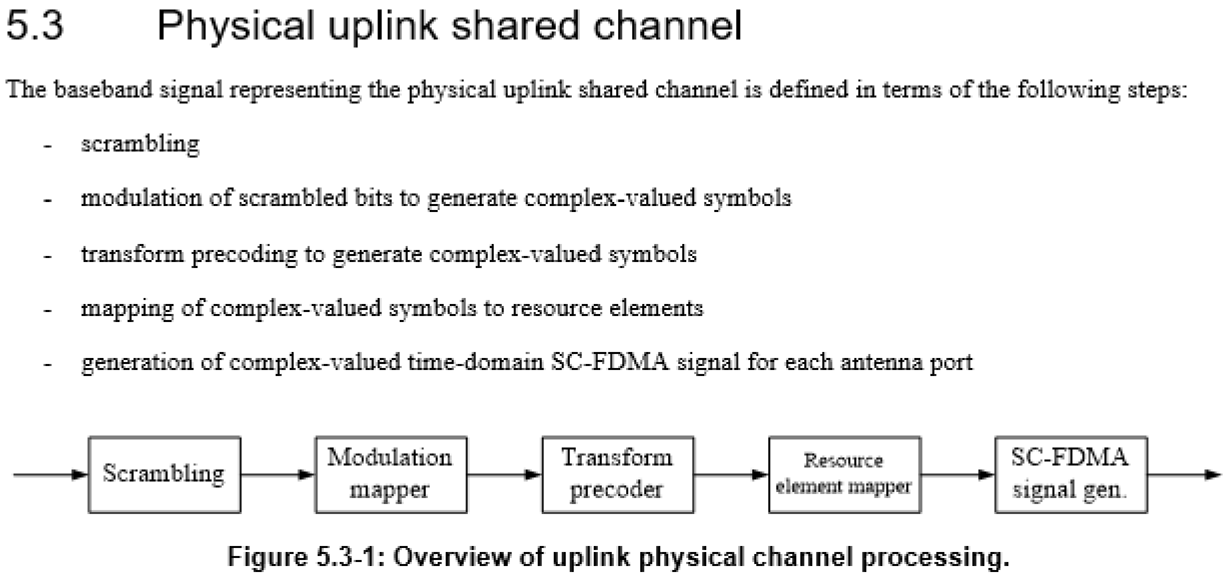
Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

The UE transmits OFDM signals carrying data on the physical uplink shared channel (PUSCH).



5.3 Physical uplink shared channel

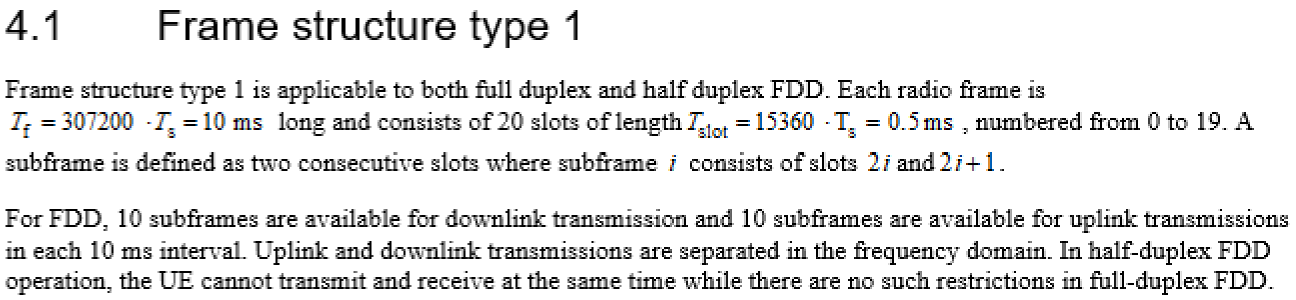
The baseband signal representing the physical uplink shared channel is defined in terms of the following steps:

- scrambling
- modulation of scrambled bits to generate complex-valued symbols
- transform precoding to generate complex-valued symbols
- mapping of complex-valued symbols to resource elements
- generation of complex-valued time-domain SC-FDMA signal for each antenna port

Figure 5.3-1: Overview of uplink physical channel processing.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

In LTE, both the type 1 and type 2 frame structures include multiple time slots.



4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10$ ms long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

US Patent No. 10,833,908: Claim 21(b)
"a first type of transmitter signal processing circuit configured to:
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

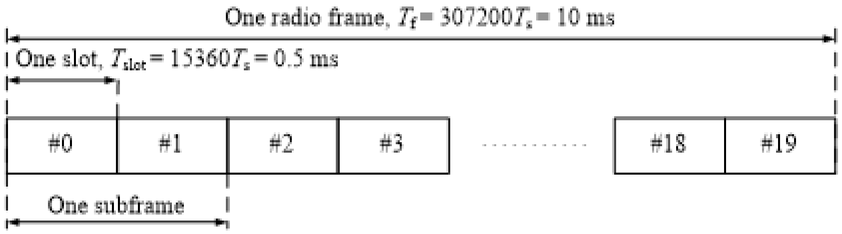
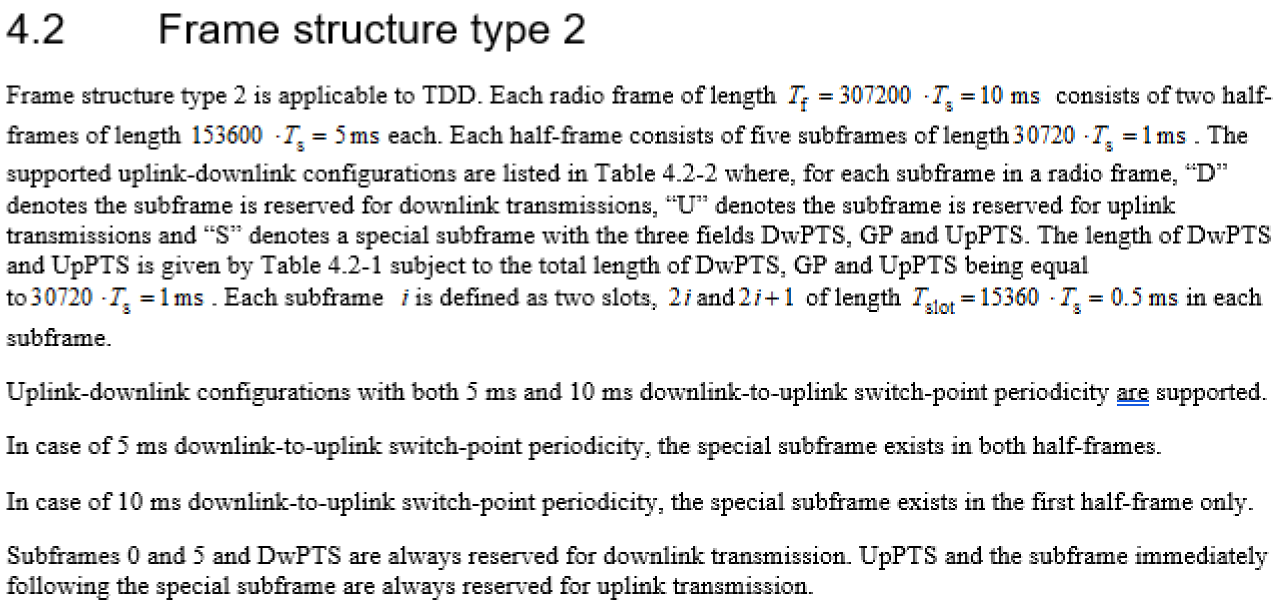


Figure 4.1-1: Frame structure type 1.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 9.



4.2 Frame structure type 2

Frame structure type 2 is applicable to TDD. Each radio frame of length $T_f = 307200 \cdot T_s = 10$ ms consists of two half-frames of length $153600 \cdot T_s = 5$ ms each. Each half-frame consists of five subframes of length $30720 \cdot T_s = 1$ ms. The supported uplink-downlink configurations are listed in Table 4.2-2 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 4.2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_s = 1$ ms. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_{slot} = 15360 \cdot T_s = 0.5$ ms in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

US Patent No. 10,833,908: Claim 21(b)

“a first type of transmitter signal processing circuit configured to:

generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

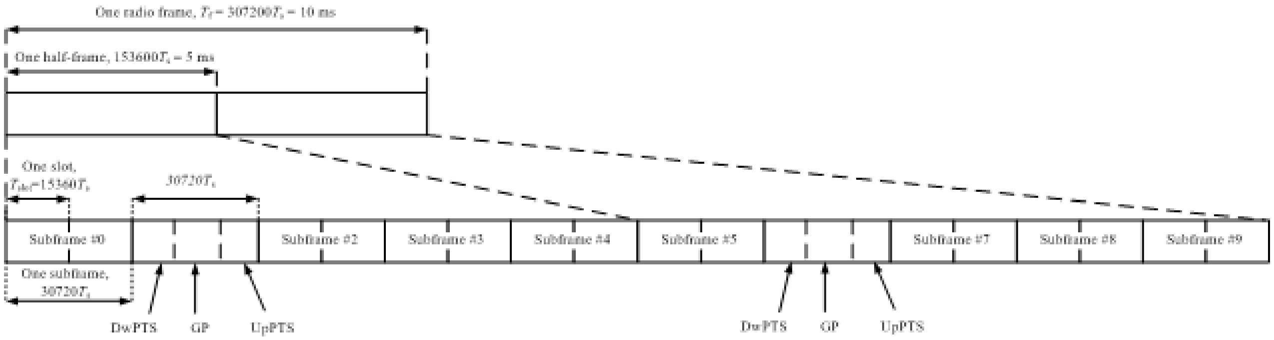
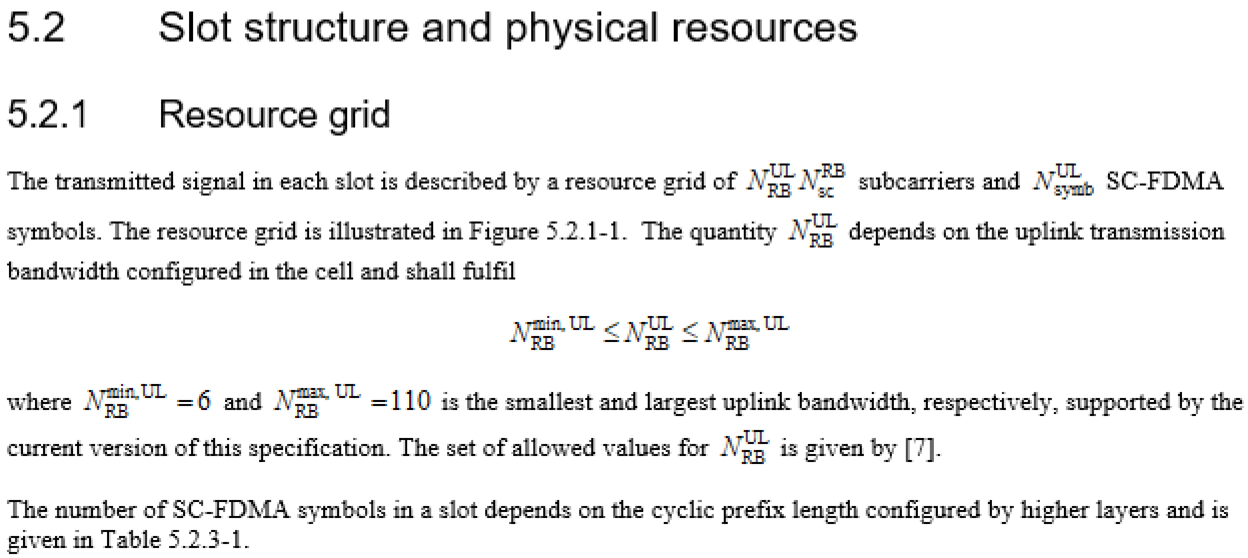


Figure 4.2-1: Frame structure type 2 (for 5 ms switch-point periodicity).

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 10.

Each time slot includes 7 symbols for a normal cyclic prefix (6 for extended).



5.2 Slot structure and physical resources

5.2.1 Resource grid

The transmitted signal in each slot is described by a resource grid of $N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers and $N_{\mathrm{symb}}^{\mathrm{UL}}$ SC-FDMA symbols. The resource grid is illustrated in Figure 5.2.1-1. The quantity $N_{\mathrm{RB}}^{\mathrm{UL}}$ depends on the uplink transmission bandwidth configured in the cell and shall fulfil

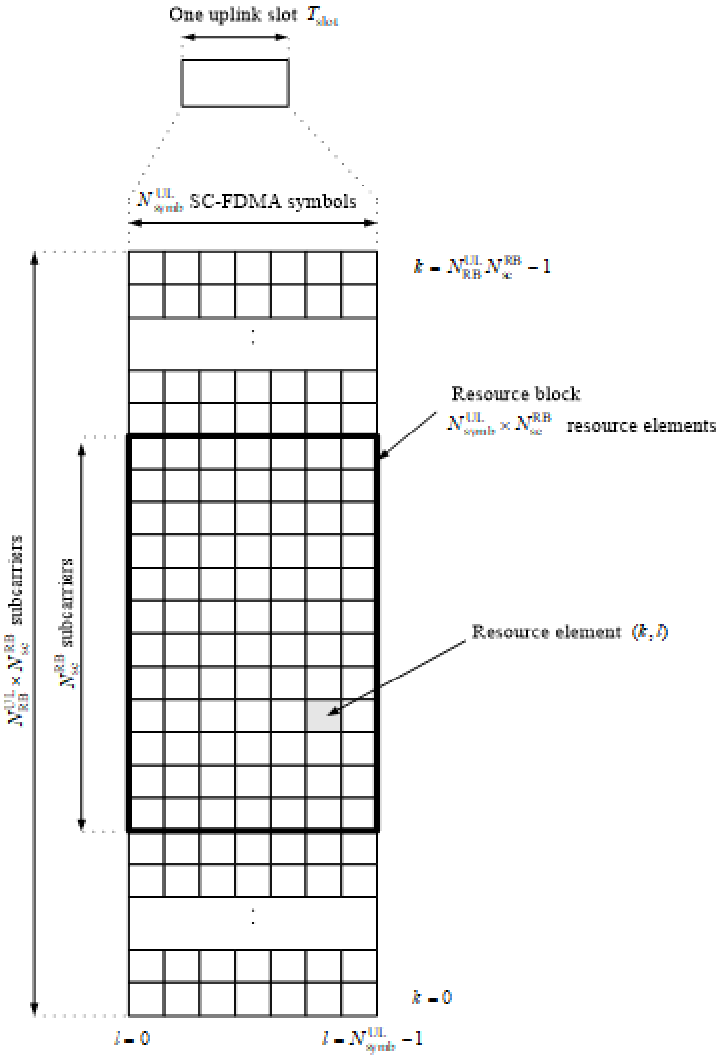
$$N_{\mathrm{RB}}^{\min,\mathrm{UL}} \le N_{\mathrm{RB}}^{\mathrm{UL}} \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$$

where $N_{\mathrm{RB}}^{\min,\mathrm{UL}} = 6$ and $N_{\mathrm{RB}}^{\max,\mathrm{UL}} = 110$ is the smallest and largest uplink bandwidth, respectively, supported by the current version of this specification. The set of allowed values for $N_{\mathrm{RB}}^{\mathrm{UL}}$ is given by [7].

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

US Patent No. 10,833,908: Claim 21(b)
“a first type of transmitter signal processing circuit configured to:

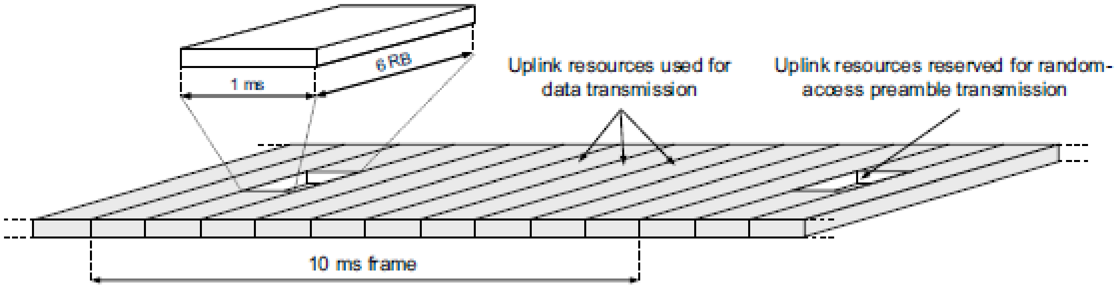
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers”

	 **Figure 5.2.1-1: Uplink resource grid.** See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.

US Patent No. 10,833,908: Claim 21(b)

"a first type of transmitter signal processing circuit configured to:

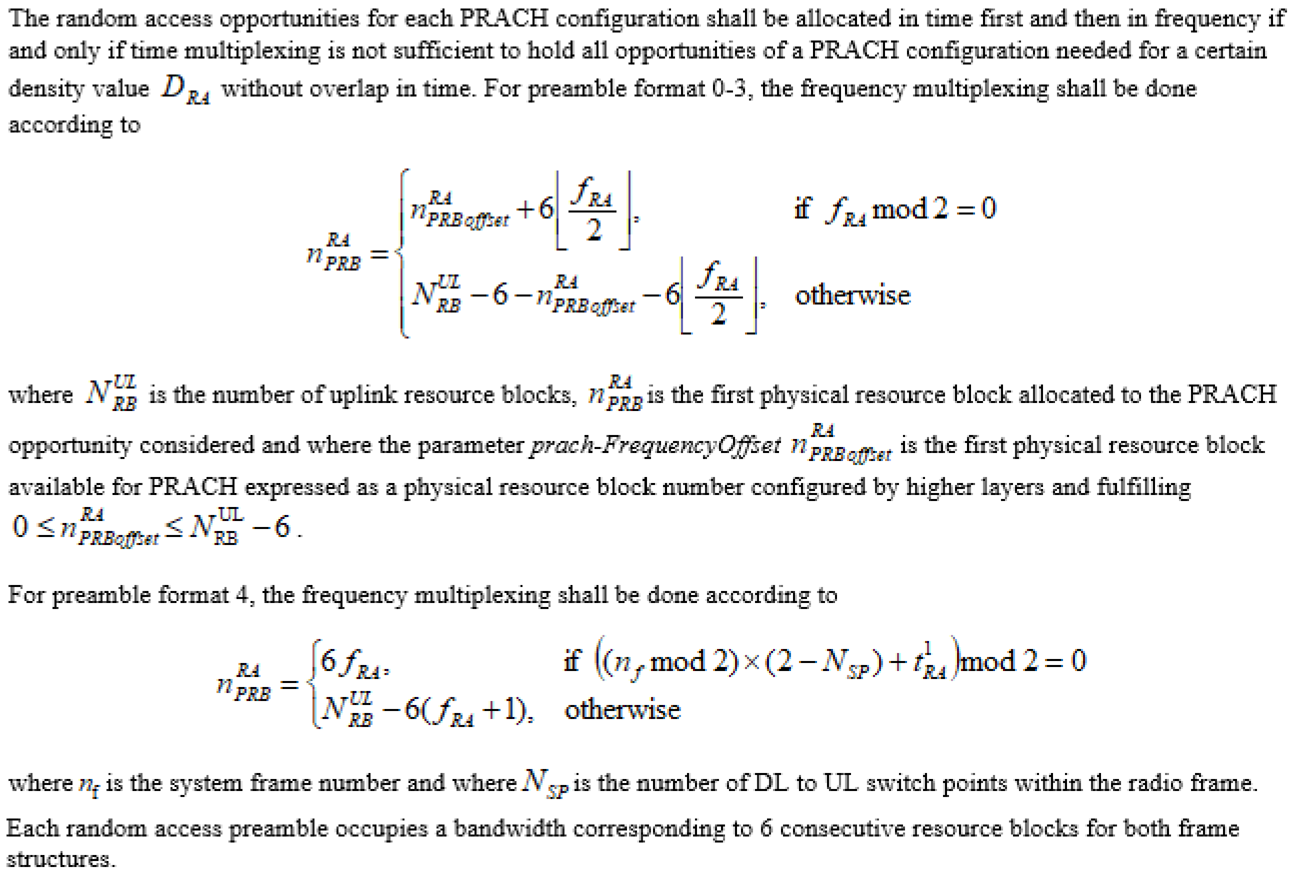
generate a first uplink signal, wherein the first uplink signal is an orthogonal frequency division multiplexing (OFDM) signal and utilizes a frame format comprising a plurality of timeslots, each timeslot comprising a plurality of OFDM symbols; modulate the first uplink signal onto a set of OFDM subcarriers"

	 **FIGURE 14.10** Principal illustration of random-access preamble transmission See also Daulman, Parkvall, and Skold, "4G: LTE/LTE-Advanced for Mobile Broadband," Second Edition (2014) at p. 361 (illustrating an example preamble transmission across uplink resources)

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station,	FCA’s Accused Instrumentalities includes a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station. *E.g.*, The random access signal, e.g., a random access preamble transmitted on the PRACH occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures, which is a fraction of the overall channel bandwidth (frequency band) for any other bandwidth than the smallest. The range of the overall channel bandwidth is the bandwidth of 6 to 100 resource blocks, corresponding to bandwidths 1.4MHz to 20MHz, with 20MHz being the most commonly used bandwidth. The Accused Products are configured to operate within a channel bandwidth of more than 6 resource blocks.  5.7 Physical random access channel 5.7.1 Time and frequency structure …

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33, 35-36.

US Patent No. 10,833,908: Claim 21(c)

"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1 Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

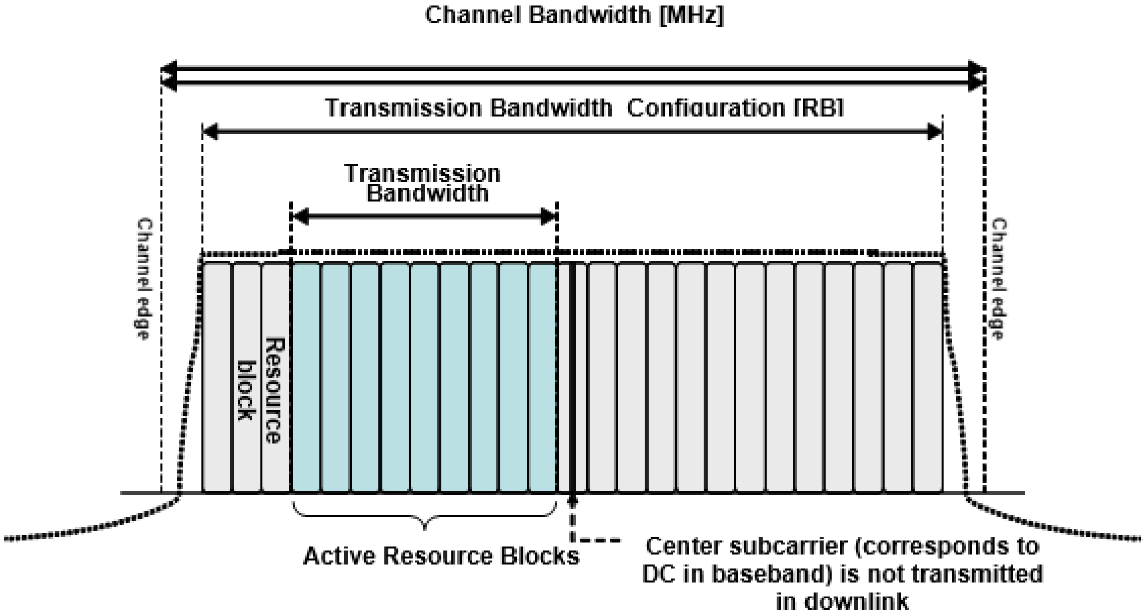
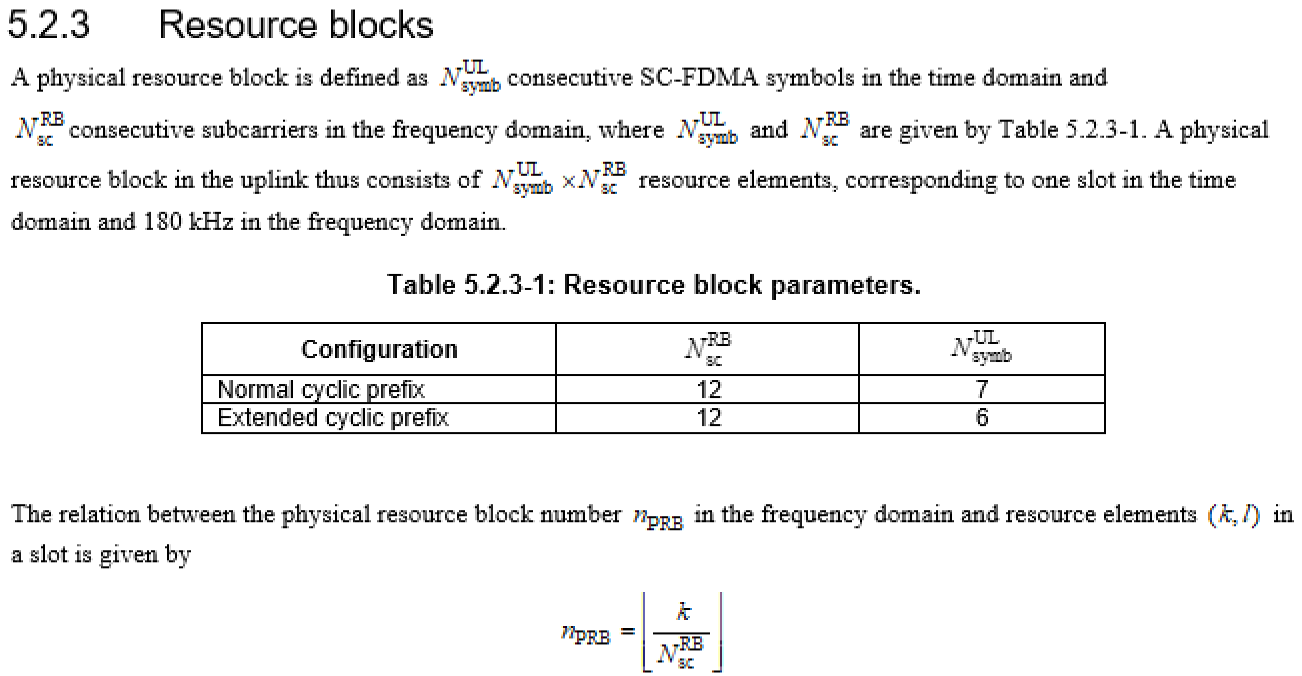


Figure 5.6-1 Definition of Channel Bandwidth and Transmission Bandwidth Configuration for one E-UTRA carrier

See e.g., 3GPP TS 36.101 V8.29.0 at pg. 15

US Patent No. 10,833,908: Claim 21(c)
"a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station"



5.2.3 Resource blocks

A physical resource block is defined as $N_{\text{symb}}^{\text{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{UL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\text{symb}}^{\text{UL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

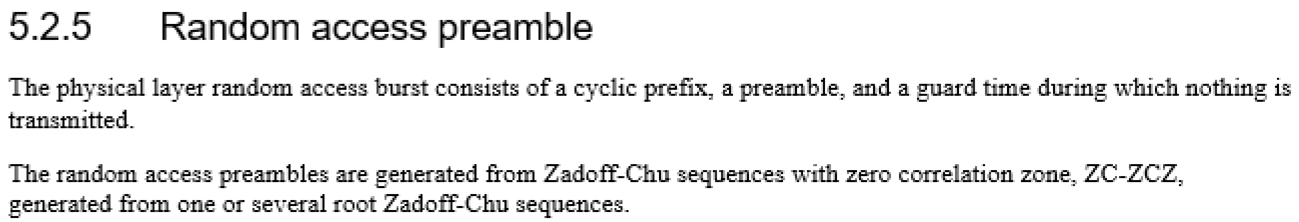
Configuration	$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

The random access burst includes a guard time added after the preamble transmission.

