***Ericsson Inc. and Telefonaktiebolaget LM Ericsson*, Petitioners**

v.

***Intellectual Ventures II LLC*, Patent Owner**

IPR2015-01664
U.S. Patent No. 7,787,431

Exhibit 2006

Before Jameson Lee, Justin Busch and J. John Lee,
Administrative Patent Judges

Ground for Institution

- “claims 8-12 and 18-22 of the ‘431 patent are unpatentable, under 35 U.S.C. §103(a), as obvious over the combination of Dulin, Yamaura, Hwang, and Zhuang”

Institution Decision at p. 21

Petitioner's Proposed Prior Art Combination for Independent Claim 8 of the '431 Patent

8.0	A cellular base station comprising:
8.1	circuitry configured to transmit a broadcast channel in an orthogonal frequency division multiple access (OFDMA) core-band;
8.2	wherein the core-band is substantially centered at an operating center frequency and the core-band includes a first plurality of subcarrier groups, wherein each subcarrier group includes a plurality of subcarriers;
8.3	wherein the core-band is utilized to communicate a primary preamble sufficient to enable radio operations;
8.4	the primary preamble being a direct sequence in the time domain with a frequency content confined within the core-band or being an OFDM symbol corresponding to a particular frequency pattern within the core-band;

Alleged prior art

- Dulin (green)
- Yamaura (purple)
- Hwang (red)
- Zhuang (blue)

Patent Owner Response at pp. 23-24

Petitioner's Proposed Prior Art Combination for Independent Claim 8 of the '431 Patent (cont.)

8.5	wherein properties of the primary preamble comprise: an autocorrelation having a large correlation peak with respect to sidelobes;
8.6	a cross-correlation with other primary preambles having a small cross-correlation coefficient with respect to power of other primary preambles; and
8.7	a small peak-to-average ratio; and
8.8	wherein a large number of primary preamble sequences exhibit the properties; and
8.9	circuitry configured to transmit control and data channels using a variable band including a second plurality of subcarrier groups, wherein the variable band includes at least the core-band.

Alleged prior art

- Dulin
- Yamaura
- Hwang
- Zhuang

Patent Owner Response at p. 24

Petitioner's Proposed Prior Art Combination for Independent Claim 18 of the '431 Patent

18.0	A variable bandwidth communication method comprising:
18.1	transmitting a broadcast channel by a cellular base station in an orthogonal frequency division multiple access (OFDMA) core-band;
18.2	wherein the core-band is substantially centered at an operating center frequency and the core-band includes a first plurality of subcarrier groups, wherein each subcarrier group includes a plurality of subcarriers;
18.3	wherein the core-band is utilized to communicate a primary preamble sufficient to enable radio operations;
18.4	the primary preamble being a direct sequence in the time domain with a frequency content confined within the core-band or being an OFDM symbol corresponding to a particular frequency pattern within the core-band;

Alleged prior art

Green	Dulin
Purple	Yamaura
Red	Hwang
Blue	Zhuang

Patent Owner Response at p. 25

Petitioner's Proposed Prior Art Combination for Independent Claim 18 of the '431 Patent (cont.)

18.5	wherein properties of the primary preamble comprise: an autocorrelation having a large correlation peak with respect to sidelobes;
18.6	a cross-correlation with other primary preambles having a small cross-correlation coefficient with respect to power of other primary preambles; and
18.7	a small peak-to-average ratio; and
18.8	wherein a large number of primary preamble sequences exhibit the properties; and
18.9	transmitting control and data channels by the cellular base station using a variable band including a second plurality of subcarrier groups, wherein the variable band includes at least the core-band.

Alleged prior art

- Dulin
- Yamaura
- Hwang
- Zhuang

Patent Owner Response at p. 25-26

Summary of Argument

- The Prior Art Combination Does Not Disclose All of the Claim Elements of Independent Claims 8 or 18
  – Claim elements 8.1 and 18.1: "transmit[ting] a broadcast channel [] in an orthogonal frequency division multiple access (OFDMA) core-band"
  – Claim elements 8.9 and 18.9: "transmit[ting] control and data channels [] using a variable band including a second plurality of subcarrier groups, wherein the variable band includes at least the core-band"

Patent Owner Response at pp. 27, 37

Summary of Argument (cont.)