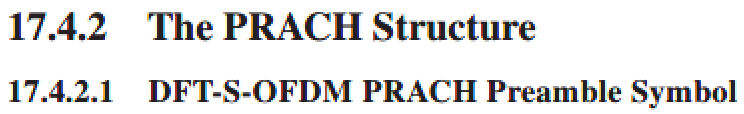


5.2.5 Random access preamble

The physical layer random access burst consists of a cyclic prefix, a preamble, and a guard time during which nothing is transmitted.

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, ZC-ZCZ, generated from one or several root Zadoff-Chu sequences.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 29.

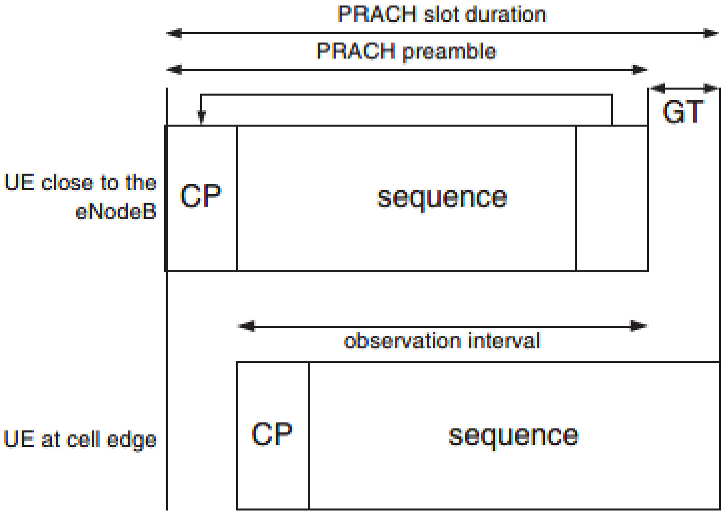


17.4.2 The PRACH Structure

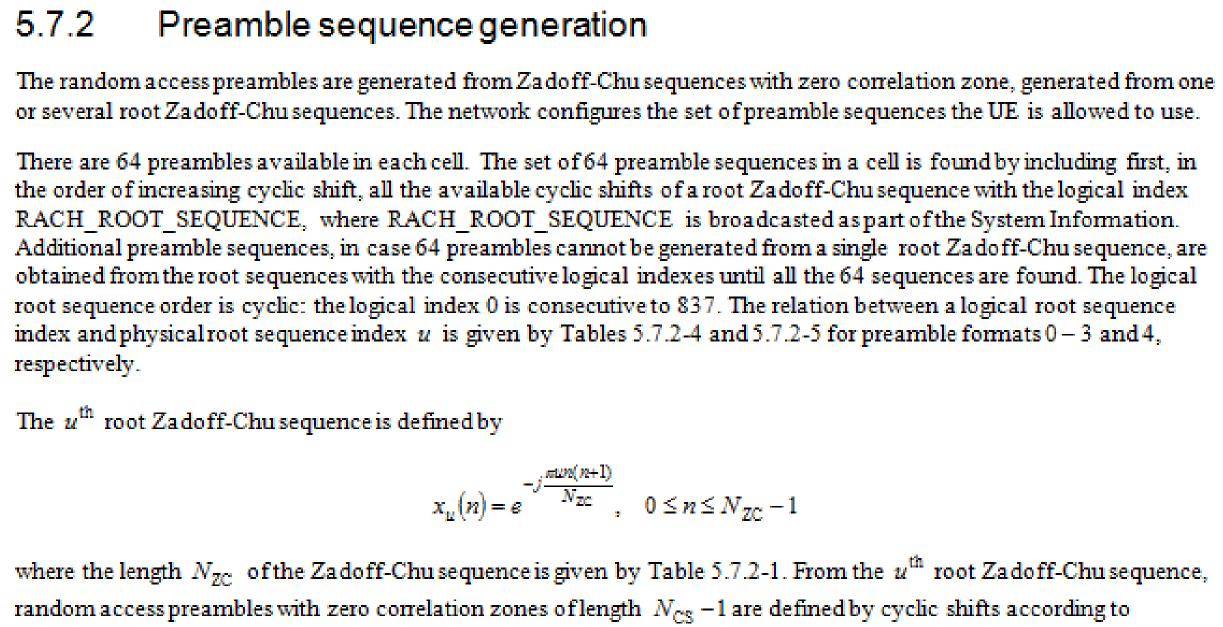
17.4.2.1 DFT-S-OFDM PRACH Preamble Symbol

...

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”

	The UE aligns the start of the random access preamble with the start of the corresponding uplink subframe at the UE assuming a timing advance of zero (see Section 18.2), and the preamble length is shorter than the PRACH slot in order to provide room for a Guard Time (GT) to absorb the propagation delay. Figure 17.6 shows two preambles at the eNodeB received with different timings depending on the propagation delay: as for a conventional  Figure 17.6: PRACH preamble received at the eNodeB. OFDM symbol, a single observation interval can be used regardless of the UE’s delay, within which periodic correlation is possible. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pgs. 377-378. The random access preamble includes one of 64 sequences e.g., Zadoff-Chu sequences, associated with each cell.

US Patent No. 10,833,908: Claim 21(c)
“a second type of transmitter signal processing circuit configured to generate an random access signal followed by a guard period, wherein the random access signal includes a sequence associated with a base station”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS} - 1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

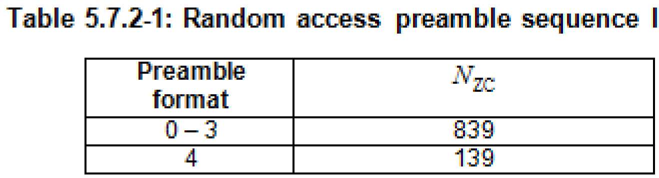
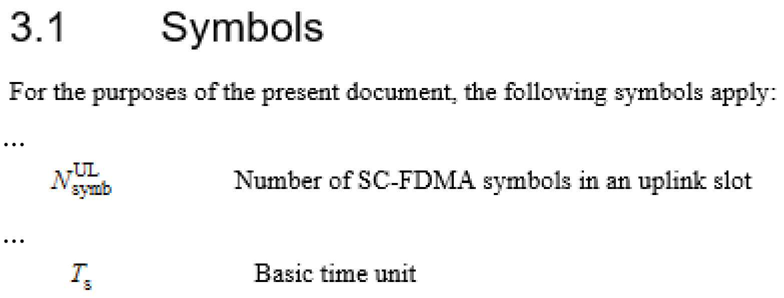
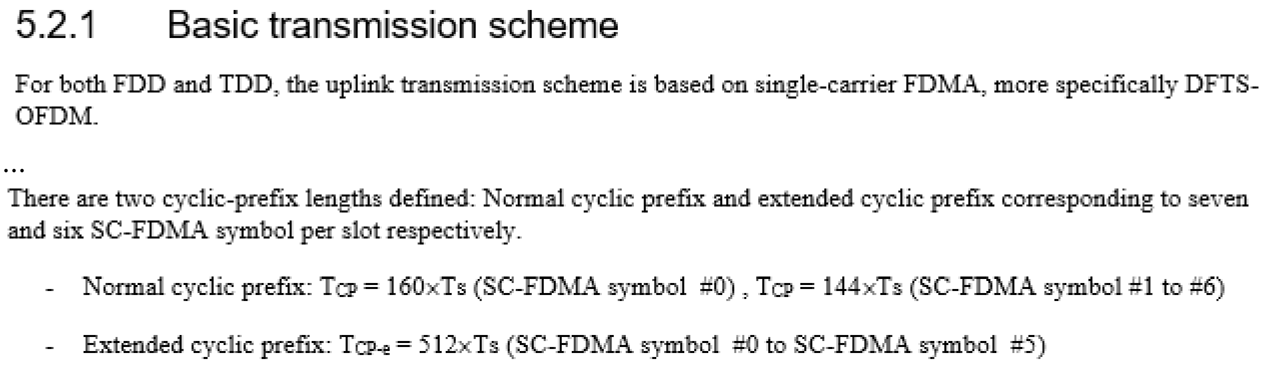


Table 5.7.2-1: Random access preamble sequence length.

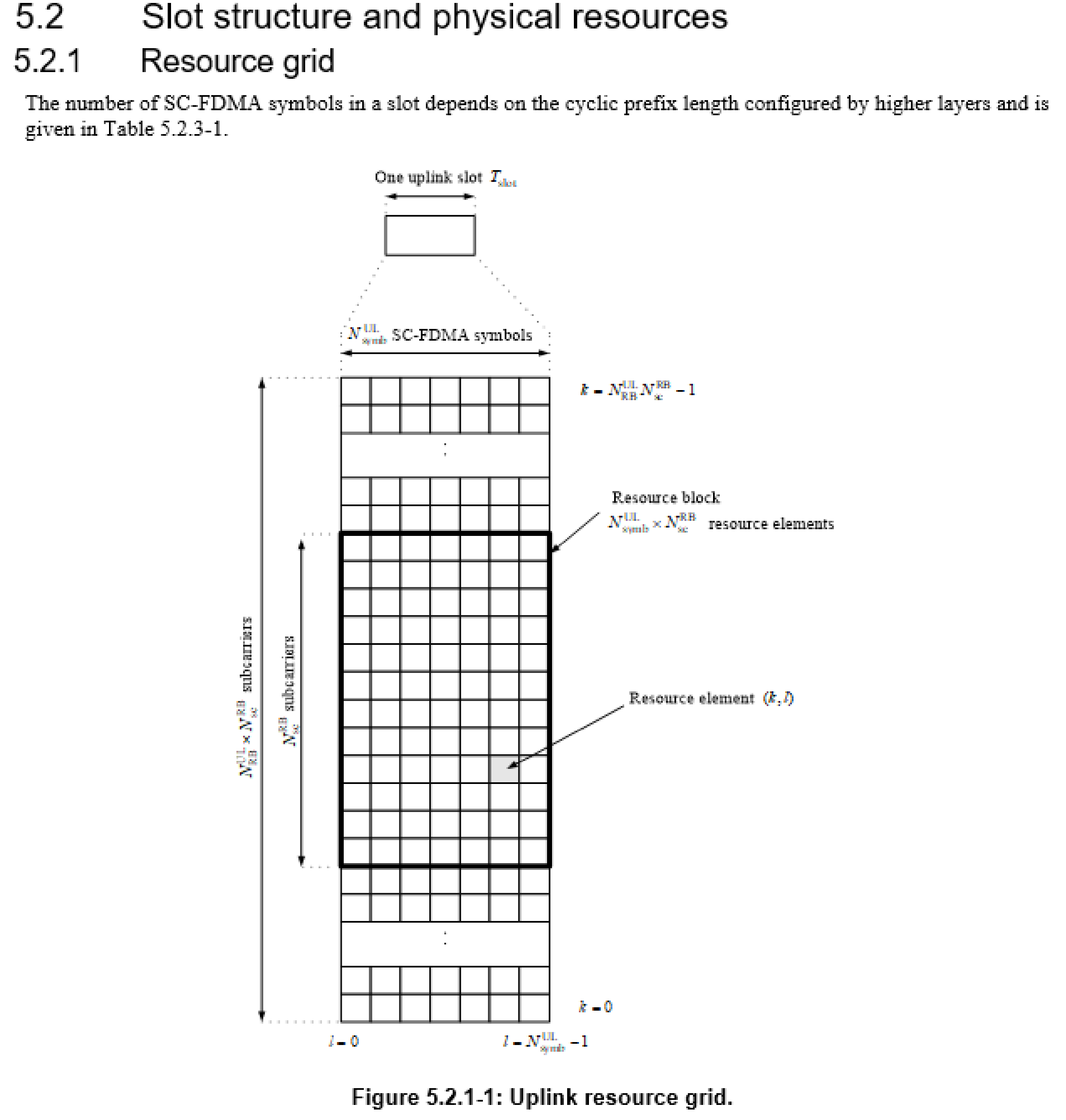
Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”

wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and	The time duration of a combination of the random access signal and the guard period implemented using FCA’s Accused Instrumentalities is greater than a time duration of at least one of the plurality of OFDM symbols. *E.g.*, LTE defines a basic time unit (*T*s) and is equal to 1/ (15000 x 2048) seconds. The OFDM symbol time is 2048 **T*s or 66.7 µs. 3.1 Symbols For the purposes of the present document, the following symbols apply: ... $N_{\text{symb}}^{\text{UL}}$ Number of SC-FDMA symbols in an uplink slot ... T_s Basic time unit See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 7-8. An LTE slot typically has 7 symbols, except for extended cyclic prefix which has 6 symbols. As a result, a symbol for a typical slot is ~2192 base time intervals and for extended cyclic prefix is ~2560 basic time intervals. 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. ... There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160\times T_s$ (SC-FDMA symbol #0) , $T_{CP} = 144\times T_s$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512\times T_s$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(d)
“wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and”



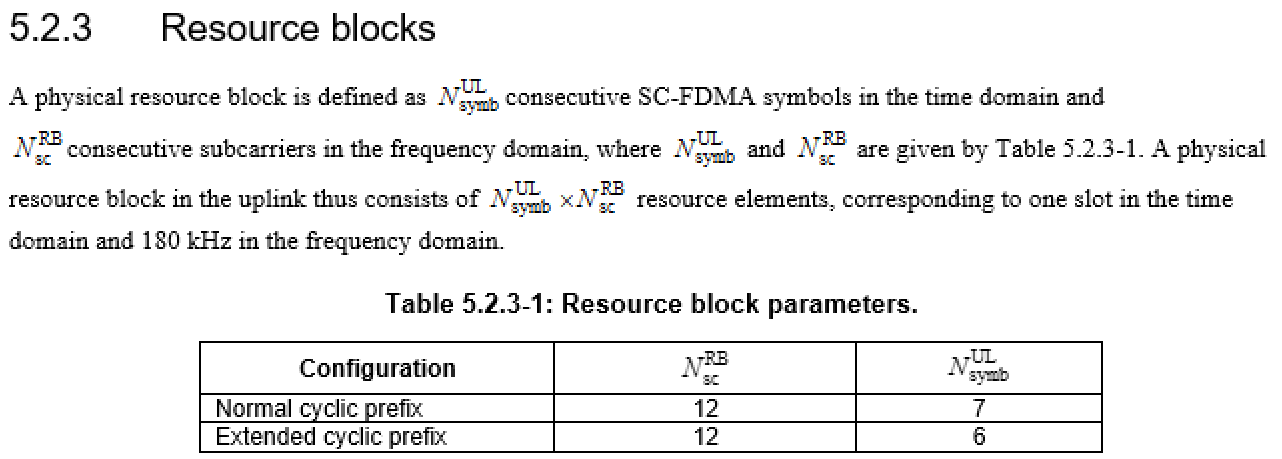
5.2 Slot structure and physical resources

5.2.1 Resource grid

The number of SC-FDMA symbols in a slot depends on the cyclic prefix length configured by higher layers and is given in Table 5.2.3-1.

Figure 5.2.1-1: Uplink resource grid.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 12.



5.2.3 Resource blocks

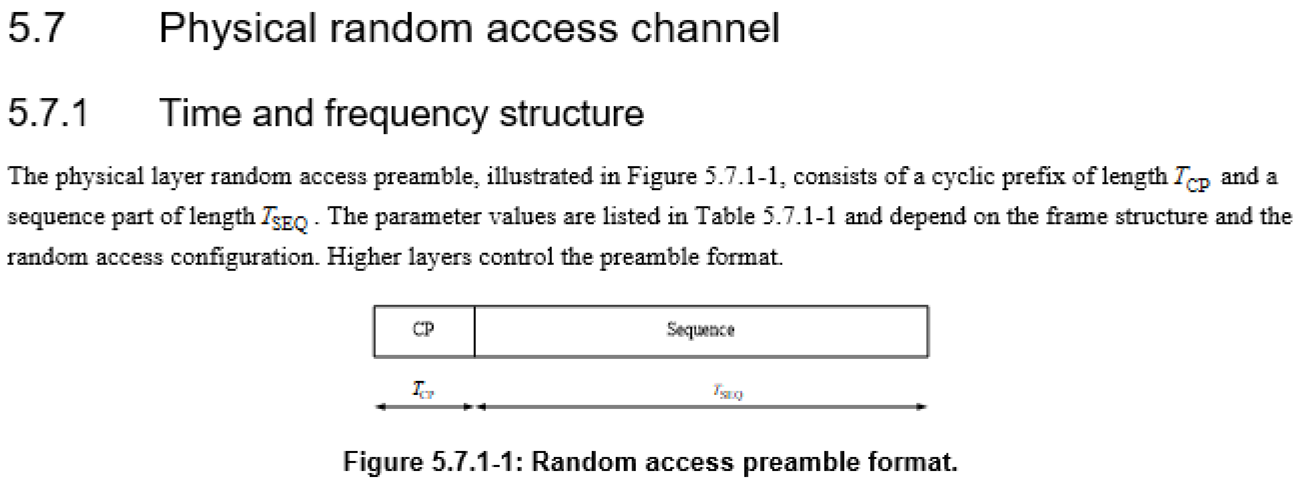
A physical resource block is defined as $N_{\mathrm{symb}}^{\mathrm{UL}}$ consecutive SC-FDMA symbols in the time domain and $N_{\mathrm{sc}}^{\mathrm{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\mathrm{symb}}^{\mathrm{UL}}$ and $N_{\mathrm{sc}}^{\mathrm{RB}}$ are given by Table 5.2.3-1. A physical resource block in the uplink thus consists of $N_{\mathrm{symb}}^{\mathrm{UL}} \times N_{\mathrm{sc}}^{\mathrm{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Table 5.2.3-1: Resource block parameters.

Configuration	$N_{\mathrm{sc}}^{\mathrm{RB}}$	$N_{\mathrm{symb}}^{\mathrm{UL}}$
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 13.

Preamble formats 0-4 have sequence lengths of 4096 to 49,152 basic time intervals.



5.7 Physical random access channel

5.7.1 Time and frequency structure

The physical layer random access preamble, illustrated in Figure 5.7.1-1, consists of a cyclic prefix of length T_{CP} and a sequence part of length T_{SEQ}. The parameter values are listed in Table 5.7.1-1 and depend on the frame structure and the random access configuration. Higher layers control the preamble format.

Figure 5.7.1-1: Random access preamble format.

US Patent No. 10,833,908: Claim 21(d)
"wherein a time duration of a combination of the random access signal and the guard period is greater than a time duration of at least one of the plurality of OFDM symbols; and"

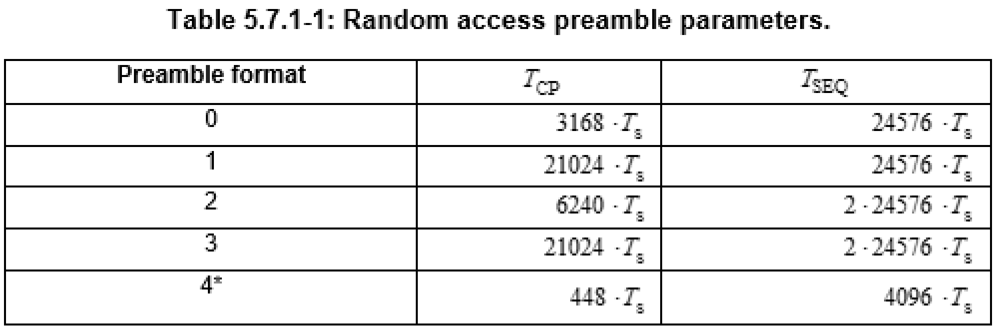


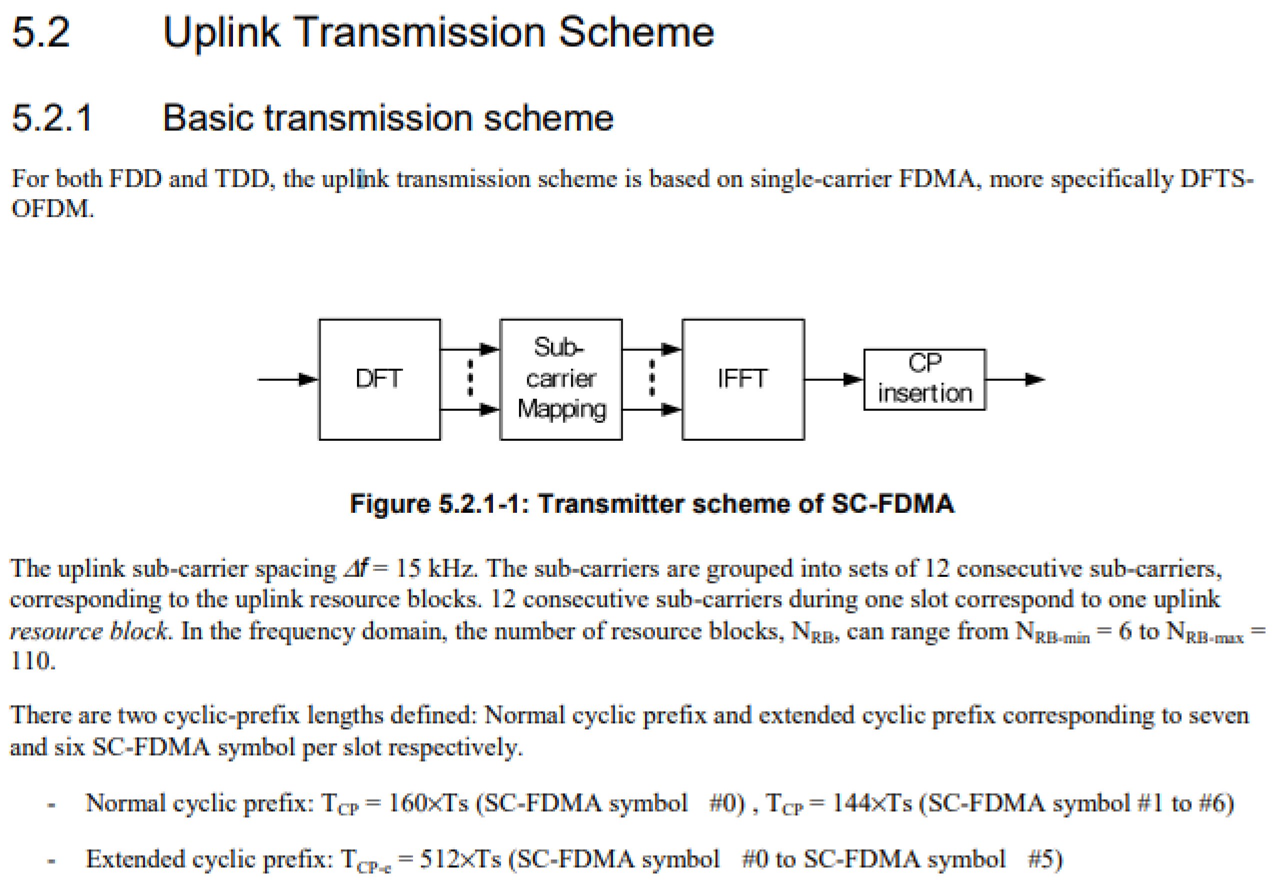
Table 5.7.1-1: Random access preamble parameters.

Preamble format	T_{CP}	T_{SEQ}
0	$3168 \cdot T_s$	$24576 \cdot T_s$
1	$21024 \cdot T_s$	$24576 \cdot T_s$
2	$6240 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
3	$21024 \cdot T_s$	$2 \cdot 24576 \cdot T_s$
4*	$448 \cdot T_s$	$4096 \cdot T_s$

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 33.

US Patent No. 10,833,908: Claim 21(e)

“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;	FCA’s Accused Instrumentalities include a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal. *E.g.*, FCA’s Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuitry includes an analog to digital circuit to output a digital signal and a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 21(e)
“a circuit configured to provide at least the first uplink signal or the random access signal to output a digital signal; a digital-to-analog (D/A) conversion circuit configured to convert the digital signal to an analog signal;”

14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

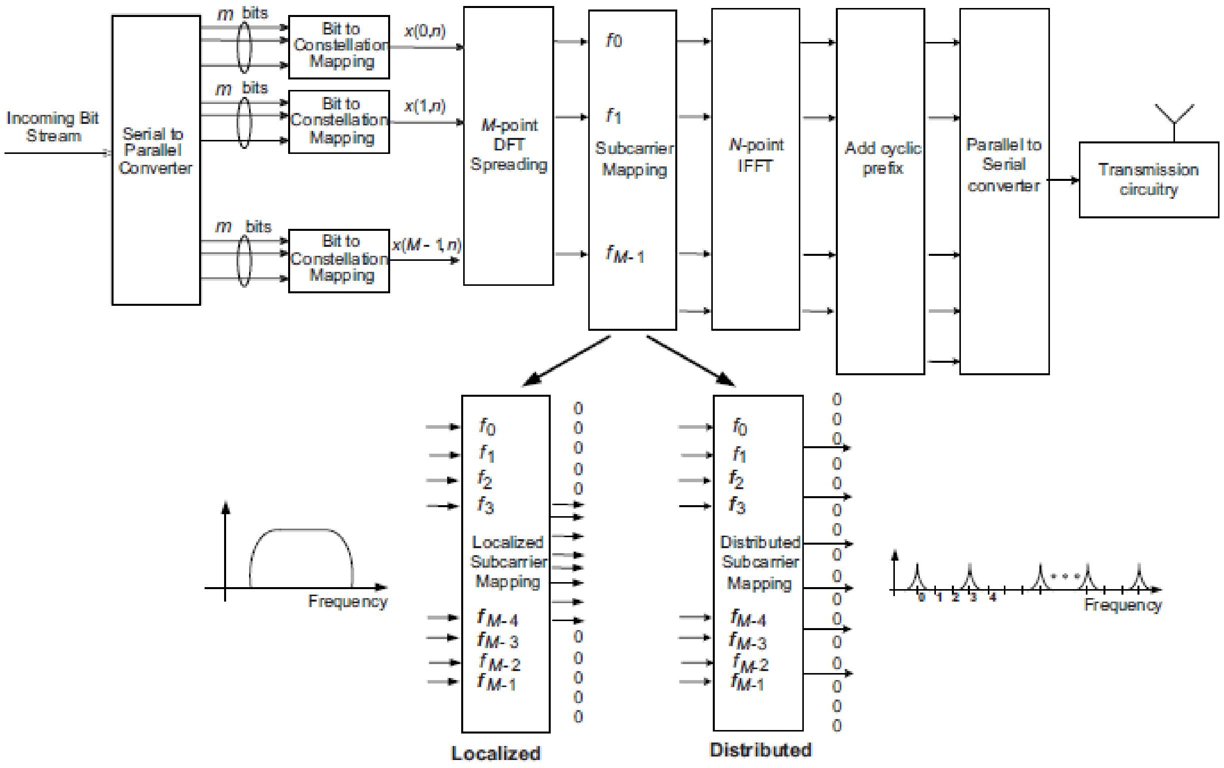


Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

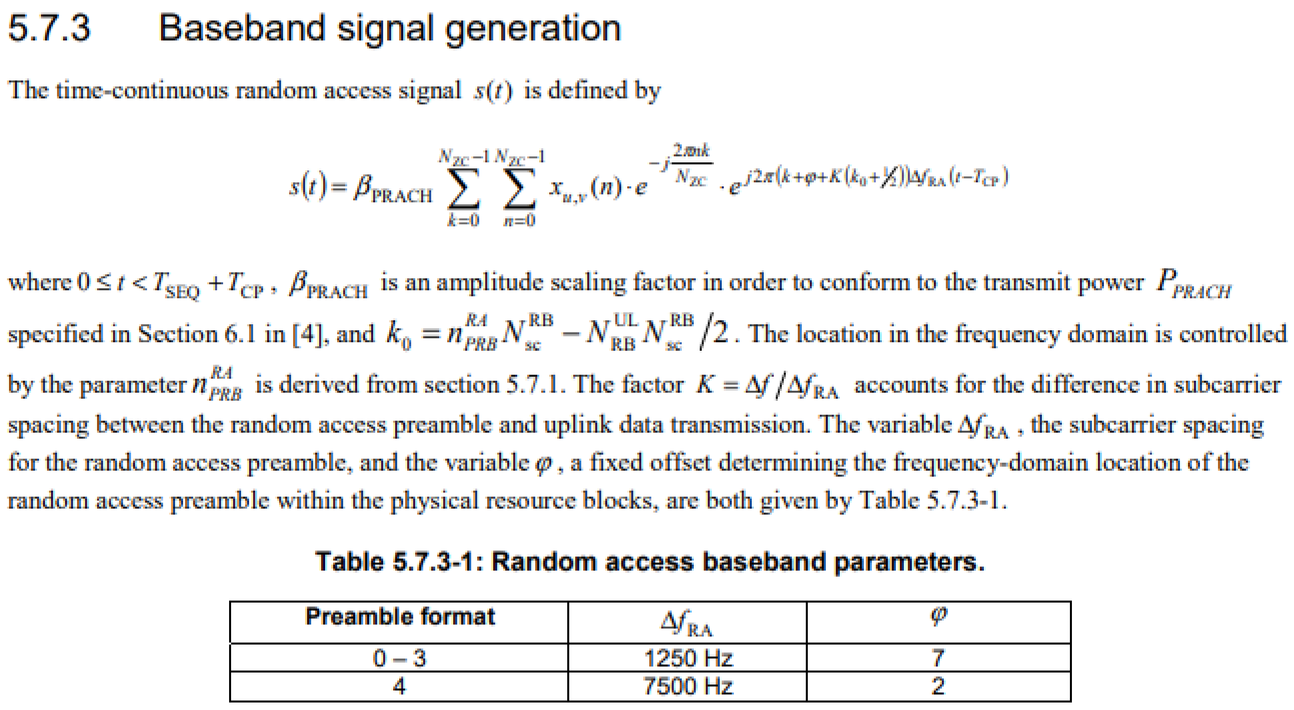
See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 320.

US Patent No. 10,833,908: Claim 21(f)
"wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band"

<table>
<tr>
<td>wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band;</td>
<td>

FCA's Accused Instrumentalities are configured to transmit wherein the mobile station is configured to transmit, to the base station, the analog signal in a frequency band, wherein the random access signal occupies in a frequency domain only a portion of the frequency band. *E.g.*,

Random access signals are generated only for a portion of the frequency spectrum of an uplink.



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{ZC}-1}\sum_{n=0}^{N_{ZC}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{ZC}}}\cdot e^{j2\pi\left(k+\varphi+K\left(k_0+\frac{1}{2}\right)\right)\Delta f_{\text{RA}}\left(t-T_{\text{CP}}\right)}$$

where $0\le t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

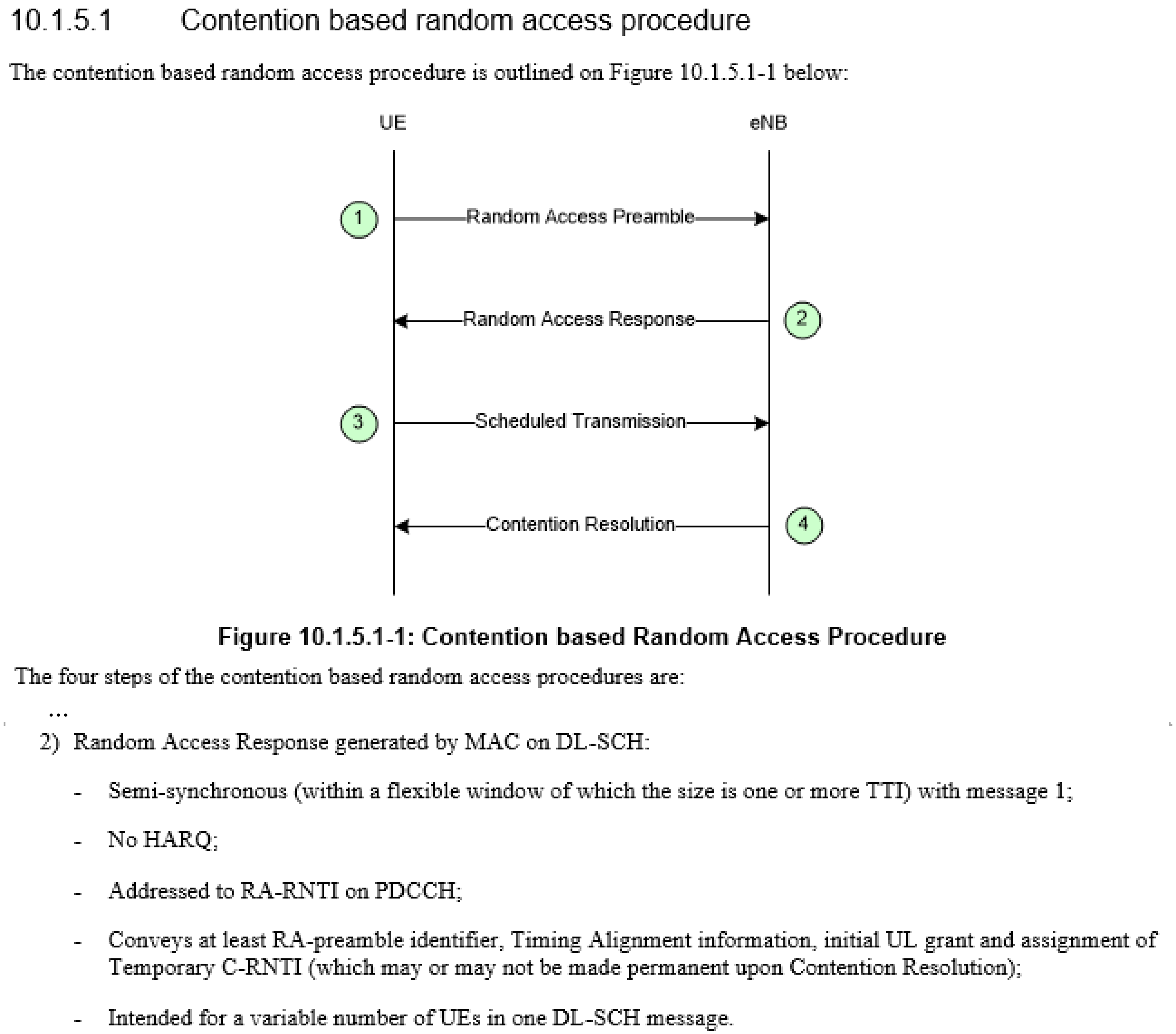
Table 5.7.3-1: Random access baseband parameters.

<table>
<tr><th>Preamble format</th><th>Δf_{RA}</th><th>φ</th></tr>
<tr><td>0 – 3</td><td>1250 Hz</td><td>7</td></tr>
<tr><td>4</td><td>7500 Hz</td><td>2</td></tr>
</table>

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

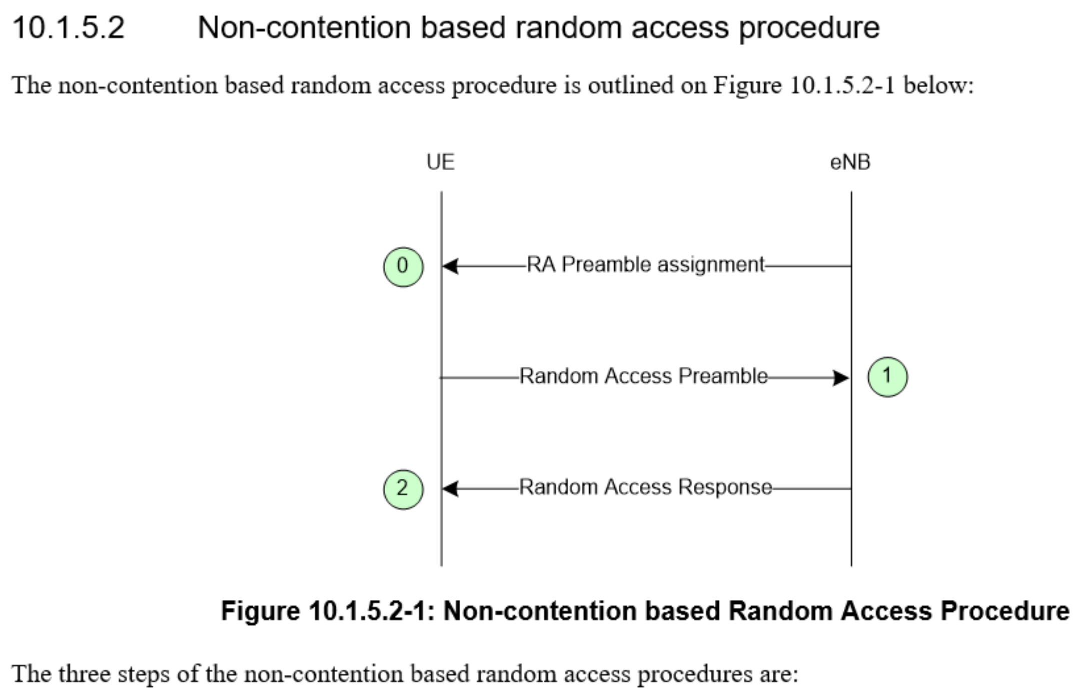
</td>
</tr>
</table>

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

wherein the mobile station is further configured to receive, from the base station, a second analog signal	FCA's Accused Instrumentalities receive, from the base station, a second analog signal. *E.g.*, Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: … 2) Random Access Response generated by MAC on DL-SCH: - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1; - No HARQ; - Addressed to RA-RNTI on PDCCH; - Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution); - Intended for a variable number of UEs in one DL-SCH message.

US Patent No. 10,833,908: Claim 21(g)
“wherein the mobile station is further configured to receive, from the base station, a second analog signal”

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



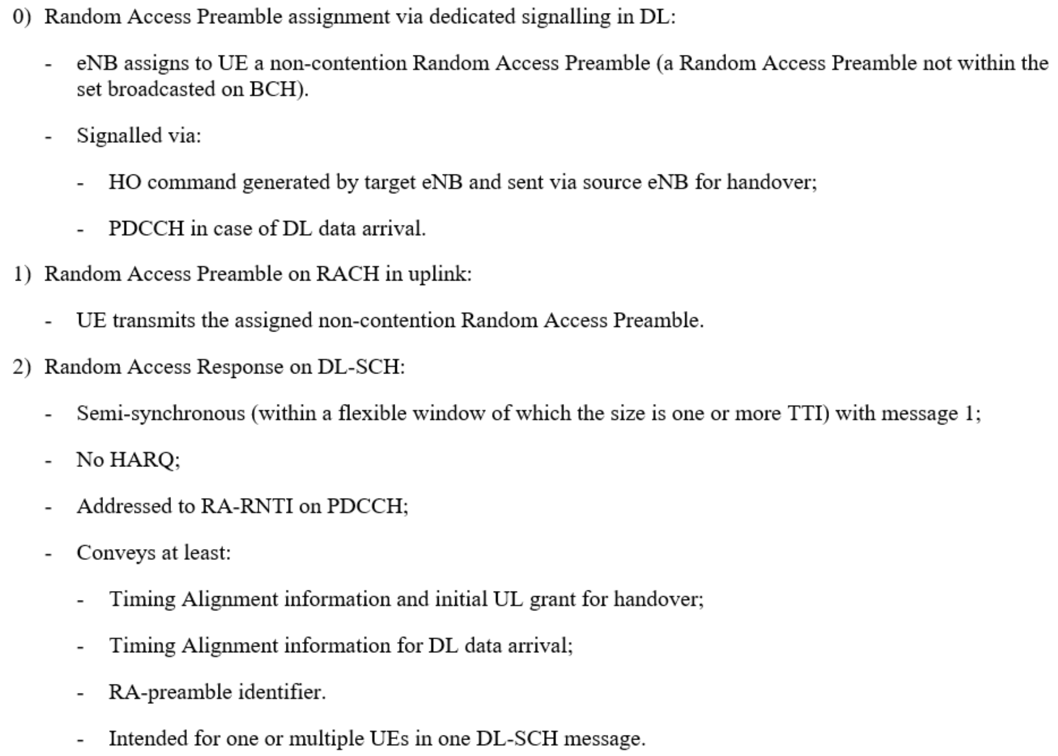
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

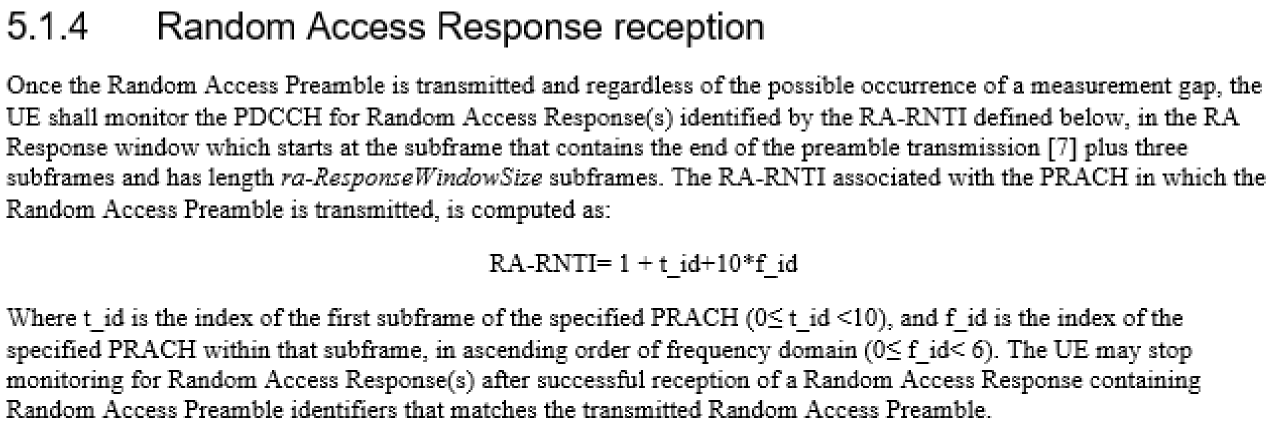
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



5.1.4 Random Access Response reception

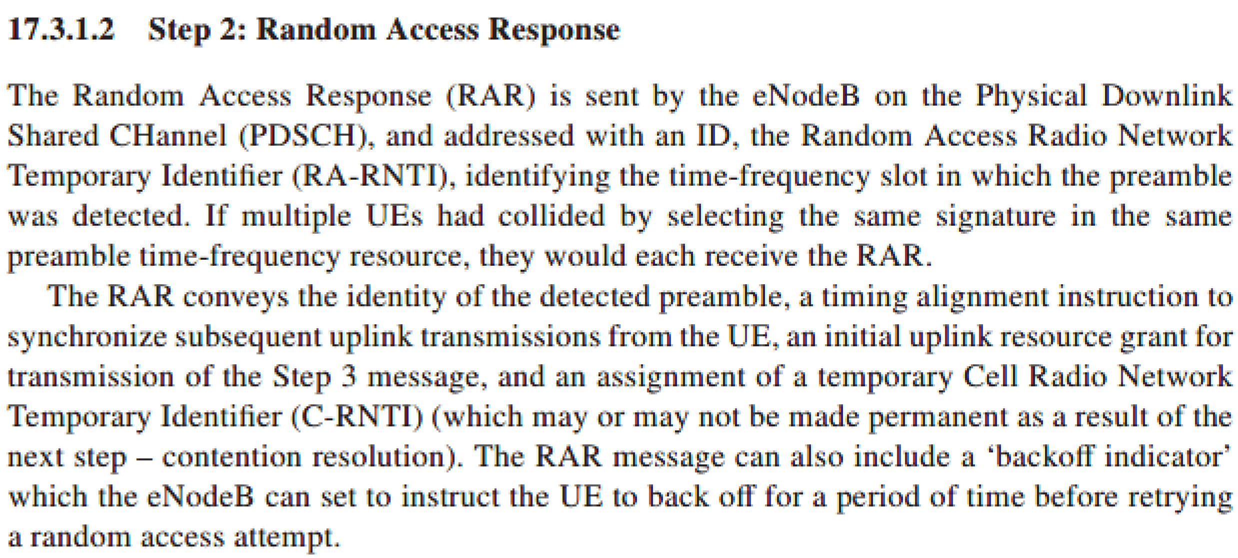
Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$RA\text{-}RNTI= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0\leq t\_id <10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0\leq f\_id< 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

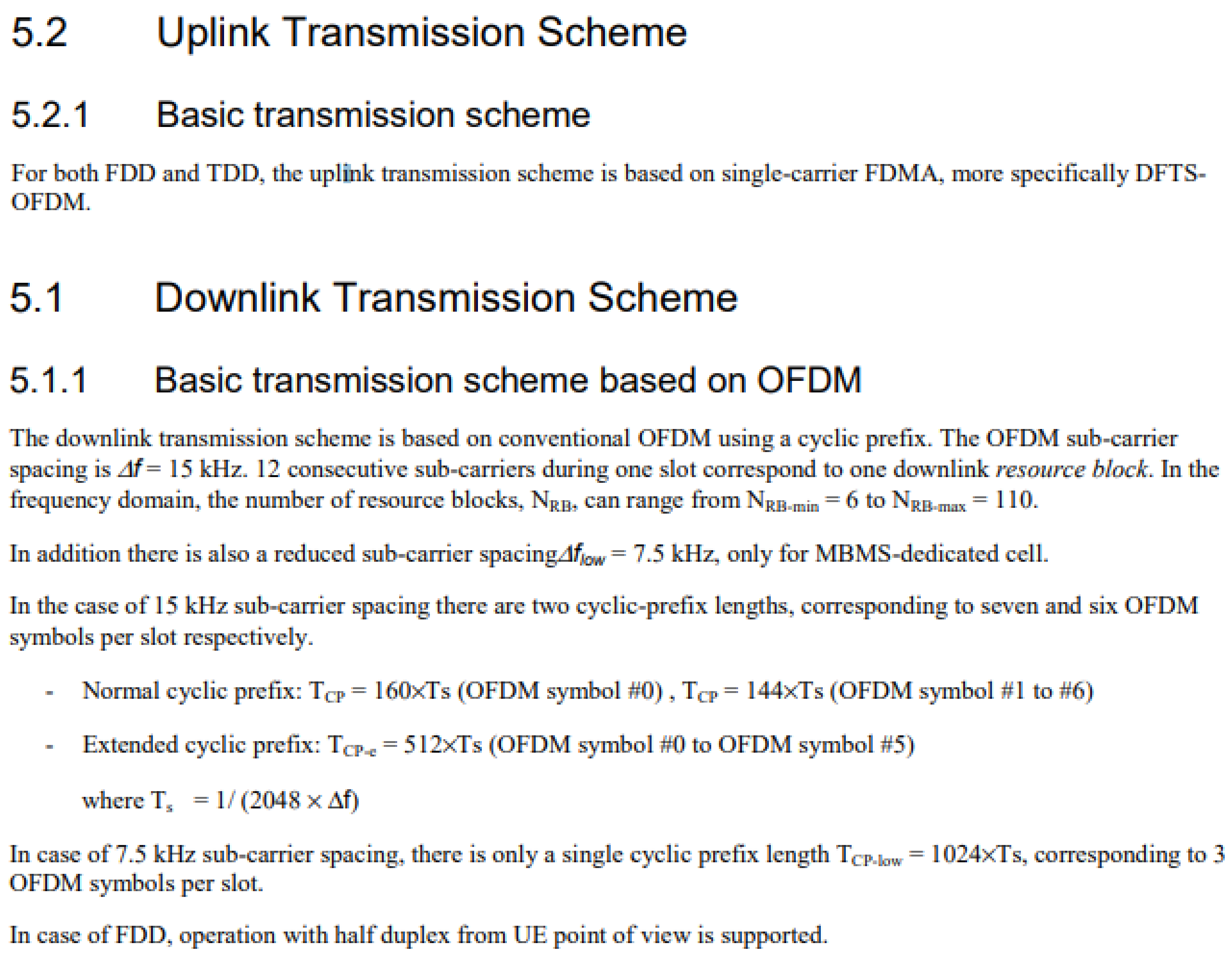
See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 21(g)
"wherein the mobile station is further configured to receive, from the base station, a second analog signal"

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.	FCA's Accused Instrumentalities further include an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal and a receiver circuit configured to receive, based on the second digital signal, a response message. *E.g.*, FCA's Accused Instrumentalities implement at least these circuit elements for transmitting an uplink signal. The circuit includes an analog to digital circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. 5.1 Downlink Transmission Scheme 5.1.1 Basic transmission scheme based on OFDM The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell. In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively. - Normal cyclic prefix: T_{CP} = 160×Ts (OFDM symbol #0) , T_{CP} = 144×Ts (OFDM symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (OFDM symbol #0 to OFDM symbol #5) where $T_s = 1/(2048 \times \Delta f)$ In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low}$ = 1024×Ts, corresponding to 3 OFDM symbols per slot. In case of FDD, operation with half duplex from UE point of view is supported.

See e.g., 3GPP TS 36.300 V8.12.0 at pg. 25.

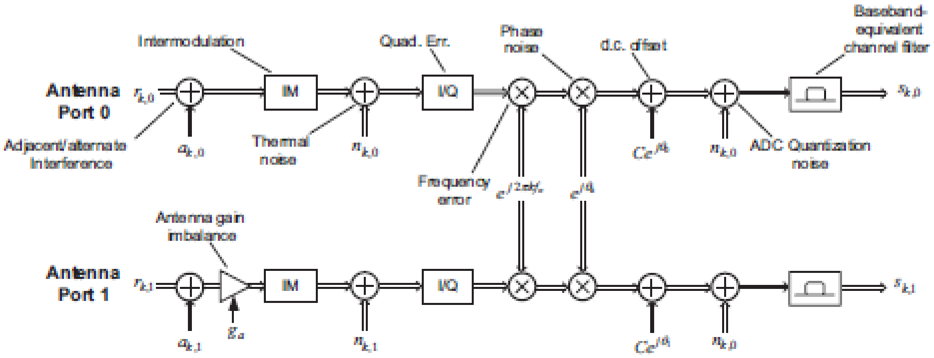


Figure 21.19: Model of multi-antenna receiver impairments. Reproduced by permission of © 2006 Motorola.

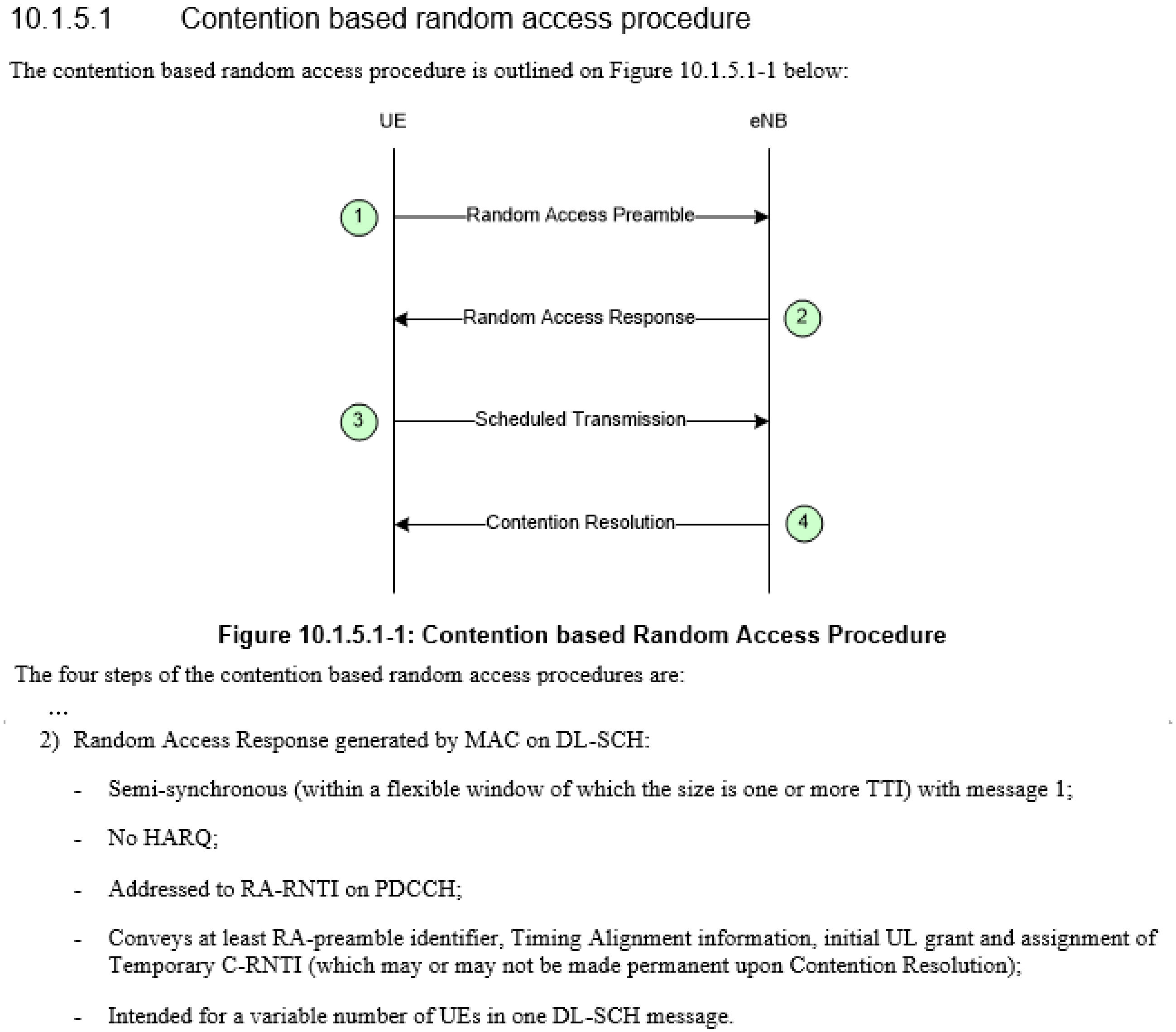
- **Quadrature error component:** as with the transmitter, this element models the loss of quadrature in the frequency conversion process. As an initial assumption, quadrature error may be neglected in eNodeB receivers, but is an essential element in direct conversion UE receiver modelling.
- **Frequency error:** the eNodeB receiver frequency error attributed to eNodeB LO error may be neglected since the UE uses the downlink waveform as a frequency reference. Clearly, in some circumstances there can be a significant frequency shift between the downlink signal received by the UE and the resulting uplink signal observed by the eNodeB.
- **Phase noise:** this corresponds to the eNodeB and UE LO phase noise process.
- **d.c. offset:** as for the transmitter model, this can arise due to LO leakage effects.
- **Analogue to Digital Converter (ADC):** similarly to the transmitter, this can be modelled as a quantization noise source.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

Once the Random Access Preamble is transmitted, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI. The random access response is sent by the eNB and received by the UE via the PDSCH and addresses with the RA-RNTI ID.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



10.1.5.1 Contention based random access procedure

The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

…

2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

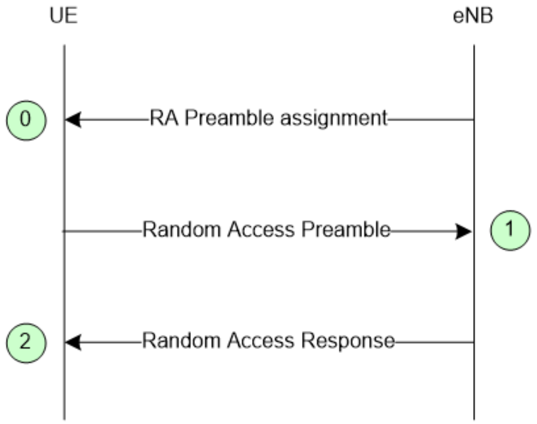
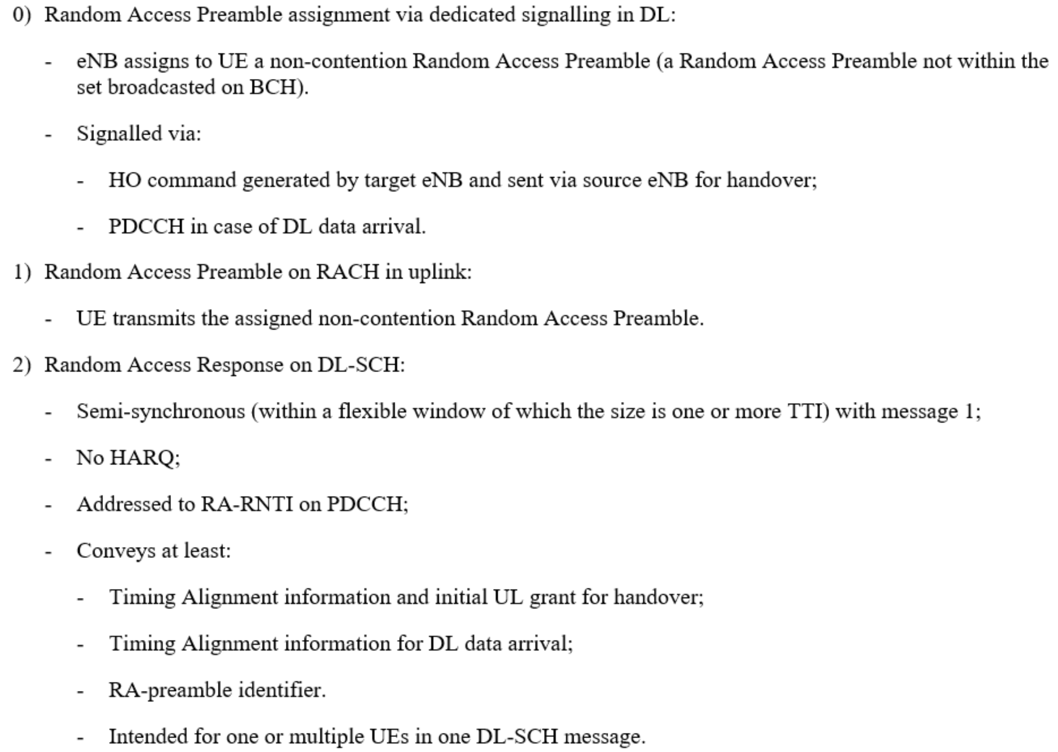


Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 21(h)

"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."



0) Random Access Preamble assignment via dedicated signalling in DL:

- eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
- Signalled via:
  - HO command generated by target eNB and sent via source eNB for handover;
  - PDCCH in case of DL data arrival.

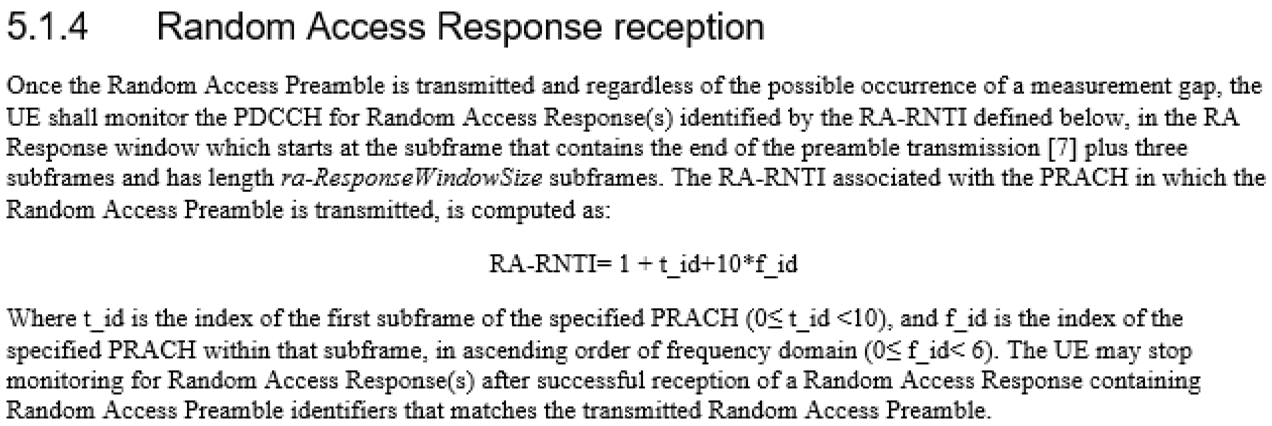
1) Random Access Preamble on RACH in uplink:

- UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least:
  - Timing Alignment information and initial UL grant for handover;
  - Timing Alignment information for DL data arrival;
  - RA-preamble identifier.
  - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



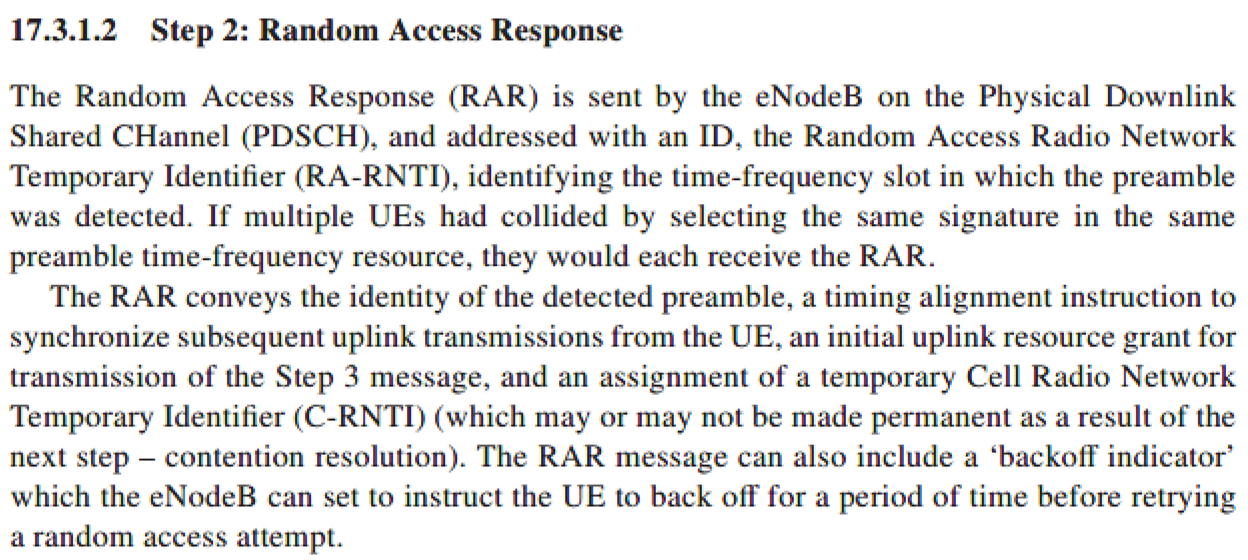
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI}= 1 + t\_id+10*f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

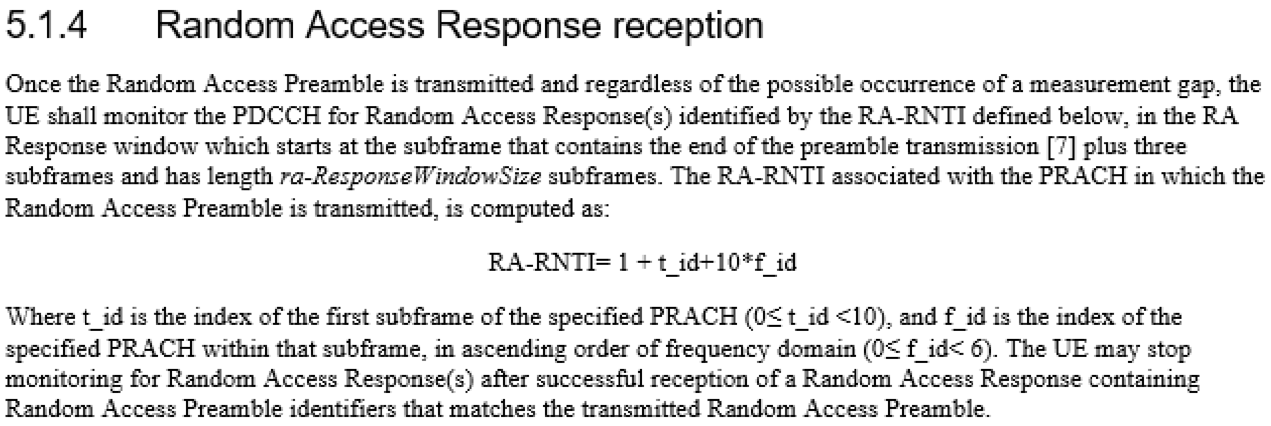
US Patent No. 10,833,908: Claim 21(h)
"wherein the mobile station further comprises: an analog-to-digital (A/D) conversion circuit configured to convert the second analog signal to a second digital signal; and a receiver circuit configured to receive, based on the second digital signal, a response message.."

	See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374.

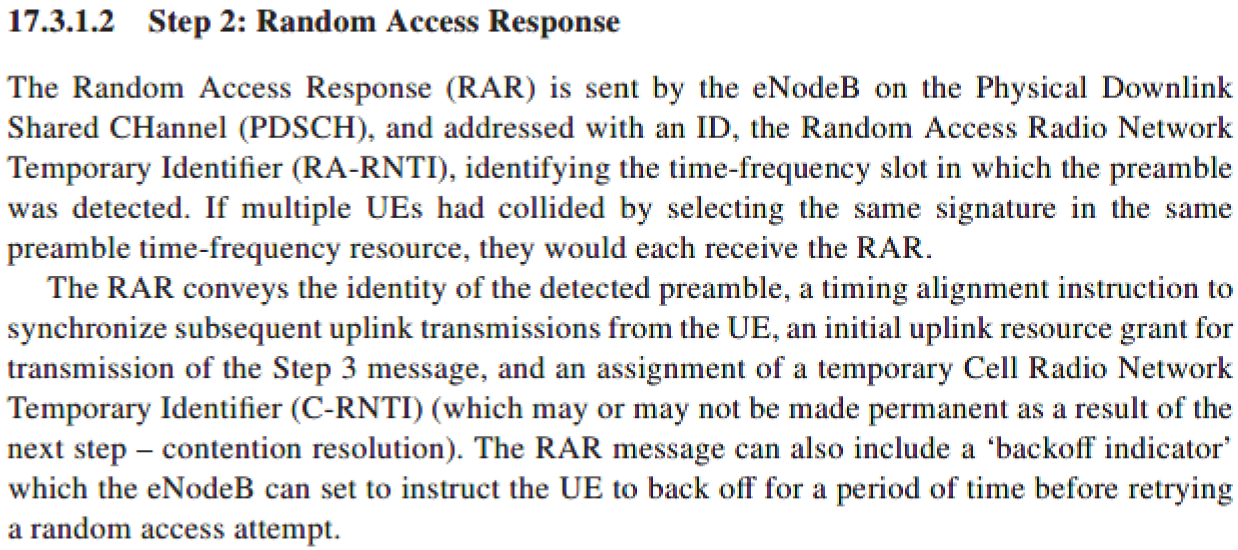
US Patent No. 10,833,908: Claim 22(a)
“The mobile station of claim 21, wherein:”

22. The mobile station of claim 21, wherein:	*See* Claim 21.

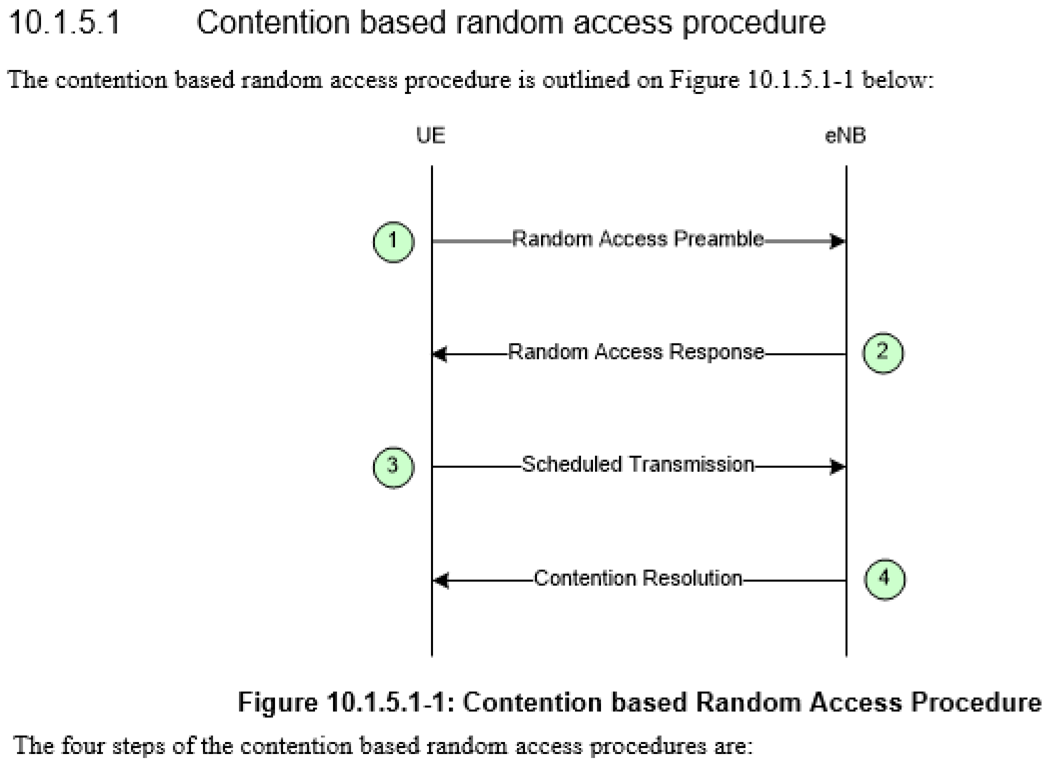
US Patent No. 10,833,908: Claim 22(b)
"the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and"

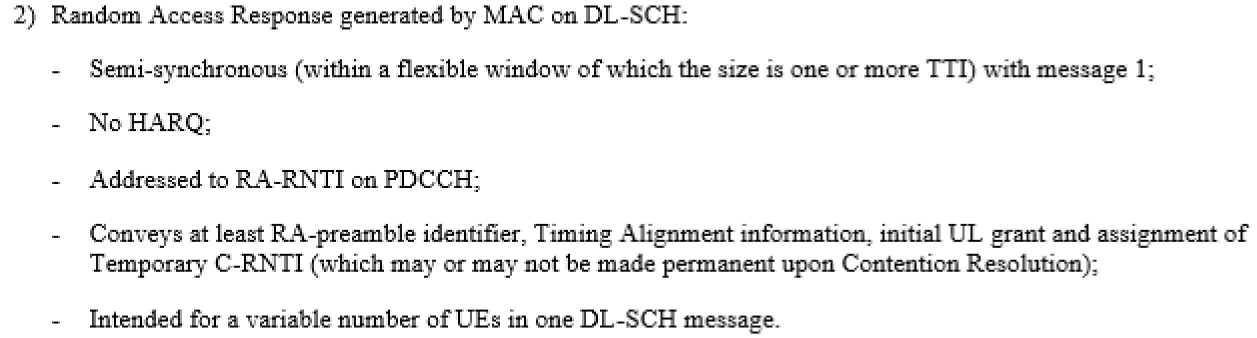
the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and	FCA's Accused Instrumentalities determines if the response message identifies the sequence associated with the base station in the random access signal. *E.g.,* The Accused Instrumentalities monitor for the response message and identify the random access preamble identifiers received in the response and whether they match the transmitted random access preamble.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$ Where t_id is the index of the first subframe of the specified PRACH ($0 \le t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \le f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

US Patent No. 10,833,908: Claim 22(b)
“the receiver circuit is configured to determine if the response message identifies the sequence associated with the base station in the random access signal; and”

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374. *See also* Claim 2.

US Patent No. 10,833,908: Claim 22(c)
"on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal."

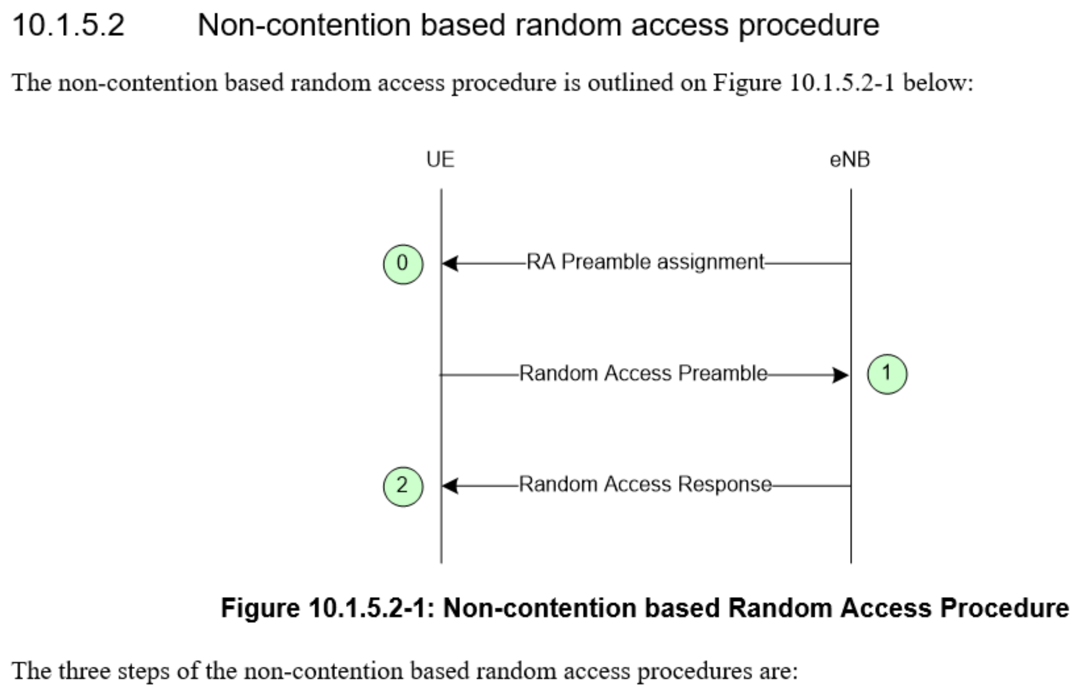
on a condition that the response message identifies the sequence associated with the base station in the random access signal, the first type of transmitter signal processing circuit is configured to transmit a second uplink signal.	On a condition that the response message identifies the sequence associated with the base station in the random access signal, FCA's Accused Instrumentalities transmits a second uplink signal. *E.g.,* When matching the transmitted random access preamble, the transmitter is configured to transmit a scheduled transmission, e.g., a Msg3 signal or an uplink control or data signal, in the uplink to the base station.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below: **Figure 10.1.5.1-1: Contention based Random Access Procedure** The four steps of the contention based random access procedures are: …



2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.



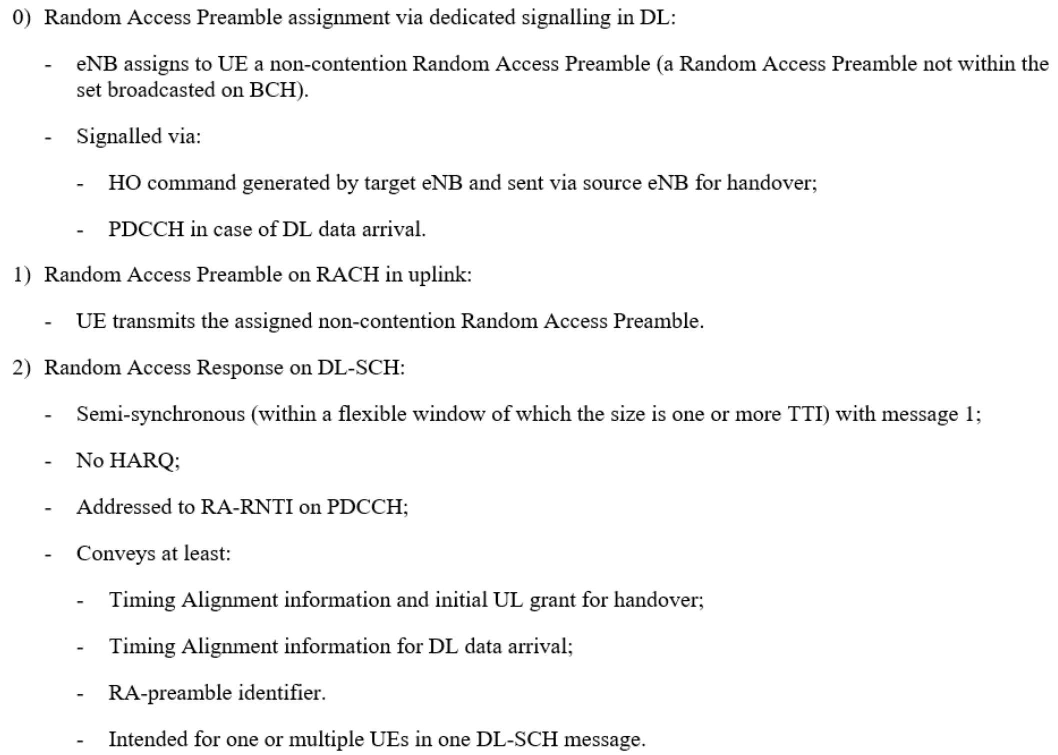
10.1.5.2 Non-contention based random access procedure

The non-contention based random access procedure is outlined on Figure 10.1.5.2-1 below:

Figure 10.1.5.2-1: Non-contention based Random Access Procedure

The three steps of the non-contention based random access procedures are:

US Patent No. 10,833,908: Claim 22(c)
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

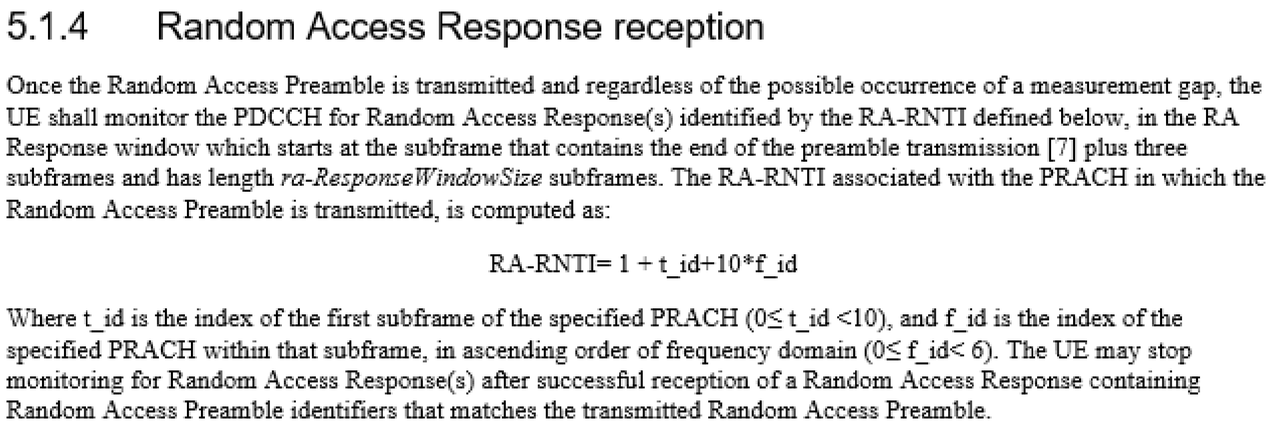


0) Random Access Preamble assignment via dedicated signalling in DL:
  - eNB assigns to UE a non-contention Random Access Preamble (a Random Access Preamble not within the set broadcasted on BCH).
  - Signalled via:
    - HO command generated by target eNB and sent via source eNB for handover;
    - PDCCH in case of DL data arrival.

1) Random Access Preamble on RACH in uplink:
  - UE transmits the assigned non-contention Random Access Preamble.

2) Random Access Response on DL-SCH:
  - Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
  - No HARQ;
  - Addressed to RA-RNTI on PDCCH;
  - Conveys at least:
    - Timing Alignment information and initial UL grant for handover;
    - Timing Alignment information for DL data arrival;
    - RA-preamble identifier.
    - Intended for one or multiple UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.7.0 at pgs. 54 and 55.



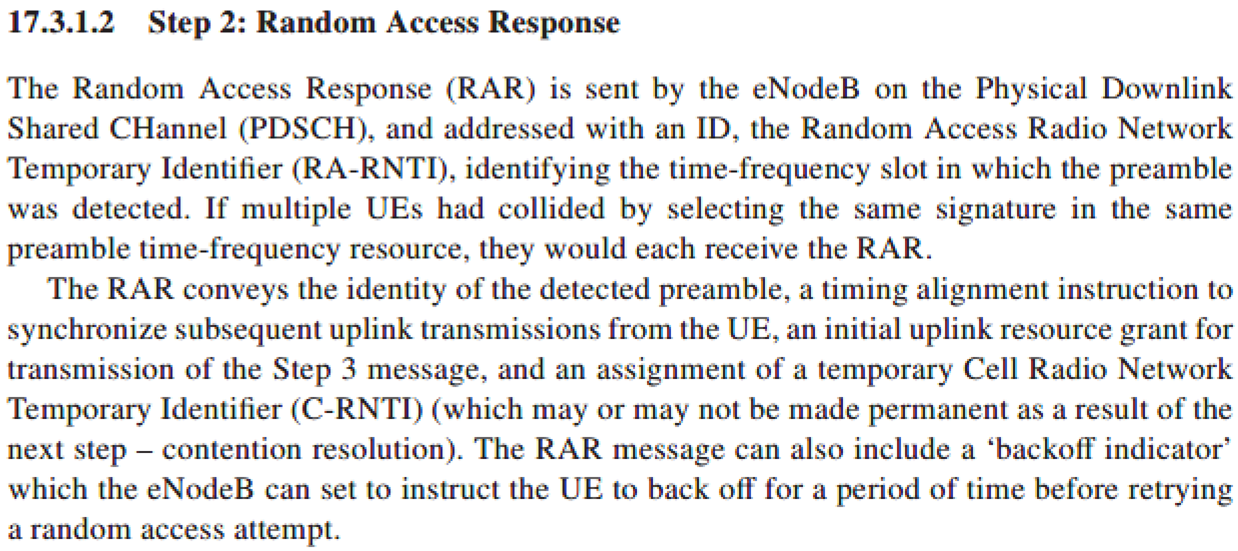
5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

$$\text{RA-RNTI} = 1 + t\_id + 10 * f\_id$$

Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t\_id < 10$), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain ($0 \leq f\_id < 6$). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a ‘backoff indicator’ which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 374.

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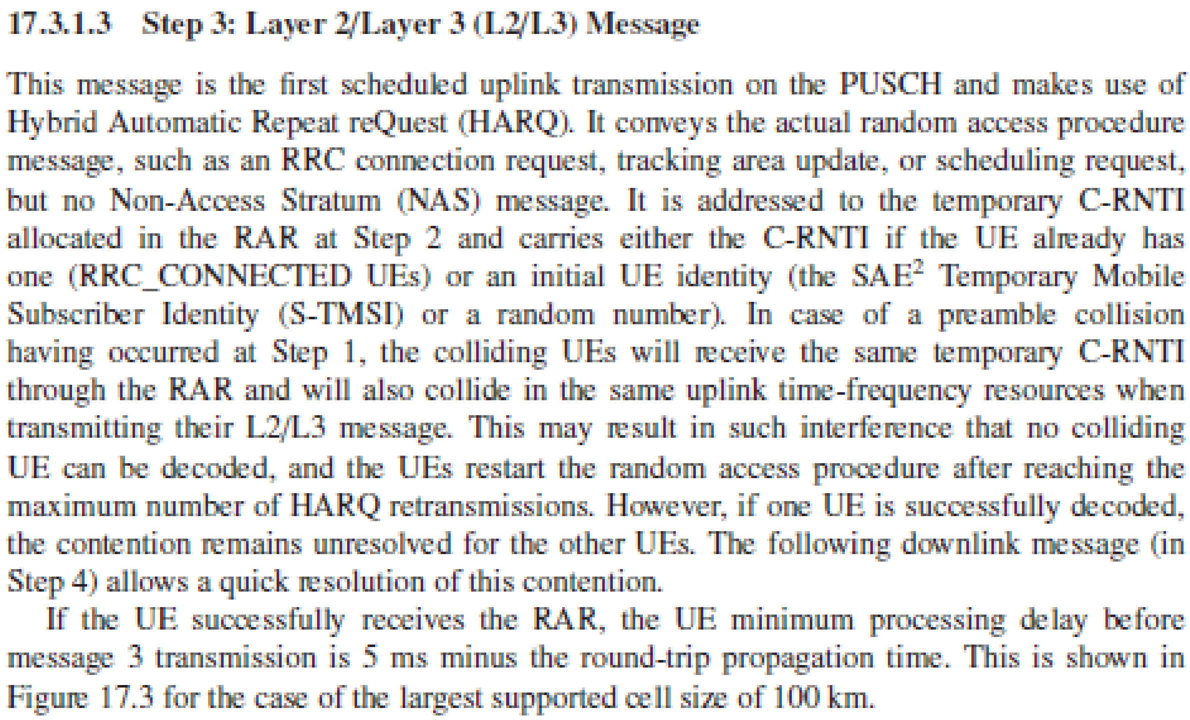
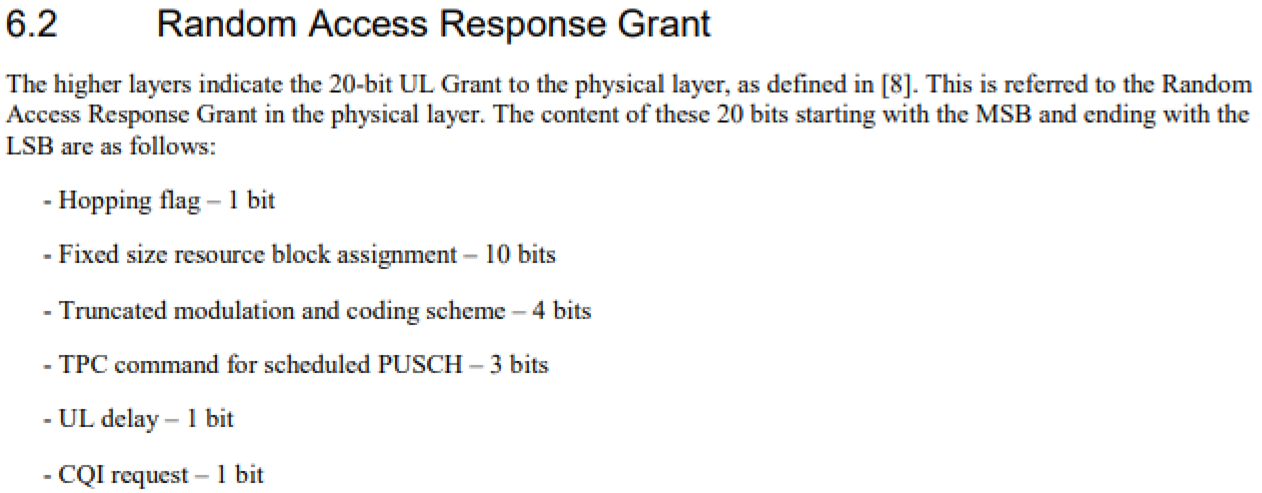
“on a condition that the response message identifies the sequence associated with the base station in the random access signal, transmitting a second uplink signal.”

	 **17.3.1.3 Step 3: Layer 2/Layer 3 (L2/L3) Message** This message is the first scheduled uplink transmission on the PUSCH and makes use of Hybrid Automatic Repeat reQuest (HARQ). It conveys the actual random access procedure message, such as an RRC connection request, tracking area update, or scheduling request, but no Non-Access Stratum (NAS) message. It is addressed to the temporary C-RNTI allocated in the RAR at Step 2 and carries either the C-RNTI if the UE already has one (RRC_CONNECTED UEs) or an initial UE identity (the SAE[2] Temporary Mobile Subscriber Identity (S-TMSI) or a random number). In case of a preamble collision having occurred at Step 1, the colliding UEs will receive the same temporary C-RNTI through the RAR and will also collide in the same uplink time-frequency resources when transmitting their L2/L3 message. This may result in such interference that no colliding UE can be decoded, and the UEs restart the random access procedure after reaching the maximum number of HARQ retransmissions. However, if one UE is successfully decoded, the contention remains unresolved for the other UEs. The following downlink message (in Step 4) allows a quick resolution of this contention. If the UE successfully receives the RAR, the UE minimum processing delay before message 3 transmission is 5 ms minus the round-trip propagation time. This is shown in Figure 17.3 for the case of the largest supported cell size of 100 km. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 375. *See also* Claim 2.

US Patent No. 10,833,908: Claim 23(a)
“The mobile station of claim 22, wherein the response message includes power adjustment information and”

23. The mobile station of claim 22, wherein the response message includes power adjustment information and	The response message received by FCA’s Accused Instrumentalities includes power adjustment information. *E.g.,* *See* Claim 22. The response message can include an uplink grant with power adjustment information, such as TPC:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right)\right\rceil - 10\right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

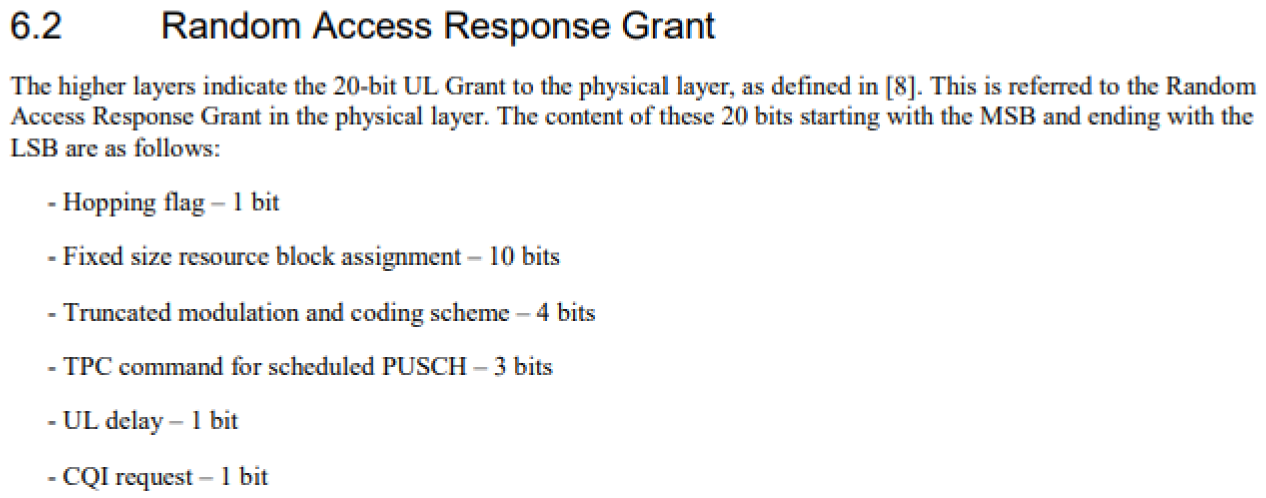
Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

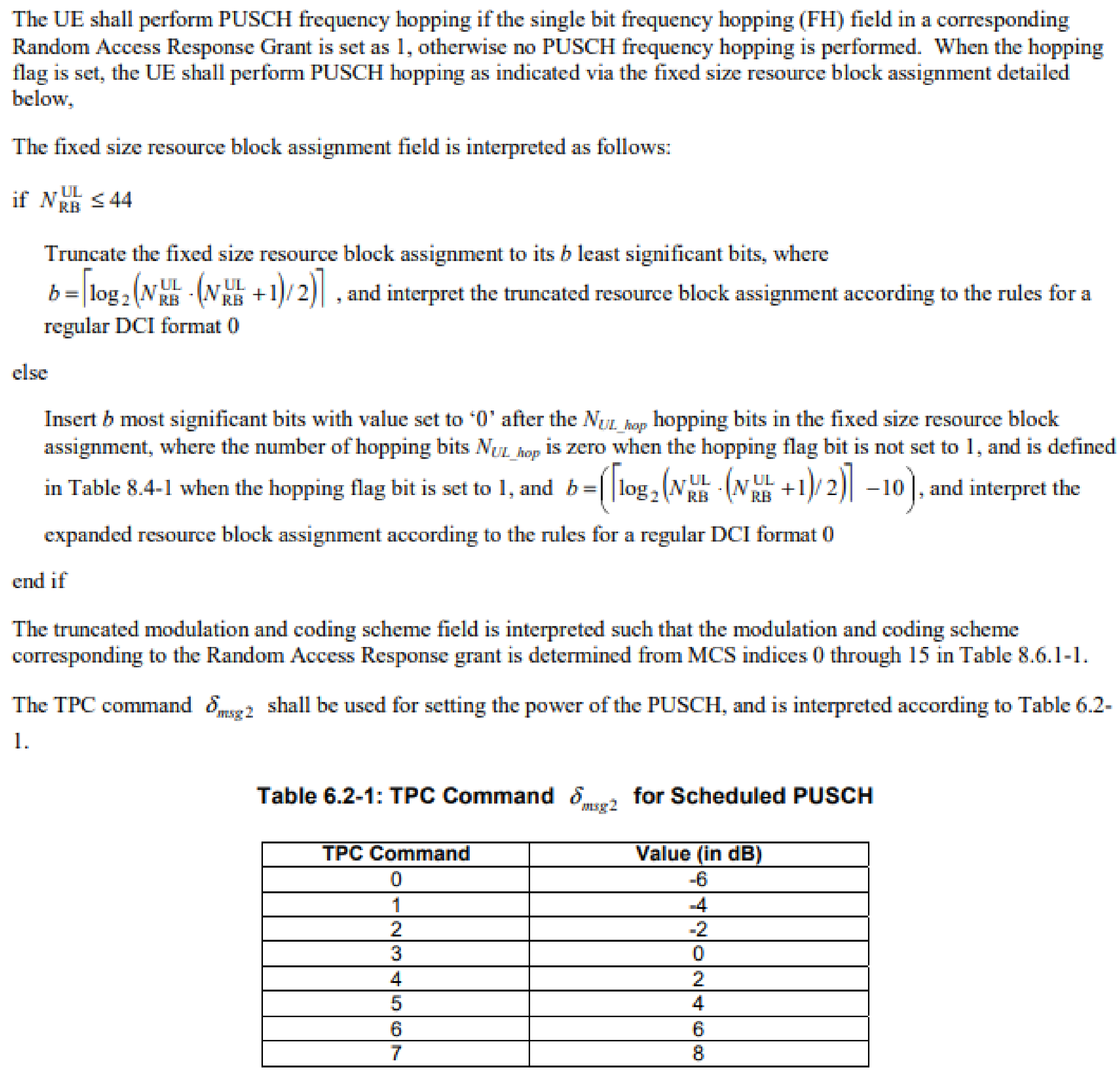
See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 23(b)
"wherein the second uplink signal is transmitted according to the power adjustment information"

wherein the first type of transmitter signal processing circuit is configured to transmit the second uplink signal according to the power adjustment information.	FCA's Accused Instrumentalities transmits the second uplink signal according to the power adjustment information. *E.g.,* The user equipment is configured to use the uplink grant on the PUSCH using the received TPC command:  6.2 Random Access Response Grant The higher layers indicate the 20-bit UL Grant to the physical layer, as defined in [8]. This is referred to the Random Access Response Grant in the physical layer. The content of these 20 bits starting with the MSB and ending with the LSB are as follows: - Hopping flag – 1 bit - Fixed size resource block assignment – 10 bits - Truncated modulation and coding scheme – 4 bits - TPC command for scheduled PUSCH – 3 bits - UL delay – 1 bit - CQI request – 1 bit

US Patent No. 10,833,908: Claim 23(b)
“wherein the second uplink signal is transmitted according to the power adjustment information”



The UE shall perform PUSCH frequency hopping if the single bit frequency hopping (FH) field in a corresponding Random Access Response Grant is set as 1, otherwise no PUSCH frequency hopping is performed. When the hopping flag is set, the UE shall perform PUSCH hopping as indicated via the fixed size resource block assignment detailed below,

The fixed size resource block assignment field is interpreted as follows:

if $N_{\mathrm{RB}}^{\mathrm{UL}} \leq 44$

Truncate the fixed size resource block assignment to its b least significant bits, where $b = \left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil$, and interpret the truncated resource block assignment according to the rules for a regular DCI format 0

else

Insert b most significant bits with value set to ‘0’ after the N_{UL_hop} hopping bits in the fixed size resource block assignment, where the number of hopping bits N_{UL_hop} is zero when the hopping flag bit is not set to 1, and is defined in Table 8.4-1 when the hopping flag bit is set to 1, and $b = \left(\left\lceil \log_2\left(N_{\mathrm{RB}}^{\mathrm{UL}} \cdot \left(N_{\mathrm{RB}}^{\mathrm{UL}} + 1\right)/2\right) \right\rceil - 10 \right)$, and interpret the expanded resource block assignment according to the rules for a regular DCI format 0

end if

The truncated modulation and coding scheme field is interpreted such that the modulation and coding scheme corresponding to the Random Access Response grant is determined from MCS indices 0 through 15 in Table 8.6.1-1.

The TPC command δ_{msg2} shall be used for setting the power of the PUSCH, and is interpreted according to Table 6.2-1.

Table 6.2-1: TPC Command δ_{msg2} for Scheduled PUSCH

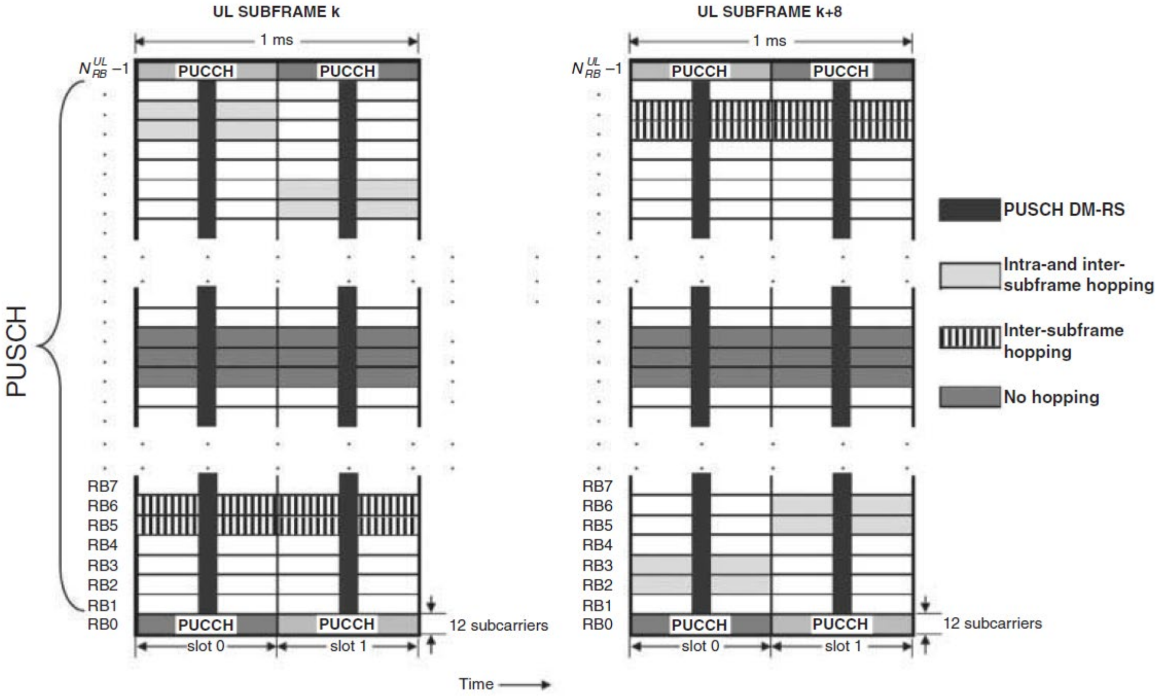
TPC Command	Value (in dB)
0	-6
1	-4
2	-2
3	0
4	2
5	4
6	6
7	8

See e.g., 3GPP TS 36.213 V8.8.0 at pgs. 17-18.

See also Claim 3.

US Patent No. 10,833,908: Claim 24

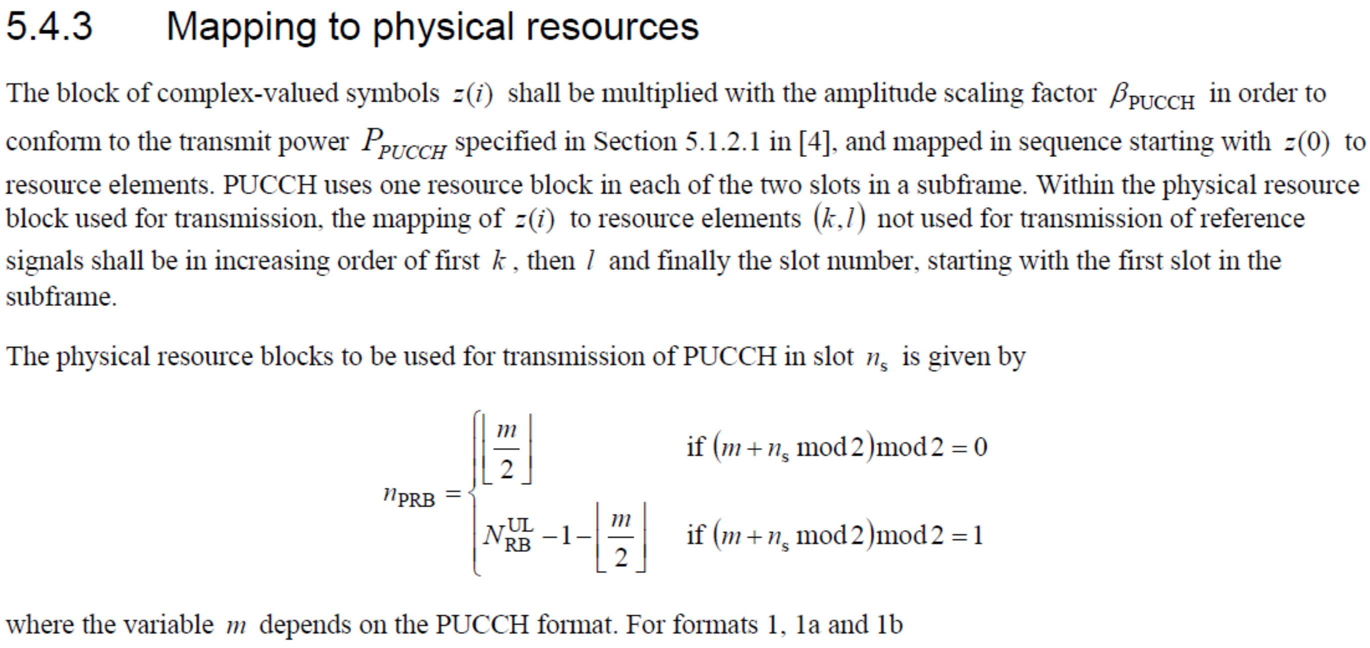
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

24. The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.	The portion of the frequency band used for transmission of the random access signal by FCA’s Accused Instrumentalities does not include control channels. *E.g.,* *See* Claim 21. The uplink control channels, such as the PUCCH, does not overlap with the PRACH or other random access signaling, e.g., via the PUSCH.  Figure 16.3: Uplink physical data channel processing. See Sesia, Toufik and Baker, “LTE: The UMTS Long Term Evolution From Theory to Practice”, at pg. 347. *See also id.* at Chapter 16 (“Uplink Physical Channel Structure”).

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

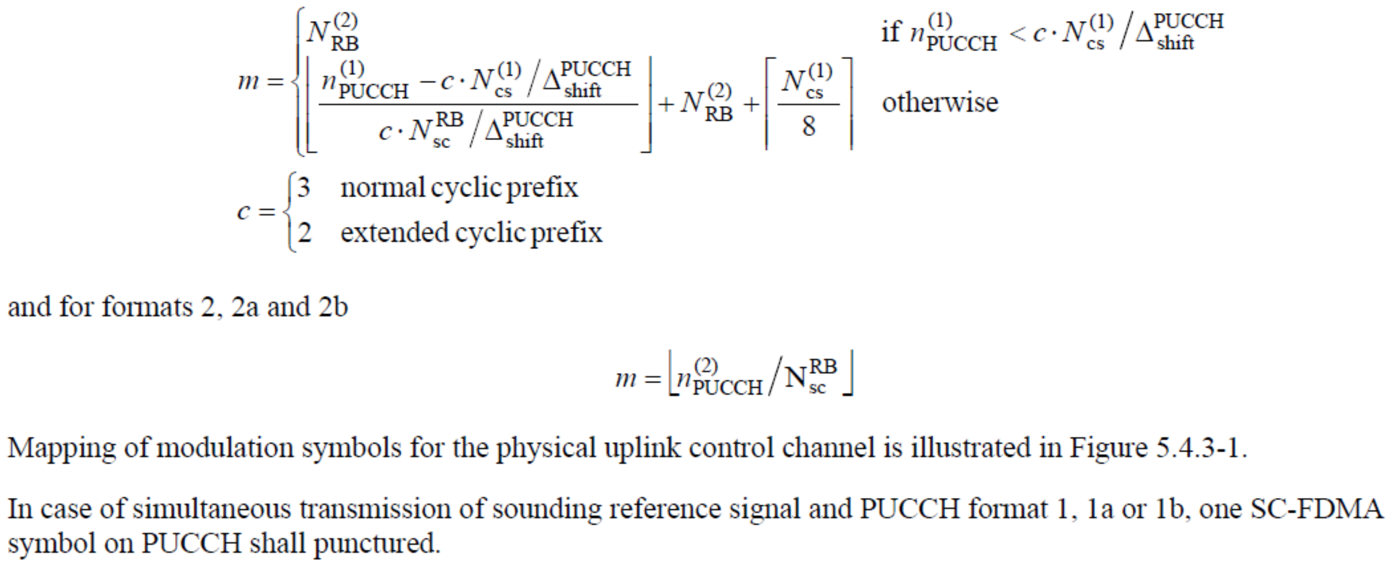
The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 24

“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

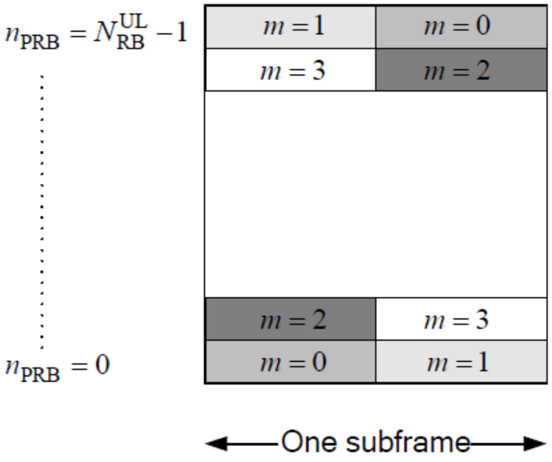


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

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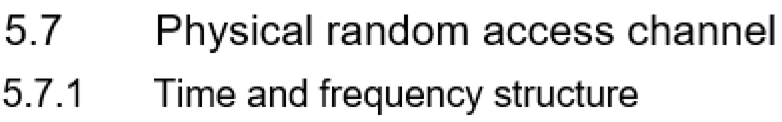
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

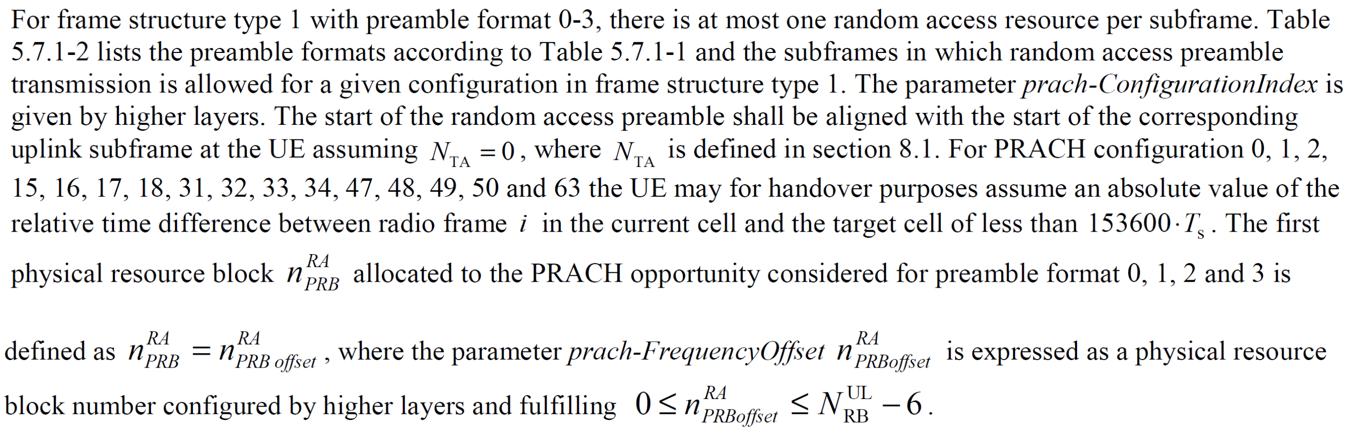
determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

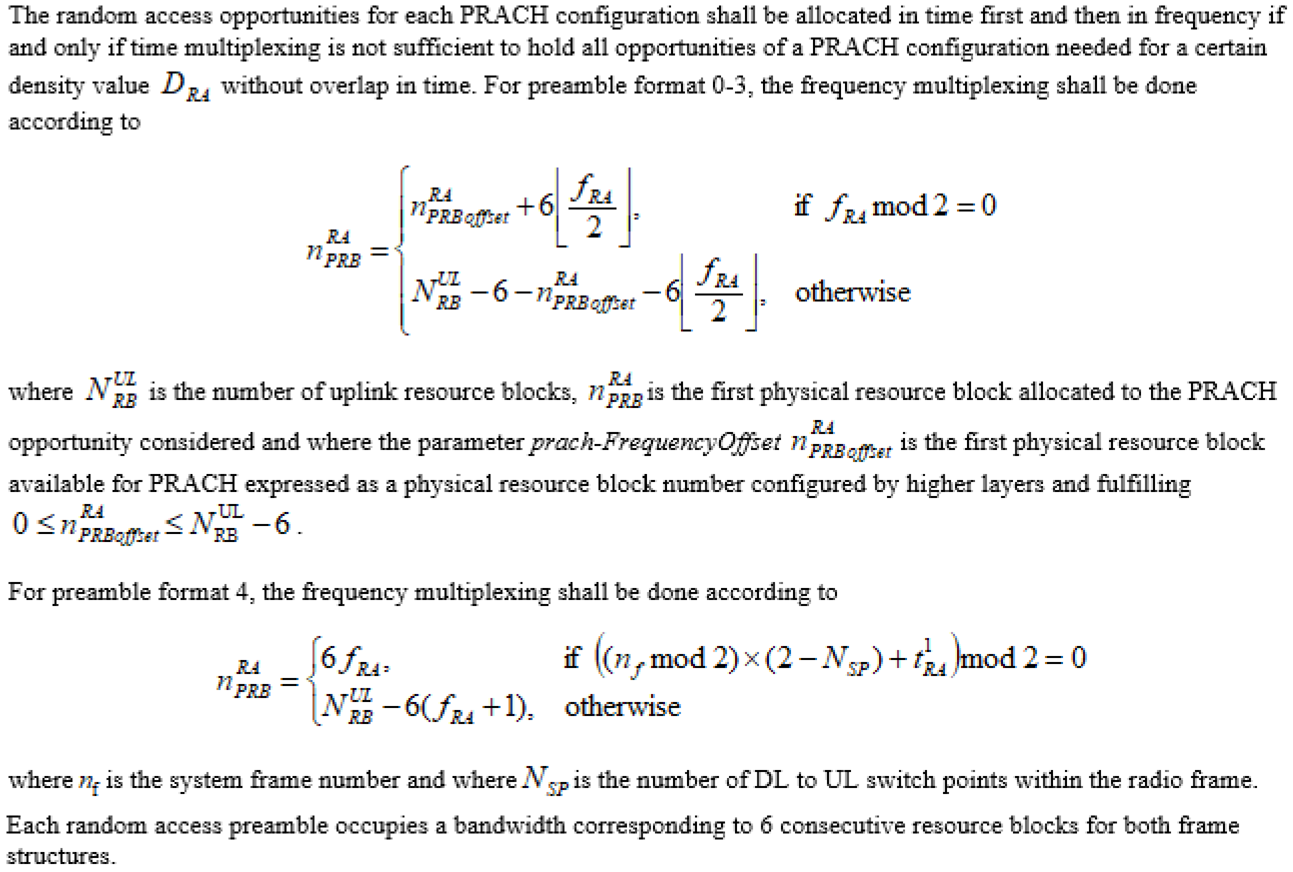
…



For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_{\mathrm{s}}$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{\mathrm{UL}}_{\mathrm{RB}} - 6$.

…

US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

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“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\mathrm{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\mathrm{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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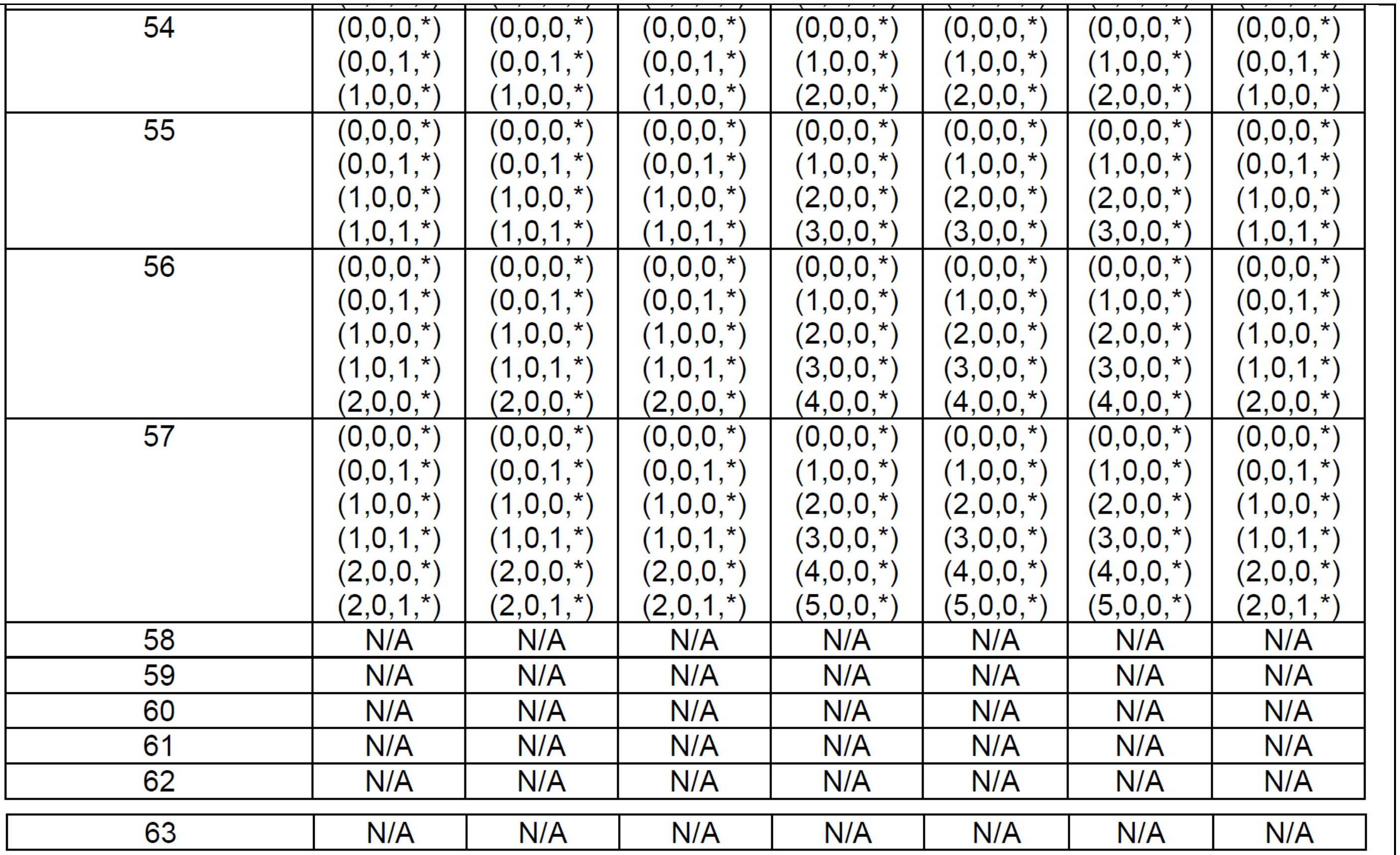
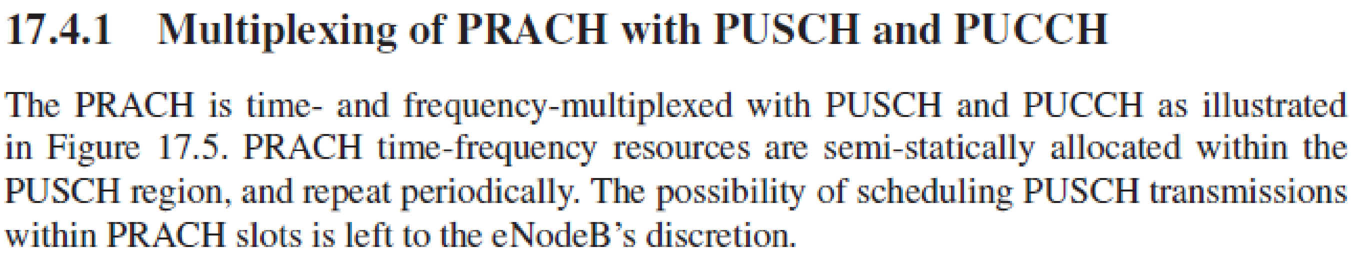
US Patent No. 10,833,908: Claim 24
“ The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels.”



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

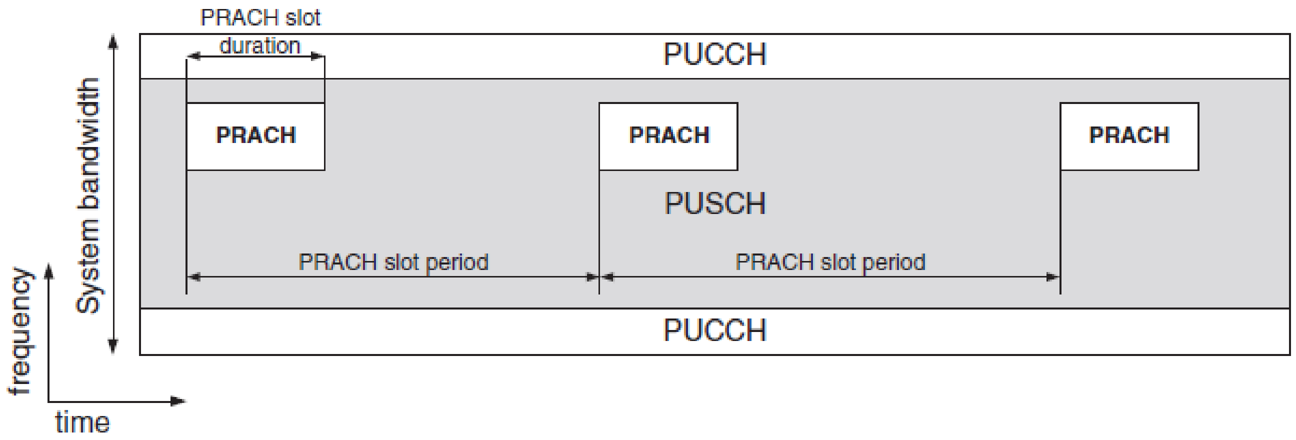
See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.



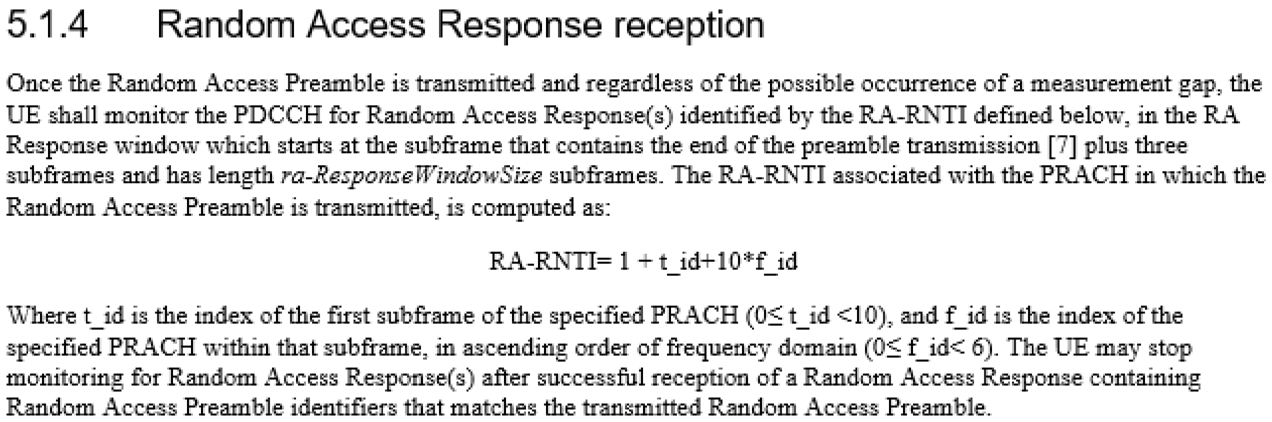
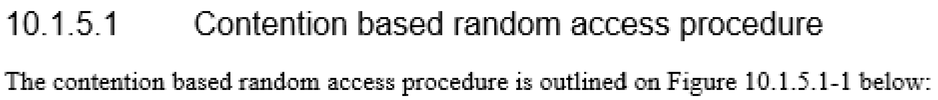
17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB’s discretion.

" The mobile station of claim 21, wherein the portion of the frequency band used for transmission of the random access signal does not include control channels."

	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 4.

US Patent No. 10,833,908: Claim 25
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station.	The response message received by the receiver of FCA's Accused Instrumentalities includes a mobile station identifier assigned to the mobile station. *E.g.,* *See* Claim 21. The response message is both addressed by a Random Access Radio Network Temporary Identifier (RA-RNTI) used by the mobile station and further assigns a Cell Radio Network Temporary Identifier (C-RNTI) to the receiving mobile station, both identifiers assigned to the mobile station.  5.1.4 Random Access Response reception Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the UE shall monitor the PDCCH for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission [7] plus three subframes and has length *ra-ResponseWindowSize* subframes. The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: RA-RNTI= 1 + t_id+10*f_id Where t_id is the index of the first subframe of the specified PRACH (0≤ t_id <10), and f_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f_id< 6). The UE may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble. See e.g., 3GPP TS 36.321 V8.12.0 at pg. 14.  10.1.5.1 Contention based random access procedure The contention based random access procedure is outlined on Figure 10.1.5.1-1 below:

US Patent No. 10,833,908: Claim 25

"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

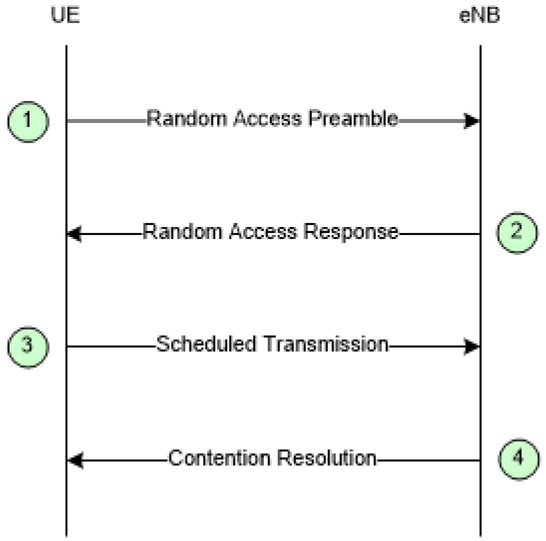


Figure 10.1.5.1-1: Contention based Random Access Procedure

The four steps of the contention based random access procedures are:

...

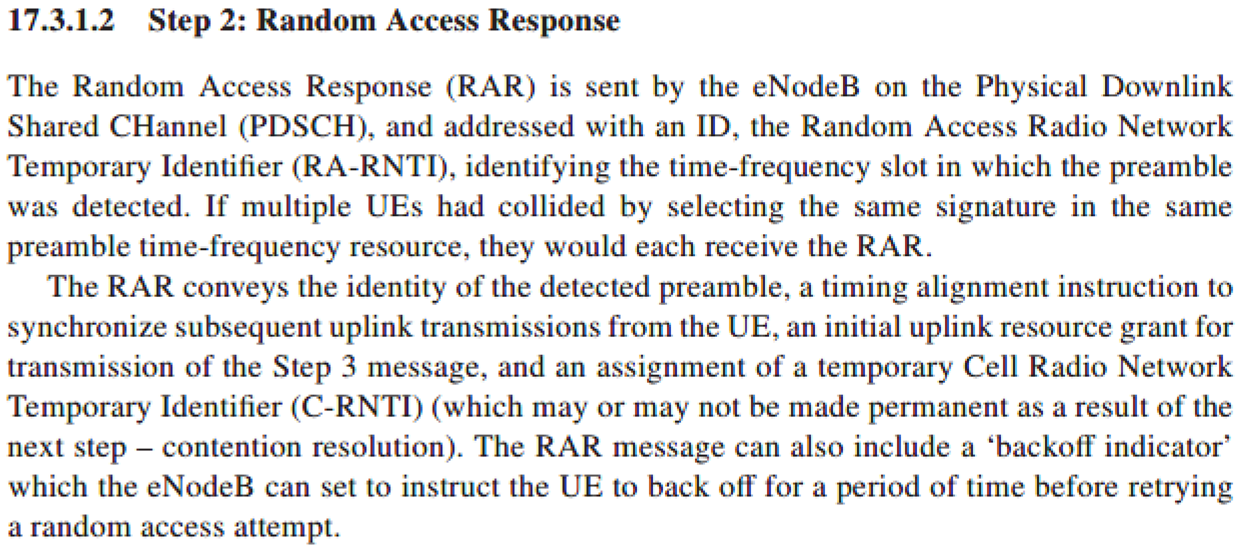
2) Random Access Response generated by MAC on DL-SCH:

- Semi-synchronous (within a flexible window of which the size is one or more TTI) with message 1;
- No HARQ;
- Addressed to RA-RNTI on PDCCH;
- Conveys at least RA-preamble identifier, Timing Alignment information, initial UL grant and assignment of Temporary C-RNTI (which may or may not be made permanent upon Contention Resolution);
- Intended for a variable number of UEs in one DL-SCH message.

See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 52-53.

US Patent No. 10,833,908: Claim 25

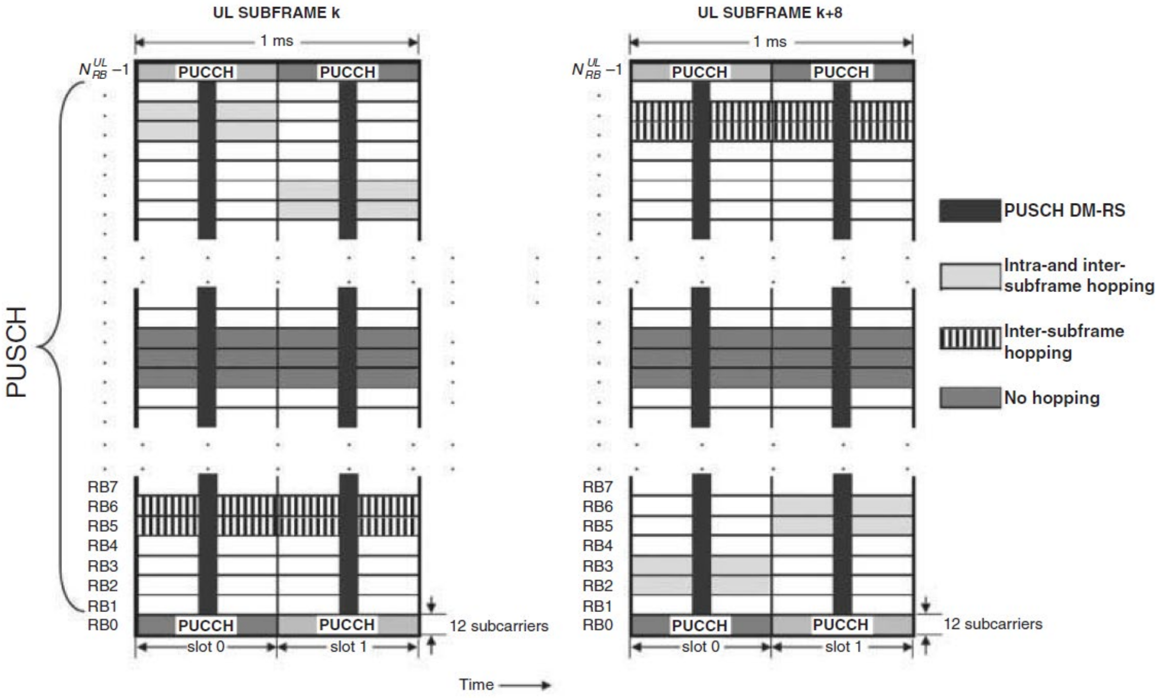
"25. The mobile station of claim 21, wherein the response message includes a mobile station identifier assigned to the mobile station."

	 **17.3.1.2 Step 2: Random Access Response** The Random Access Response (RAR) is sent by the eNodeB on the Physical Downlink Shared CHannel (PDSCH), and addressed with an ID, the Random Access Radio Network Temporary Identifier (RA-RNTI), identifying the time-frequency slot in which the preamble was detected. If multiple UEs had collided by selecting the same signature in the same preamble time-frequency resource, they would each receive the RAR. The RAR conveys the identity of the detected preamble, a timing alignment instruction to synchronize subsequent uplink transmissions from the UE, an initial uplink resource grant for transmission of the Step 3 message, and an assignment of a temporary Cell Radio Network Temporary Identifier (C-RNTI) (which may or may not be made permanent as a result of the next step – contention resolution). The RAR message can also include a 'backoff indicator' which the eNodeB can set to instruct the UE to back off for a period of time before retrying a random access attempt. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 374. *See also* Claim 5.

US Patent No. 10,833,908: Claim 26
"The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols."

26. The mobile station of claim 21, wherein the time duration of the combination of the random access signal and the guard period is greater than a time duration of at least two of the plurality of OFDM symbols.	The time duration of the combination of the random access signal and the guard period used with FCA's Accused Instrumentalities is greater than a time duration of at least two of the plurality of OFDM symbols. *E.g.,* *See* Claim 21. *See* element 21(d) showing the combination of the random access signal and a guard period greater than at least two of the plurality of OFDM symbols. *See also* Claim 6.

US Patent No. 10,833,908: Claim 27
“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

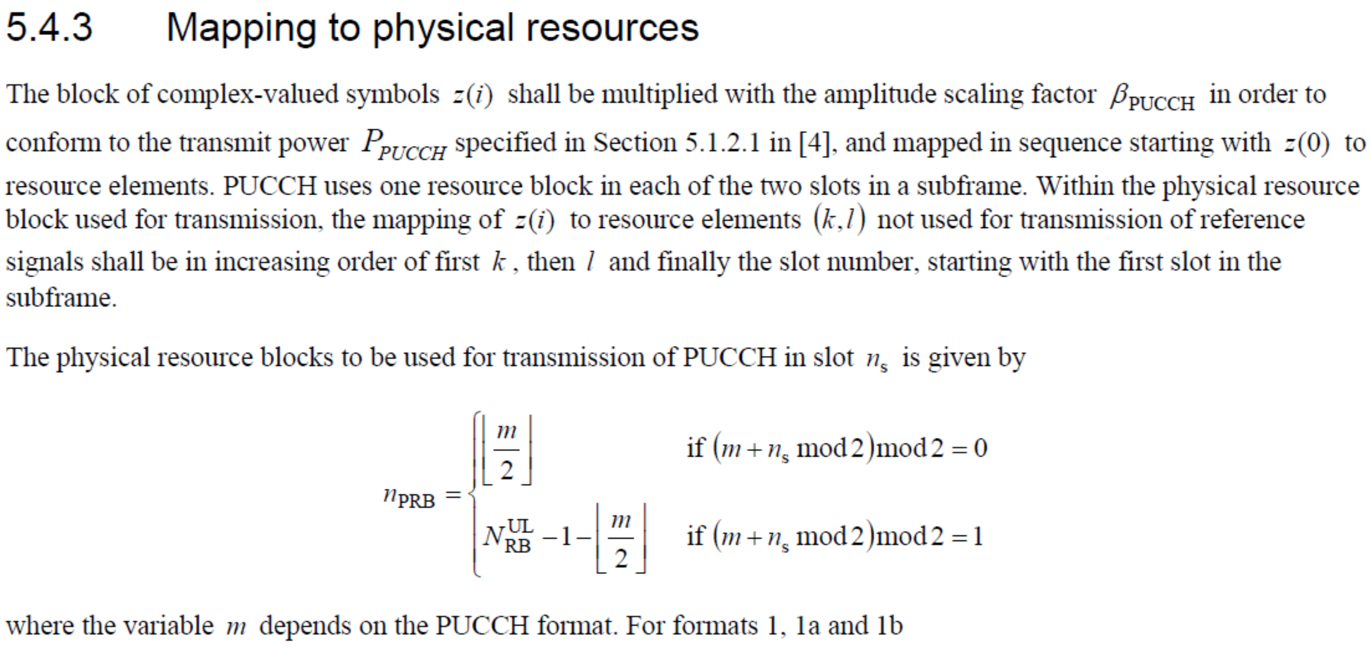
27. The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.	*See* Claim 1. The frequency band used with FCA’s Accused Instrumentalities includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion. *E.g.,* For example, the uplink control channels, such as the PUCCH are allocate resources at the edges of an operating frequency band, e.g., an outer portion of the frequency band, whereas the PRACH or other random access signaling is sent via the PUSCH, which is allocated resources in between the edges, e.g., a center portion of the frequency band.  Figure 16.3: Uplink physical data channel processing.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 347. *See also id.* at Chapter 16 ("Uplink Physical Channel Structure").

For example, the PUCCH is mapped into a resource block a single resource block in each time slot that is located near the top or the bottom of the uplink bandwidth and the PRACH is transmitted in a disjoint frequency band.



5.4.3 Mapping to physical resources

The block of complex-valued symbols $z(i)$ shall be multiplied with the amplitude scaling factor β_{PUCCH} in order to conform to the transmit power P_{PUCCH} specified in Section 5.1.2.1 in [4], and mapped in sequence starting with $z(0)$ to resource elements. PUCCH uses one resource block in each of the two slots in a subframe. Within the physical resource block used for transmission, the mapping of $z(i)$ to resource elements (k,l) not used for transmission of reference signals shall be in increasing order of first k, then l and finally the slot number, starting with the first slot in the subframe.

The physical resource blocks to be used for transmission of PUCCH in slot n_{s} is given by

$$n_{\mathrm{PRB}} = \begin{cases} \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 0 \\ N_{\mathrm{RB}}^{\mathrm{UL}} - 1 - \left\lfloor \frac{m}{2} \right\rfloor & \text{if } (m + n_{\mathrm{s}} \bmod 2) \bmod 2 = 1 \end{cases}$$

where the variable m depends on the PUCCH format. For formats 1, 1a and 1b

US Patent No. 10,833,908: Claim 27

“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

$$m = \begin{cases} N_{\mathrm{RB}}^{(2)} & \text{if } n_{\mathrm{PUCCH}}^{(1)} < c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}} \\ \left\lfloor \dfrac{n_{\mathrm{PUCCH}}^{(1)} - c \cdot N_{\mathrm{cs}}^{(1)} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}}{c \cdot N_{\mathrm{sc}}^{\mathrm{RB}} / \Delta_{\mathrm{shift}}^{\mathrm{PUCCH}}} \right\rfloor + N_{\mathrm{RB}}^{(2)} + \left\lceil \dfrac{N_{\mathrm{cs}}^{(1)}}{8} \right\rceil & \text{otherwise} \end{cases}$$

$$c = \begin{cases} 3 & \text{normal cyclic prefix} \\ 2 & \text{extended cyclic prefix} \end{cases}$$

and for formats 2, 2a and 2b

$$m = \left\lfloor n_{\mathrm{PUCCH}}^{(2)} / \mathrm{N}_{\mathrm{sc}}^{\mathrm{RB}} \right\rfloor$$

Mapping of modulation symbols for the physical uplink control channel is illustrated in Figure 5.4.3-1.

In case of simultaneous transmission of sounding reference signal and PUCCH format 1, 1a or 1b, one SC-FDMA symbol on PUCCH shall punctured.

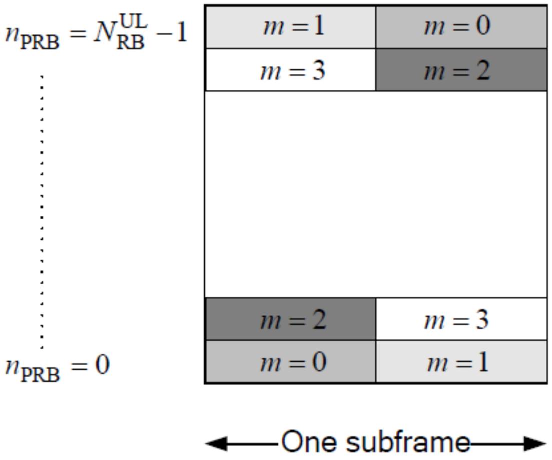


Figure 5.4.3-1: Mapping to physical resource blocks for PUCCH.

See e.g., 3GPP TS 36.211 V8.9.0 at pg. 20-21.

The random access preamble is transmitted on the PRACH which occupies a bandwidth corresponding to 6 consecutive resource blocks in both the type 1 and type 2 frame structures. The location of the PRACH is

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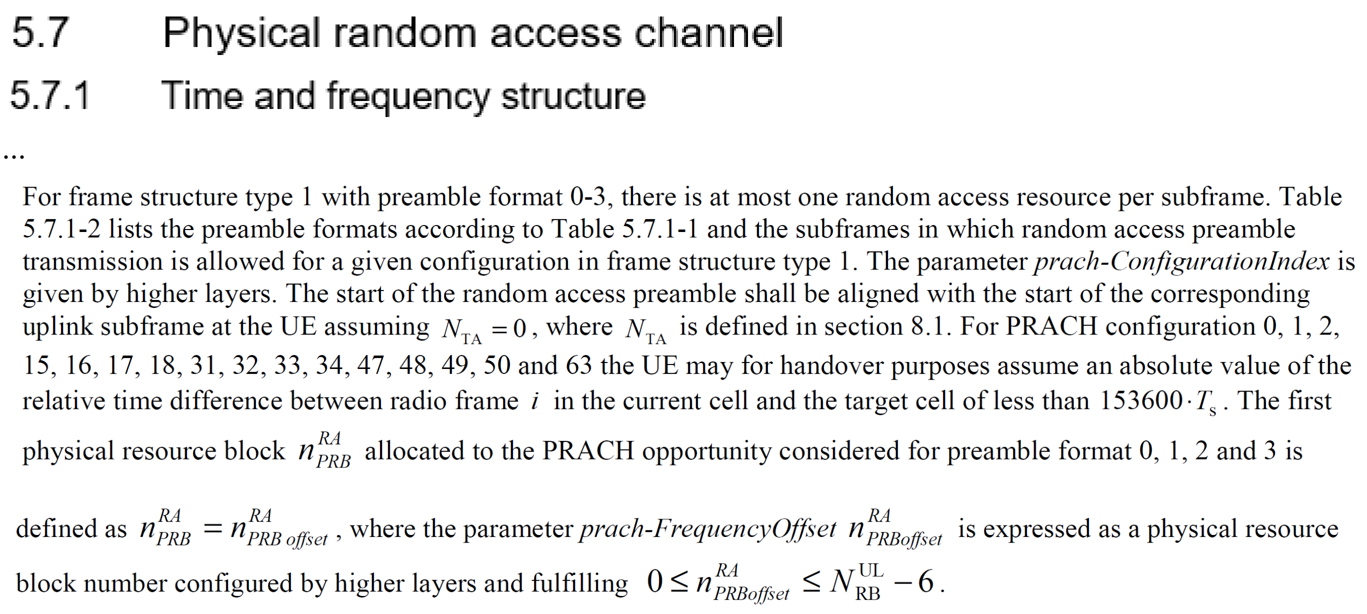
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

determined by the parameter prach-FrequencyOffset $n^{RA}_{PRBoffset}$. For FDD, the parameter directly determines the location of the PRACH. For TDD, the final location of the PRACH is determined by a series of equations dependent upon a PRACH resource frequency index f_{RA}. In most circumstances, the network will configure the parameter such that the PRACH will fall towards the middle of the uplink bandwidth and not overlap with the PUCCH.



5.7 Physical random access channel

5.7.1 Time and frequency structure

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For frame structure type 1 with preamble format 0-3, there is at most one random access resource per subframe. Table 5.7.1-2 lists the preamble formats according to Table 5.7.1-1 and the subframes in which random access preamble transmission is allowed for a given configuration in frame structure type 1. The parameter *prach-ConfigurationIndex* is given by higher layers. The start of the random access preamble shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{TA}=0$, where N_{TA} is defined in section 8.1. For PRACH configuration 0, 1, 2, 15, 16, 17, 18, 31, 32, 33, 34, 47, 48, 49, 50 and 63 the UE may for handover purposes assume an absolute value of the relative time difference between radio frame i in the current cell and the target cell of less than $153600 \cdot T_s$. The first physical resource block n^{RA}_{PRB} allocated to the PRACH opportunity considered for preamble format 0, 1, 2 and 3 is defined as $n^{RA}_{PRB} = n^{RA}_{PRB\,offset}$, where the parameter *prach-FrequencyOffset* $n^{RA}_{PRBoffset}$ is expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n^{RA}_{PRBoffset} \le N^{UL}_{RB} - 6$.

…

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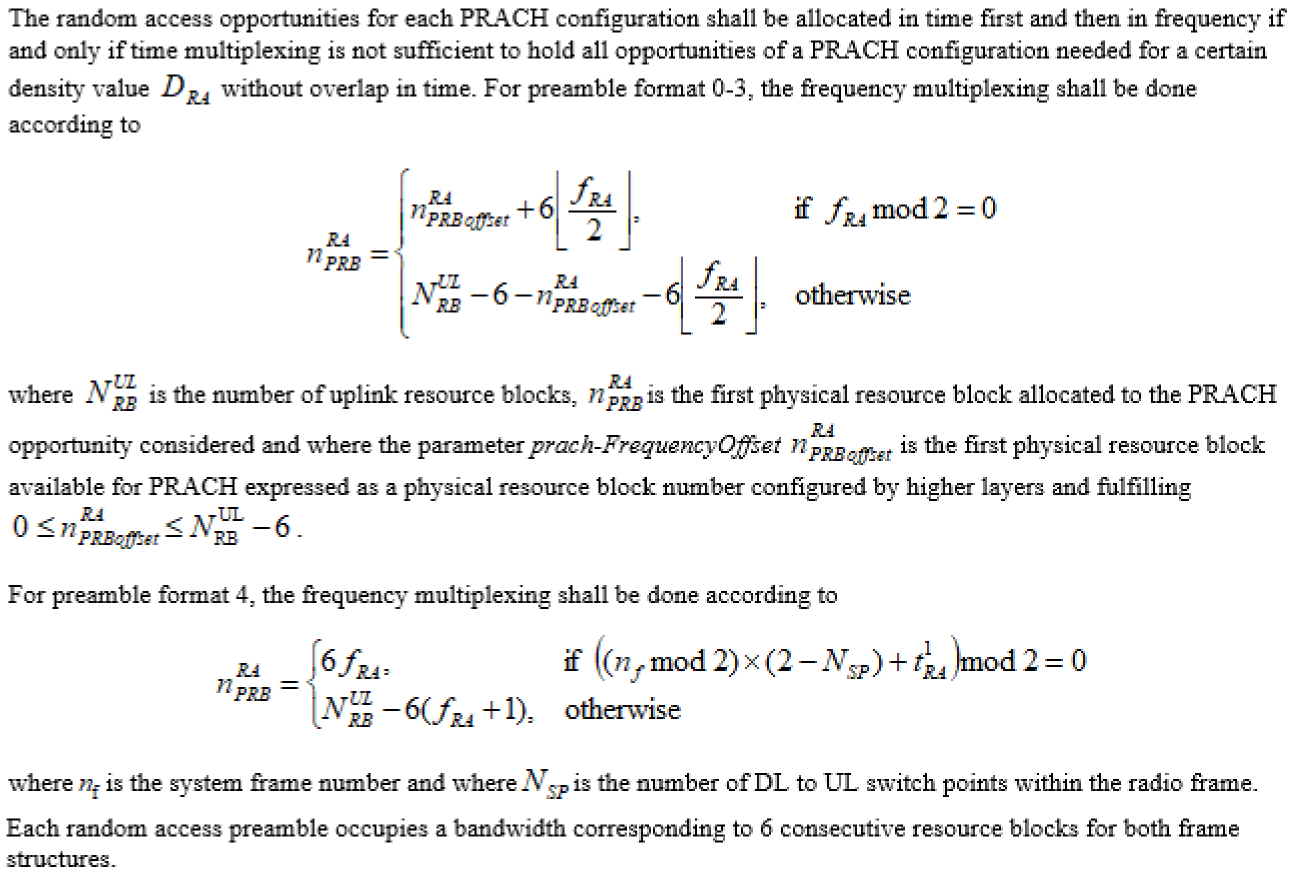
"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

	 The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$ where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{\mathrm{RB}}^{\mathrm{UL}} - 6$. For preamble format 4, the frequency multiplexing shall be done according to $n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$ where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame. Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures. See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 33-36.

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“The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion.”

Table 5.7.1-4 lists the mapping to physical resources for the different random access opportunities needed for a certain PRACH density value, D_{RA}. Each quadruple of the format $(f_{RA}, t_{RA}^{0}, t_{RA}^{1}, t_{RA}^{2})$ indicates the location of a specific random access resource, where f_{RA} is a frequency resource index within the considered time instance, $t_{RA}^{0} = 0,1,2$ indicates whether the resource is reoccurring in all radio frames, in even radio frames, or in odd radio frames, respectively, $t_{RA}^{1} = 0,1$ indicates whether the random access resource is located in first half frame or in second half frame, respectively, and where t_{RA}^{2} is the uplink subframe number where the preamble starts, counting from 0 at the first uplink subframe between 2 consecutive downlink-to-uplink switch points, with the exception of preamble format 4 where t_{RA}^{2} is denoted as (*). The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming $N_{\text{TA}} = 0$ and the random access preamble format 4 shall start $4832 \cdot T_{s}$ before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE"s uplink frame timing assuming $N_{\text{TA}} = 0$.

Table 5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency.

PRACH configuration Index (See Table 5.7.1-3)	UL/DL configuration (See Table 4.2-2)						
	0	1	2	3	4	5	6
0	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)	(0,1,0,1)	(0,1,0,0)	(0,1,0,2)
1	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)	(0,2,0,1)	(0,2,0,0)	(0,2,0,2)
2	(0,1,1,2)	(0,1,1,1)	(0,1,1,0)	(0,1,0,1)	(0,1,0,0)	N/A	(0,1,1,1)
3	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)	(0,0,0,1)	(0,0,0,0)	(0,0,0,2)
4	(0,0,1,2)	(0,0,1,1)	(0,0,1,0)	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,1,1)
5	(0,0,0,1)	(0,0,0,0)	N/A	(0,0,0,0)	N/A	N/A	(0,0,0,1)

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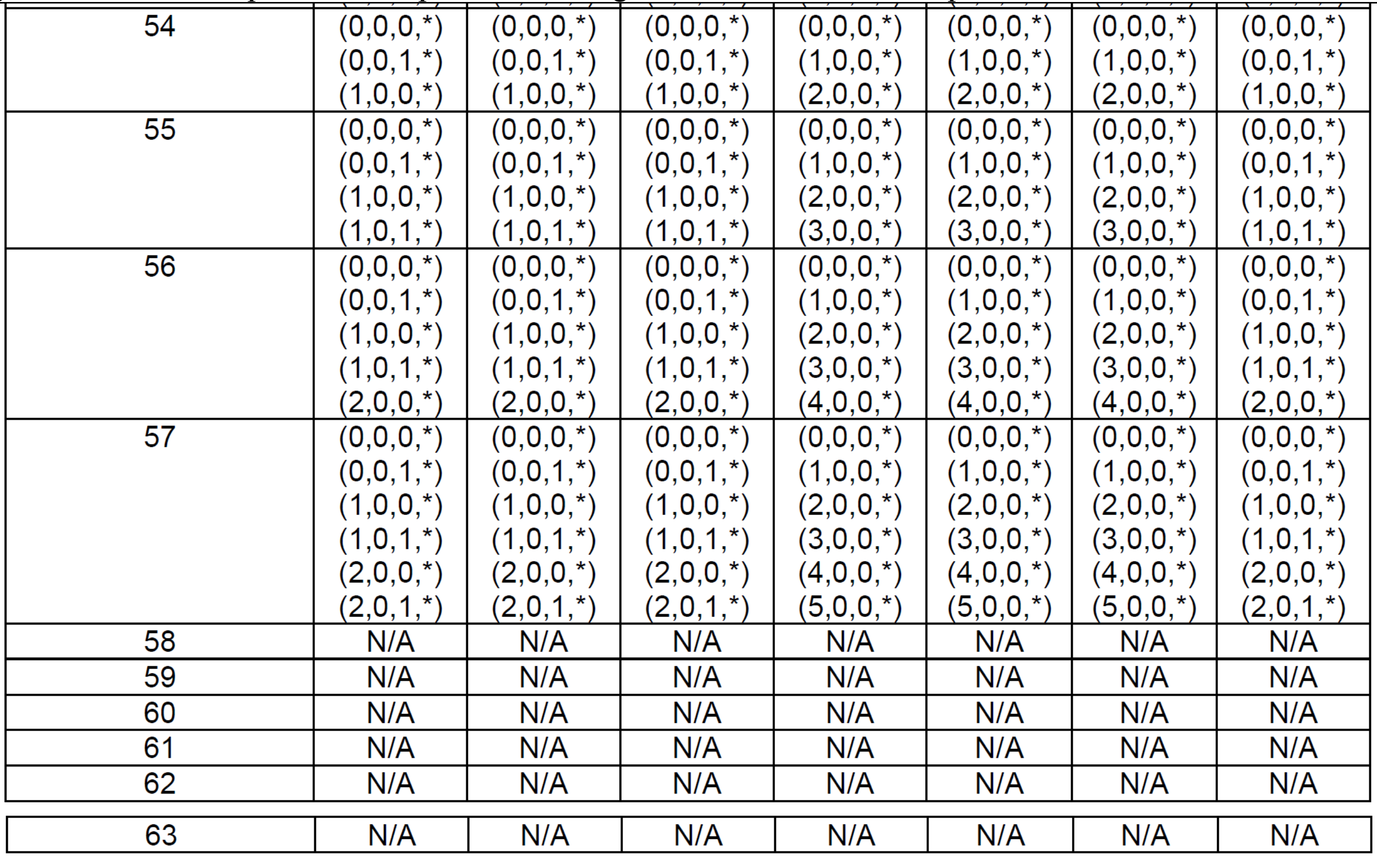
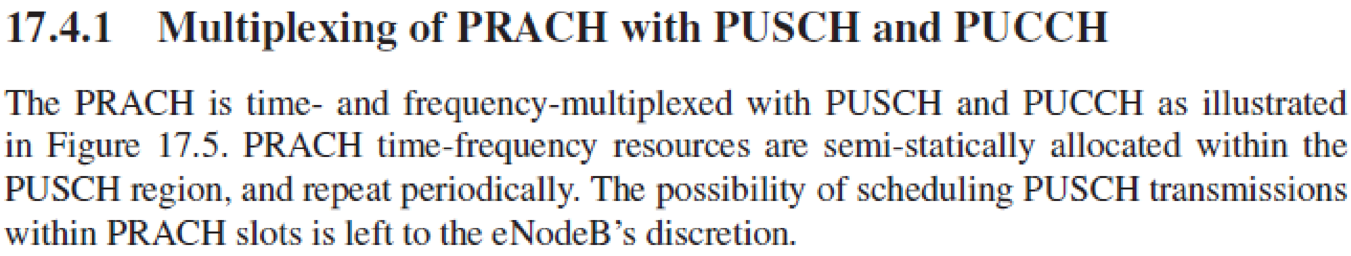
US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."



54	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*)
55	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*)
56	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*)
57	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (1,0,0,*) (2,0,0,*) (3,0,0,*) (4,0,0,*) (5,0,0,*)	(0,0,0,*) (0,0,1,*) (1,0,0,*) (1,0,1,*) (2,0,0,*) (2,0,1,*)
58	N/A	N/A	N/A	N/A	N/A	N/A	N/A
59	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A	N/A
61	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62	N/A	N/A	N/A	N/A	N/A	N/A	N/A
63	N/A	N/A	N/A	N/A	N/A	N/A	N/A

See e.g., 3GPP TS 36.211 V8.9.0 at pgs. 35-39.

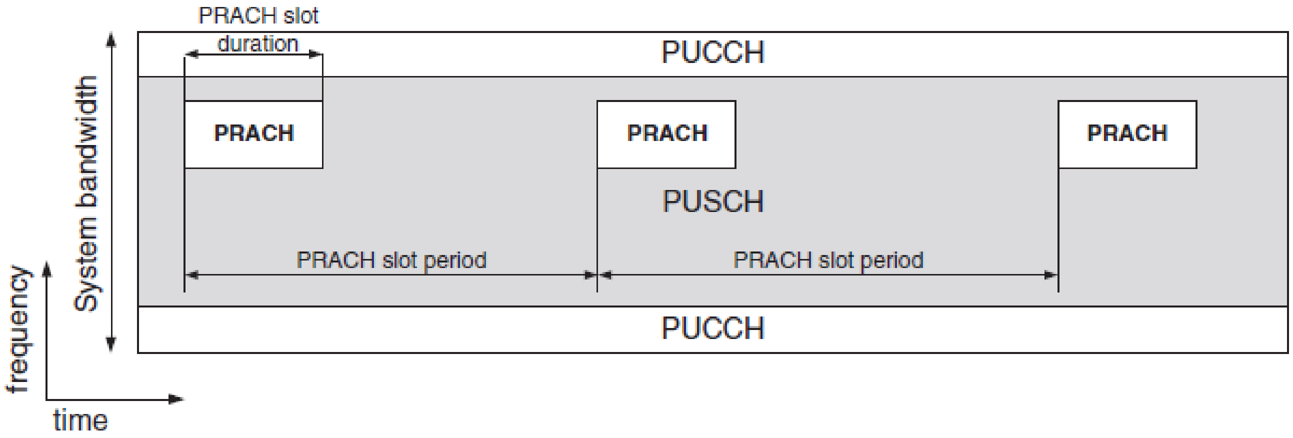


17.4.1 Multiplexing of PRACH with PUSCH and PUCCH

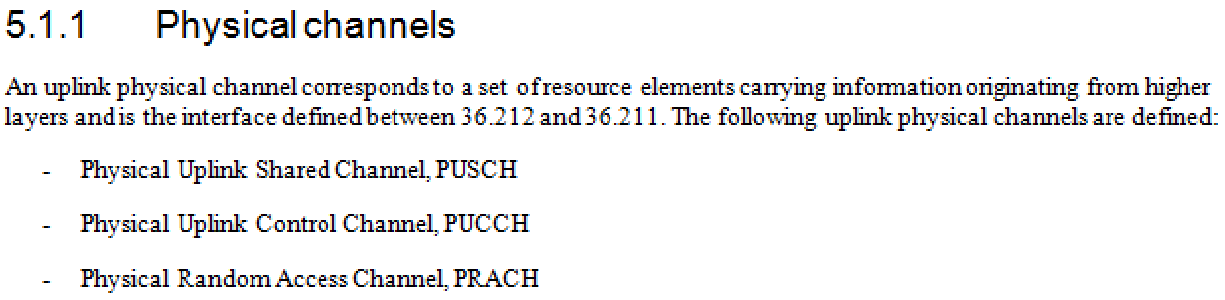
The PRACH is time- and frequency-multiplexed with PUSCH and PUCCH as illustrated in Figure 17.5. PRACH time-frequency resources are semi-statically allocated within the PUSCH region, and repeat periodically. The possibility of scheduling PUSCH transmissions within PRACH slots is left to the eNodeB's discretion.

US Patent No. 10,833,908: Claim 27

"The mobile station of claim 21, wherein the frequency band includes an outer portion and a center portion, wherein the portion of the frequency band for the random access signal is in the center portion and uplink control signals are sent in the outer portion."

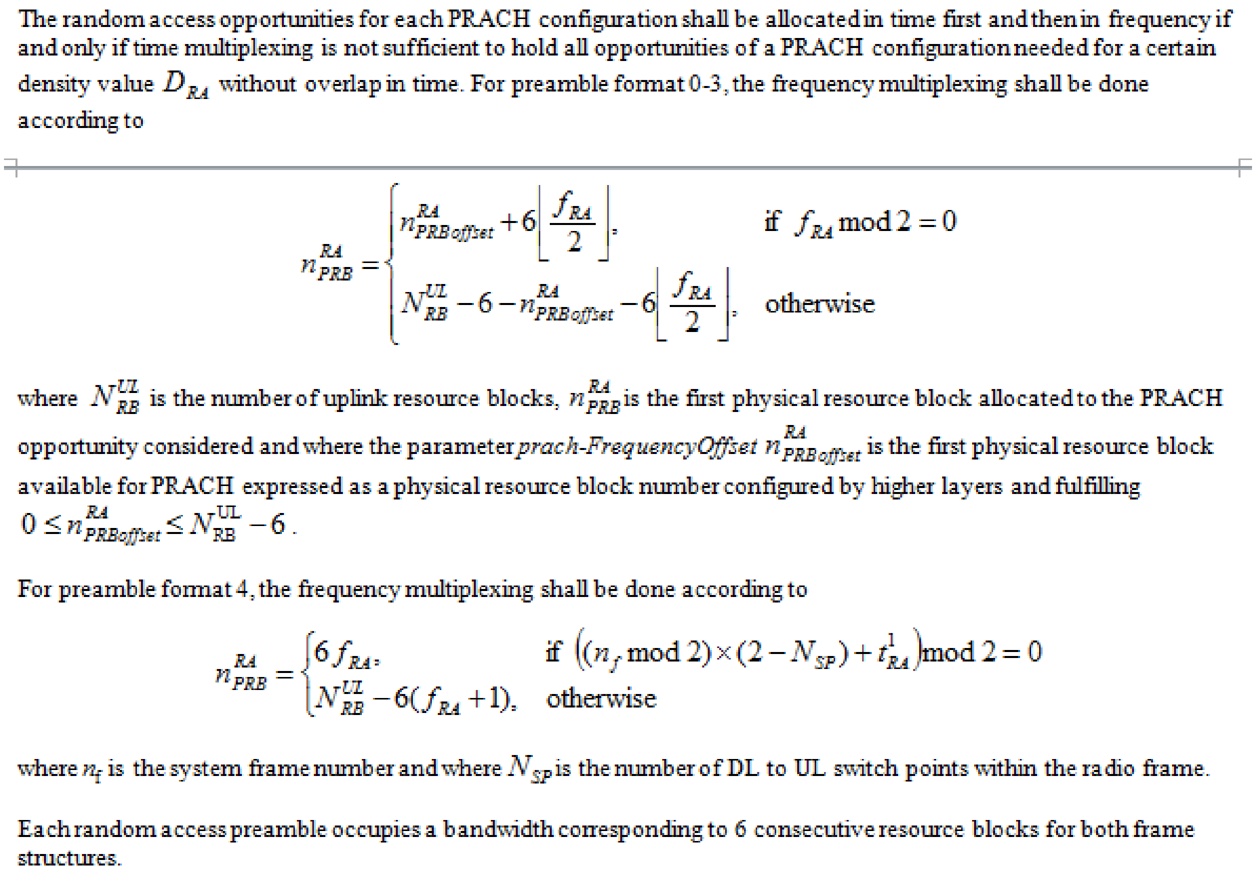
	 Figure 17.5: PRACH multiplexing with PUSCH and PUCCH. See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice," Second Edition (2011) at pgs. 376-377 and Figure 17.5. *See also* Claim 24.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

28. The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.	The receiver random access signal used with FCA's Accused Instrumentalities is a spread spectrum signal. *E.g.,* *See* Claim 21. For example, the UE transmits the random access signal, e.g., a random access preamble, on the PRACH to the eNodeB.  5.1.1 Physical channels An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers and is the interface defined between 36.212 and 36.211. The following uplink physical channels are defined: - Physical Uplink Shared Channel, PUSCH - Physical Uplink Control Channel, PUCCH - Physical Random Access Channel, PRACH See e.g., 3GPP TS 36.211 V8.9.0 at p. 11. The PRACH is transmitted in a portion, 6 physical resource blocks, of the uplink frequency bandwidth.

US Patent No. 10,833,908: Claim 28

"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."



The random access opportunities for each PRACH configuration shall be allocated in time first and then in frequency if and only if time multiplexing is not sufficient to hold all opportunities of a PRACH configuration needed for a certain density value D_{RA} without overlap in time. For preamble format 0-3, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} n_{PRBoffset}^{RA} + 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{if } f_{RA} \bmod 2 = 0 \\ N_{RB}^{UL} - 6 - n_{PRBoffset}^{RA} - 6\left\lfloor \frac{f_{RA}}{2} \right\rfloor, & \text{otherwise} \end{cases}$$

where N_{RB}^{UL} is the number of uplink resource blocks, n_{PRB}^{RA} is the first physical resource block allocated to the PRACH opportunity considered and where the parameter *prach-FrequencyOffset* $n_{PRBoffset}^{RA}$ is the first physical resource block available for PRACH expressed as a physical resource block number configured by higher layers and fulfilling $0 \le n_{PRBoffset}^{RA} \le N_{RB}^{UL} - 6$.

For preamble format 4, the frequency multiplexing shall be done according to

$$n_{PRB}^{RA} = \begin{cases} 6 f_{RA}, & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + t_{RA}^{1}\right) \bmod 2 = 0 \\ N_{RB}^{UL} - 6(f_{RA} + 1), & \text{otherwise} \end{cases}$$

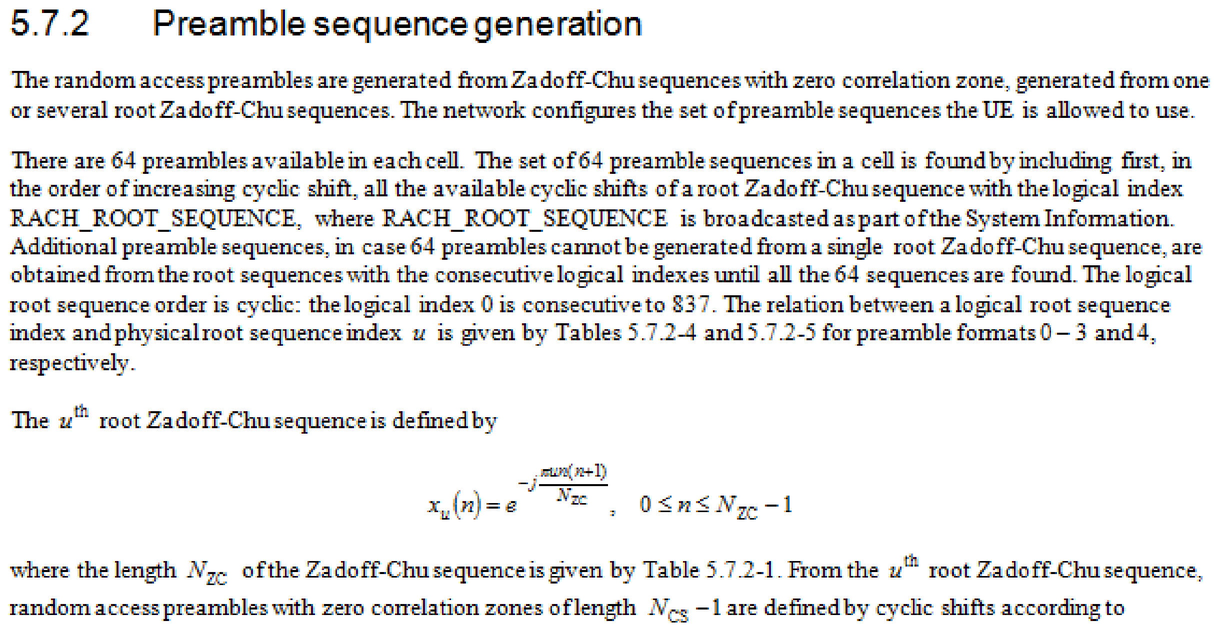
where n_f is the system frame number and where N_{SP} is the number of DL to UL switch points within the radio frame.

Each random access preamble occupies a bandwidth corresponding to 6 consecutive resource blocks for both frame structures.

See e.g., 3GPP TS 36.211 V8.9.0 at p. 35.

The UE transmits a preamble over the PRACH. The preamble is spread in the frequency domain by mapping, for formats 0-3, a length 839 sequence onto 839 subcarriers in the frequency domain.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.2 Preamble sequence generation

The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use.

There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively.

The u^{th} root Zadoff-Chu sequence is defined by

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC}-1$$

where the length N_{ZC} of the Zadoff-Chu sequence is given by Table 5.7.2-1. From the u^{th} root Zadoff-Chu sequence, random access preambles with zero correlation zones of length $N_{CS}-1$ are defined by cyclic shifts according to

See e.g., 3GPP TS 36.211 V8.9.0 at p. 39.

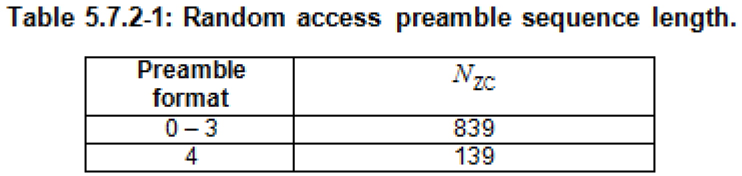
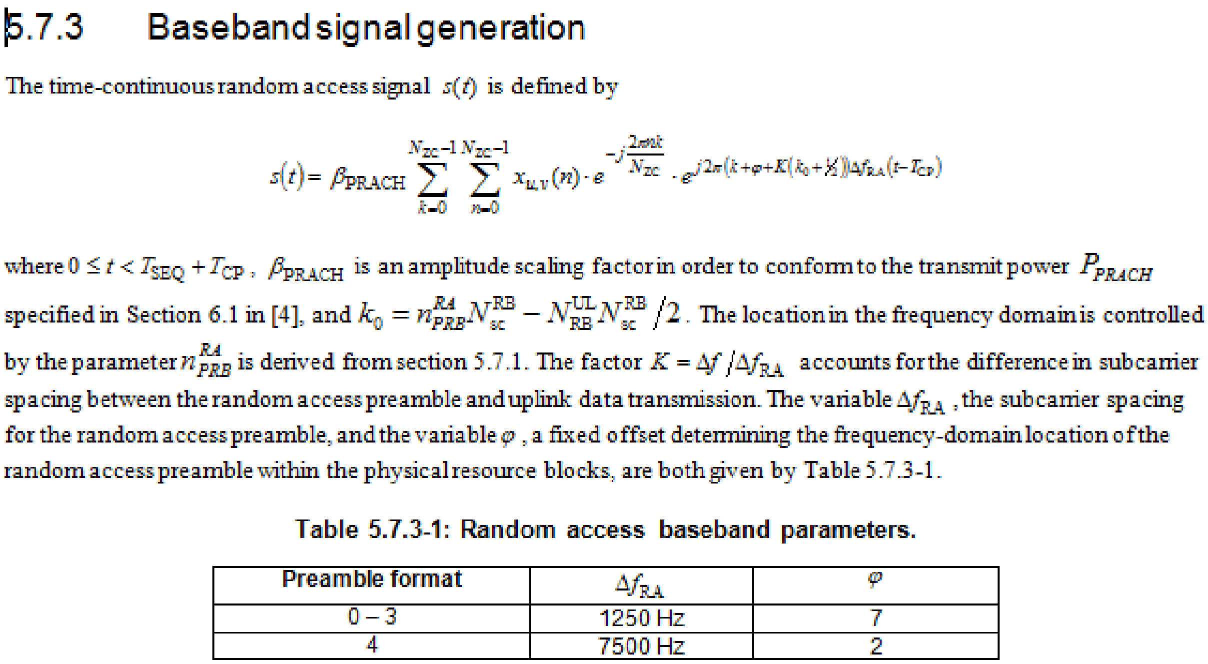


Table 5.7.2-1: Random access preamble sequence length.

Preamble format	N_{ZC}
0 – 3	839
4	139

See e.g., 3GPP TS 36.211 V8.9.0 at p. 40.

US Patent No. 10,833,908: Claim 28
“The mobile station of claim 21, wherein the random access signal is a spread spectrum signal.”



5.7.3 Baseband signal generation

The time-continuous random access signal $s(t)$ is defined by

$$s(t)=\beta_{\text{PRACH}}\sum_{k=0}^{N_{\text{ZC}}-1}\sum_{n=0}^{N_{\text{ZC}}-1}x_{u,v}(n)\cdot e^{-j\frac{2\pi nk}{N_{\text{ZC}}}}\cdot e^{j2\pi(k+\varphi+K(k_0+1/2))\Delta f_{\text{RA}}(t-T_{\text{CP}})}$$

where $0\leq t<T_{\text{SEQ}}+T_{\text{CP}}$, β_{PRACH} is an amplitude scaling factor in order to conform to the transmit power P_{PRACH} specified in Section 6.1 in [4], and $k_0=n_{PRB}^{RA}N_{\text{sc}}^{\text{RB}}-N_{\text{RB}}^{\text{UL}}N_{\text{sc}}^{\text{RB}}/2$. The location in the frequency domain is controlled by the parameter n_{PRB}^{RA} is derived from section 5.7.1. The factor $K=\Delta f/\Delta f_{\text{RA}}$ accounts for the difference in subcarrier spacing between the random access preamble and uplink data transmission. The variable Δf_{RA}, the subcarrier spacing for the random access preamble, and the variable φ, a fixed offset determining the frequency-domain location of the random access preamble within the physical resource blocks, are both given by Table 5.7.3-1.

Table 5.7.3-1: Random access baseband parameters.

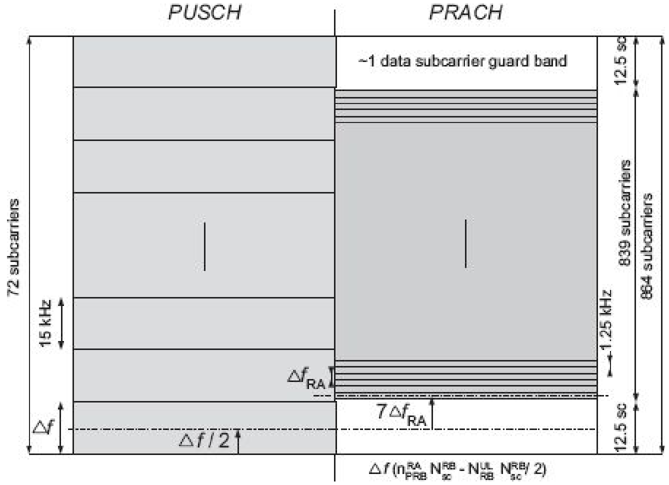
Preamble format	Δf_{RA}	φ
0 – 3	1250 Hz	7
4	7500 Hz	2

See e.g., 3GPP TS 36.211 V8.9.0 at p. 43.

US Patent No. 10,833,908: Claim 28
"The mobile station of claim 21, wherein the random access signal is a spread spectrum signal."

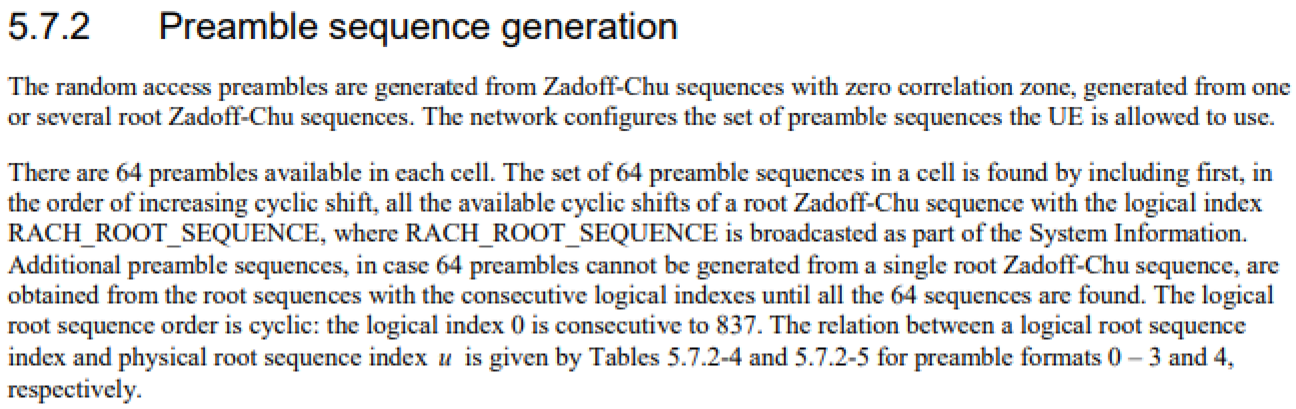
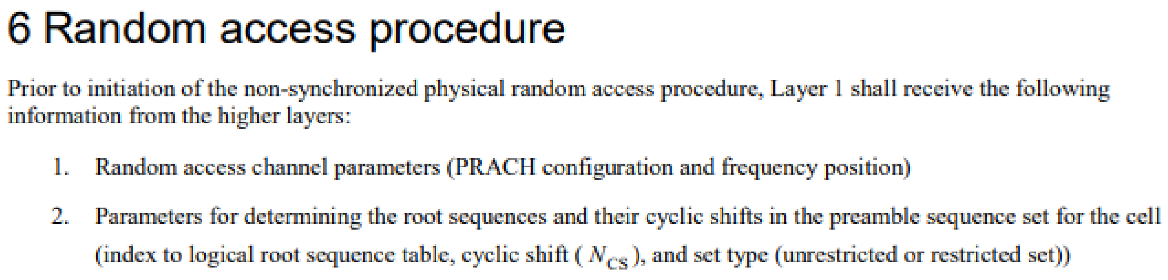
Therefore the sequence length of 839 is selected for LTE PRACH, corresponding to 69.91 PUSCH subcarriers in each SC-FDMA symbol, and offers 72 − 69.91 = 2.09 PUSCH subcarriers protection, which is very close to one PUSCH subcarrier protection on each side of the preamble. This is illustrated in Figure 17.14; note that the preamble is positioned centrally in the block of 864 available PRACH subcarriers, with 12.5 null subcarriers on each side.

Figure 17.14: PRACH preamble mapping onto allocated subcarriers.



See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at p. 387.

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

29. The mobile station of claim 21, wherein: the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.	The receiver of FCA's Accused Instrumentalities further receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal. *E.g.,* *See* Claim 11. The mobile station generates preamble sequences based on broadcasted information, including the RACH_ROOT_SEQUENCE as part of the System information.  5.7.2 Preamble sequence generation The random access preambles are generated from Zadoff-Chu sequences with zero correlation zone, generated from one or several root Zadoff-Chu sequences. The network configures the set of preamble sequences the UE is allowed to use. There are 64 preambles available in each cell. The set of 64 preamble sequences in a cell is found by including first, in the order of increasing cyclic shift, all the available cyclic shifts of a root Zadoff-Chu sequence with the logical index RACH_ROOT_SEQUENCE, where RACH_ROOT_SEQUENCE is broadcasted as part of the System Information. Additional preamble sequences, in case 64 preambles cannot be generated from a single root Zadoff-Chu sequence, are obtained from the root sequences with the consecutive logical indexes until all the 64 sequences are found. The logical root sequence order is cyclic: the logical index 0 is consecutive to 837. The relation between a logical root sequence index and physical root sequence index u is given by Tables 5.7.2-4 and 5.7.2-5 for preamble formats 0 – 3 and 4, respectively. See e.g., 3GPP TS 36.211 V8.9.0 at pg. 39.  6 Random access procedure Prior to initiation of the non-synchronized physical random access procedure, Layer 1 shall receive the following information from the higher layers: 1. Random access channel parameters (PRACH configuration and frequency position) 2. Parameters for determining the root sequences and their cyclic shifts in the preamble sequence set for the cell (index to logical root sequence table, cyclic shift (N_{CS}), and set type (unrestricted or restricted set)) See e.g., 3GPP TS 36.213 V8.8.0 at pg. 16. – RadioResourceConfigCommon

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

The IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* are used to specify common radio resource configurations in the system information and in the mobility control information, respectively, e.g., the random access parameters and the static physical layer parameters.

***RadioResourceConfigCommon* information element**

```
-- ASN1START

RadioResourceConfigCommonSIB ::=    SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon,
    bcch-Config                         BCCH-Config,
    pcch-Config                         PCCH-Config,
    prach-Config                        PRACH-ConfigSIB,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon,
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    pucch-ConfigCommon                  PUCCH-ConfigCommon,
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon,
    uplinkPowerControlCommon            UplinkPowerControlCommon,
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

RadioResourceConfigCommon ::=       SEQUENCE {
    rach-ConfigCommon                   RACH-ConfigCommon                   OPTIONAL,   -- Need ON
    prach-Config                        PRACH-Config,
    pdsch-ConfigCommon                  PDSCH-ConfigCommon                  OPTIONAL,   -- Need ON
    pusch-ConfigCommon                  PUSCH-ConfigCommon,
    phich-Config                        PHICH-Config                        OPTIONAL,   -- Need ON
    pucch-ConfigCommon                  PUCCH-ConfigCommon                  OPTIONAL,   -- Need ON
    soundingRS-UL-ConfigCommon          SoundingRS-UL-ConfigCommon          OPTIONAL,   -- Need ON
    uplinkPowerControlCommon            UplinkPowerControlCommon            OPTIONAL,   -- Need ON
    antennaInfoCommon                   AntennaInfoCommon           OPTIONAL,   -- Need ON
    p-Max                               P-Max                               OPTIONAL,   -- Need OP
    tdd-Config                          TDD-Config                          OPTIONAL,   -- Cond TDD
    ul-CyclicPrefixLength               UL-CyclicPrefixLength,
    ...
}

BCCH-Config ::=                     SEQUENCE {
    modificationPeriodCoeff             ENUMERATED {n2, n4, n8, n16}
}

PCCH-Config ::=                     SEQUENCE {
    defaultPagingCycle                  ENUMERATED {
                                            rf32, rf64, rf128, rf256},
    nB                                  ENUMERATED {
                                            fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                            oneSixteenthT, oneThirtySecondT}
}

UL-CyclicPrefixLength ::=           ENUMERATED {len1, len2}

-- ASN1STOP
```

US Patent No. 10,833,908: Claim 29
“The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal.”

See e.g., 36.331 V8.21.0 at pp. 128-129.

– RACH-ConfigCommon

The IE *RACH-ConfigCommon* is used to specify the generic random access parameters.

***RACH-ConfigCommon* information element**

```
-- ASN1START

RACH-ConfigCommon ::=       SEQUENCE {
    preambleInfo                        SEQUENCE {
        numberOfRA-Preambles                ENUMERATED {
                                                n4, n8, n12, n16 ,n20, n24, n28,
                                                n32, n36, n40, n44, n48, n52, n56,
                                                n60, n64},
        preamblesGroupAConfig               SEQUENCE {
            sizeOfRA-PreamblesGroupA            ENUMERATED {
                                                    n4, n8, n12, n16 ,n20, n24, n28,
                                                    n32, n36, n40, n44, n48, n52, n56,
                                                    n60},
            messageSizeGroupA                   ENUMERATED {b56, b144, b208, b256},
            messagePowerOffsetGroupB            ENUMERATED {
                                                    minusinfinity, dB0, dB5, dB8, dB10, dB12,
                                                    dB15, dB18},
            ...
        }           OPTIONAL                                                    -- Need OP
    },
    powerRampingParameters              SEQUENCE {
        powerRampingStep                    ENUMERATED {dB0, dB2,dB4, dB6},
        preambleInitialReceivedTargetPower  ENUMERATED {
                                                dBm-120, dBm-118, dBm-116, dBm-114, dBm-112,
                                                dBm-110, dBm-108, dBm-106, dBm-104, dBm-102,
                                                dBm-100, dBm-98, dBm-96, dBm-94,
                                                dBm-92, dBm-90}
    },
    ra-SupervisionInfo                  SEQUENCE {
        preambleTransMax                    ENUMERATED {
                                                n3, n4, n5, n6, n7, n8, n10, n20, n50,
                                                n100, n200},
        ra-ResponseWindowSize               ENUMERATED {
                                                sf2, sf3, sf4, sf5, sf6, sf7,
                                                sf8, sf10},
        mac-ContentionResolutionTimer       ENUMERATED {
                                                sf8, sf16, sf24, sf32, sf40, sf48,
                                                sf56, sf64}
    },
    maxHARQ-Msg3Tx                      INTEGER (1..8),
    ...
}
```

US Patent No. 10,833,908: Claim 29
"The mobile station of claim 21, wherein:
the receiver circuit is further configured to receive broadcast information from the base station, the broadcast information indicating at least one sequence associated with the base station for use in producing the random access signal."

```
-- ASN1STOP
```

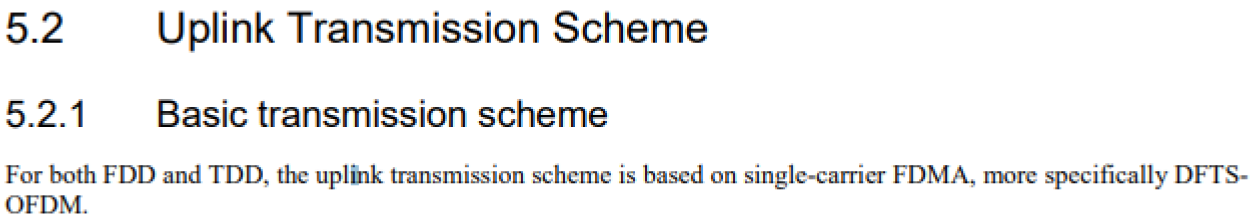
RACH-ConfigCommon field descriptions
numberOfRA-Preambles Number of non-dedicated random access preambles in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
preamblesGroupAConfig Provides the configuration for preamble grouping in TS 36.321 [6]. If the field is not signalled, the size of the random access preambles group A [6] is equal to *numberOfRA-Preambles*.
sizeOfRA-PreamblesGroupA Size of the random access preambles group A in TS 36.321 [6]. Value is an integer. Value n4 corresponds to 4, n8 corresponds to 8 and so on.
messageSizeGroupA Threshold for preamble selection in TS 36.321 [6]. Value in bits. Value b56 corresponds to 56 bits, b144 corresponds to 144 bits and so on.
messagePowerOffsetGroupB Threshold for preamble selection in TS 36.321 [6]. Value in dB. Value minusinfinity corresponds to –infinity. Value dB0 corresponds to 0 dB, dB5 corresponds to 5 dB and so on.
powerRampingStep Power ramping factor in TS 36.321 [6]. Value in dB. Value dB0 corresponds to 0 dB, dB2 corresponds to 2 dB and so on.
preambleInitialReceivedTargetPower Initial preamble power in TS 36.321 [6]. Value in dBm. Value dBm-120 corresponds to -120 dBm, dBm-118 corresponds to -118 dBm and so on.
preambleTransMax Maximum number of preamble transmission in TS 36.321 [6]. Value is an integer. Value n3 corresponds to 3, n4 corresponds to 4 and so on.
ra-ResponseWindowSize Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on.
mac-ContentionResolutionTimer Timer for contention resolution in TS 36.321 [6]. Value in subframes. Value sf8 corresponds to 8 subframes, sf16 corresponds to 16 subframes and so on.
maxHARQ-Msg3Tx Maximum number of Msg3 HARQ transmissions in TS 36.321 [6], used for contention based random access. Value is an integer.

See e.g., 36.331 V8.21.0 at pp. 126-127.

See also Claim 9.

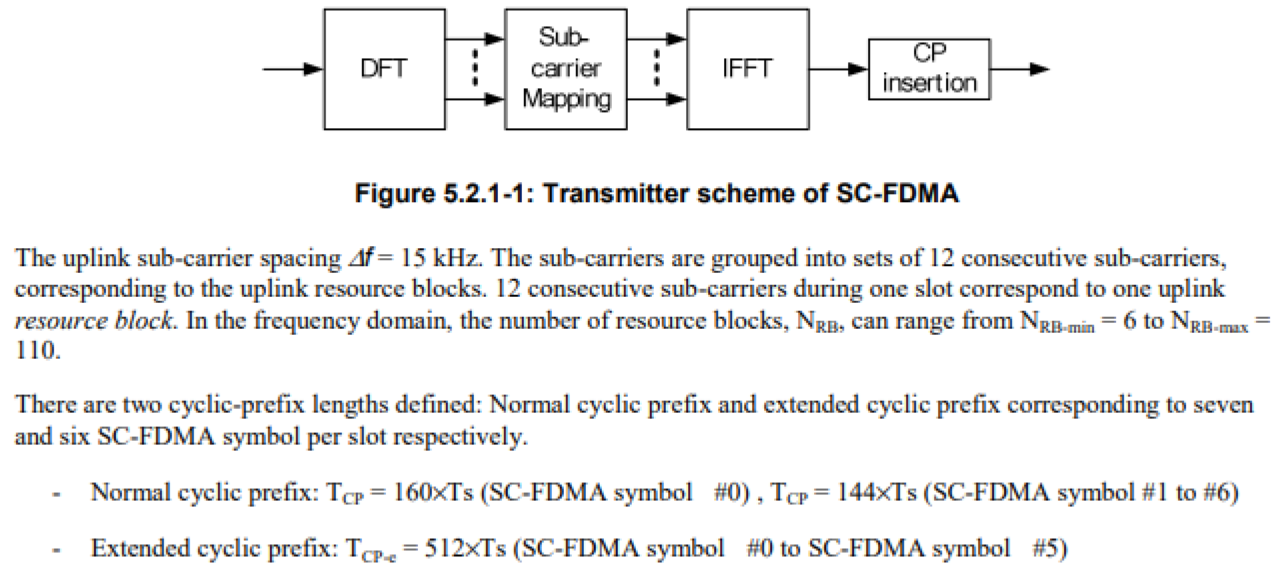
US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."

30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.	*See* Claim 21 FCA's Accused Instrumentalities include vehicles equipped with cellular communication capabilities and services made available thereupon for use and actually used in a wireless system compliant with the LTE standard starting at least at release 8. This includes one or more components or modules implemented in hardware and/or software including circuitry, which comprises at least: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit for an OFDM transmitter signal processing circuit that outputs the first uplink signal. *E.g.,* FCA's Accused Instrumentalities implement these circuit elements for transmitting an uplink signal:  5.2 Uplink Transmission Scheme 5.2.1 Basic transmission scheme For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

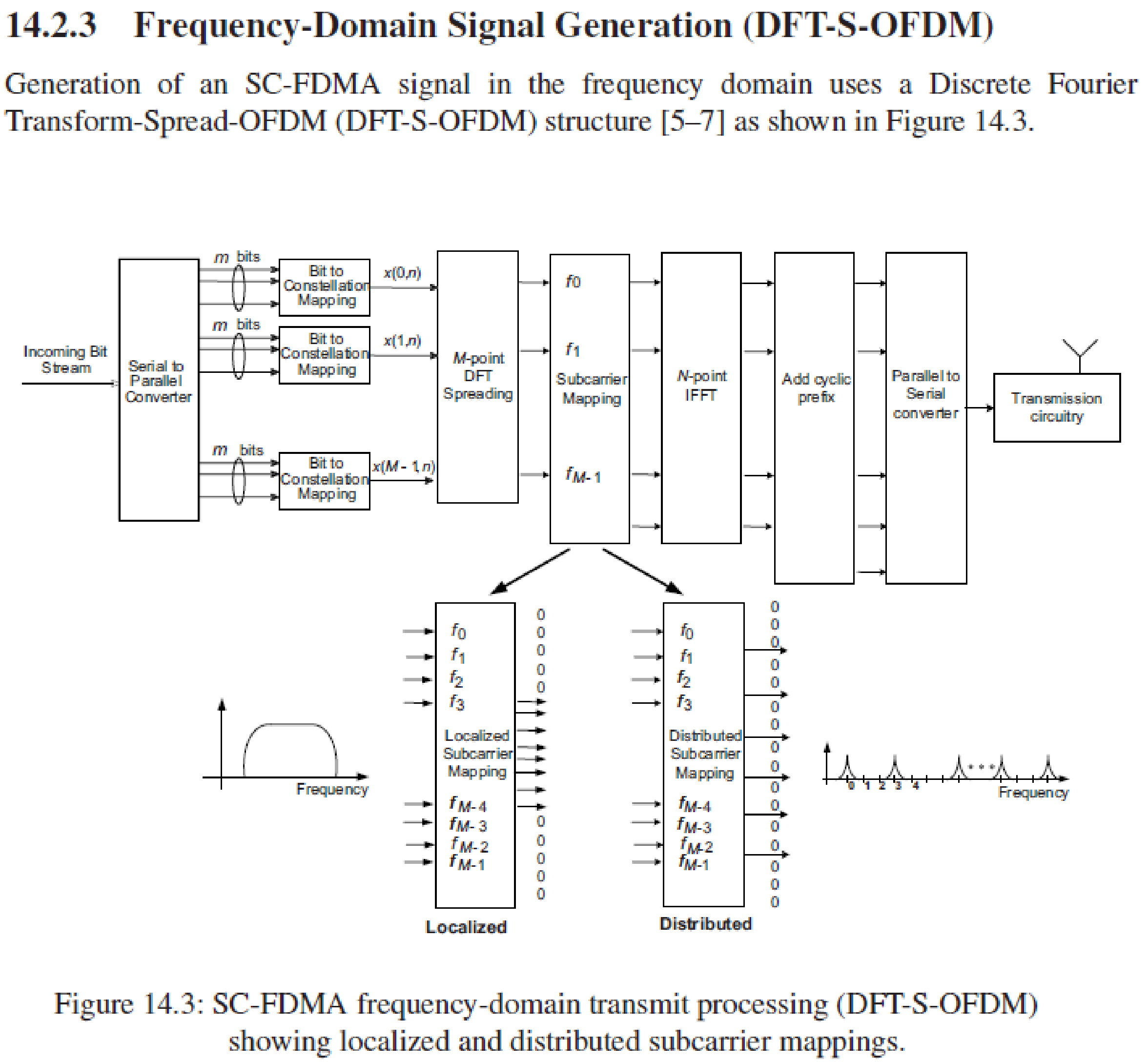
US Patent No. 10,833,908: Claim 30

“30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal.”

	 **Figure 5.2.1-1: Transmitter scheme of SC-FDMA** The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$. There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively. - Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6) - Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5) See e.g., 3GPP TS 36.300 V8.12.0 at pgs. 27-28.

US Patent No. 10,833,908: Claim 30

"30. The mobile station of claim 21, wherein: the first type of transmitter signal processing circuit is an OFDM transmitter signal processing circuit comprising: a serial to parallel converter, an inverse Fourier transform, and a cyclic prefix addition circuit; and the OFDM transmitter signal processing circuit outputs the first uplink signal."



14.2.3 Frequency-Domain Signal Generation (DFT-S-OFDM)

Generation of an SC-FDMA signal in the frequency domain uses a Discrete Fourier Transform-Spread-OFDM (DFT-S-OFDM) structure [5–7] as shown in Figure 14.3.

Figure 14.3: SC-FDMA frequency-domain transmit processing (DFT-S-OFDM) showing localized and distributed subcarrier mappings.

See Sesia, Toufik and Baker, "LTE: The UMTS Long Term Evolution From Theory to Practice", at pg. 320.

See also Claim 10.