- Petitioner Relies on an Improper Hindsight Analysis
- No Reason to Combine Dulin, Yamaura, Hwang, and Zhuang
  - Dulin Teaches Away
  - No Reasonable Expectation of Success
- Petitioner's Expert Assumes an Extraordinary Level of Skill in the Art

Patent Owner Response at pp. 47-61

Undisputed Claim Constructions

Claim Term	Agreed Construction
core-band	a frequency segment that is not greater than the smallest operating channel bandwidth among all the possible spectral bands that a receiver is designed to operate with
primary preamble	a signal transmitted near the beginning of a transmission, such as a frame or time slot, and occupying only the core-band
peak-to-average ratio	peak-to-average power ratio
first plurality of subcarrier groups	a first collection of two or more subcarrier groups, each of which includes at least two subcarriers
second plurality of subcarrier groups	a second collection of two or more subcarrier groups, distinct from the first plurality of subcarrier groups, each of which includes at least two subcarriers
control and data channels	control channels and data channels

Patent Owner Response at p. 13; Petitioner's Reply at pp. 2-3

Disputed Claim Constructions

’431 Patent Claim Term	Patent Owner’s Proposed Construction	Petitioner’s Proposed Construction
transmitting a broadcast channel in an OFDMA core-band	transmitting a broadcast channel by multiplexing the broadcast channel information using OFDMA on to subcarriers within the limits of a frequency segment that is not greater than the smallest operating channel bandwidth among all the possible spectral bands with which the receiver is designed to operate	No construction is necessary.
variable band	a frequency band having variable operating channel bandwidth	No construction necessary/ variable bandwidth

Patent Owner Response at pp. 14-16, 21-22; Petitioner Reply at pp. 3-8

Missing Claim Elements

- “transmitting a broadcast channel in an OFDMA core-band”
- “circuitry configured to transmit control and data channels using a variable band including a second plurality of subcarrier groups, wherein the variable band includes at least the core-band”

Patent Owner Response at pp. 27, 37

Missing Claim Element 8.1: transmit[ting] a broadcast channel in an OFDMA core-band

Element	Claim 8
8.1	circuitry configured to transmit a broadcast channel in an orthogonal frequency division multiple access (OFDMA) core-band;

Alleged prior art

- Dulin
- Yamaura
- Hwang
- Zhuang

Patent Owner Response at pp. 27-37

Disputed Claim Construction: “transmit[ting] a broadcast channel in an OFDMA core-band”

’431 Patent Claim Term	Patent Owner’s Proposed Construction	Petitioner’s Proposed Construction
transmitting a broadcast channel in an OFDMA core-band	Transmitting a broadcast channel by multiplexing the broadcast channel information using OFDMA on to subcarriers within the limits of a frequency segment that is not greater than the smallest operating channel bandwidth among all the possible spectral bands with which the receiver is designed to operate.	No construction necessary.

Patent Owner Response at pp. 14-16; Petitioner Reply at pp. 3-5

Disputed Claim Construction: "transmit[ting] a broadcast channel in an OFDMA core-band"

52. The claim term "in" is a preposition used to indicate "inclusion, location, or position within limits," or "within the limits, bounds, or area of." Exhibit 2004 (Merriam-Webster's Collegiate Dictionary, 11th ed. at p. 627 (2003)); Exhibit 2005 (The American Heritage Desk Dictionary, 4th ed. at 429 (2003)).

Ex. 2001, Zeger Declaration at ¶52

Disputed Claim Construction: "transmit[ting] a broadcast channel in an OFDMA core-band"

54. Set forth below is annotated Figure 6 from the '431 patent that depicts a broadcast channel transmitted within an OFDMA core-band.

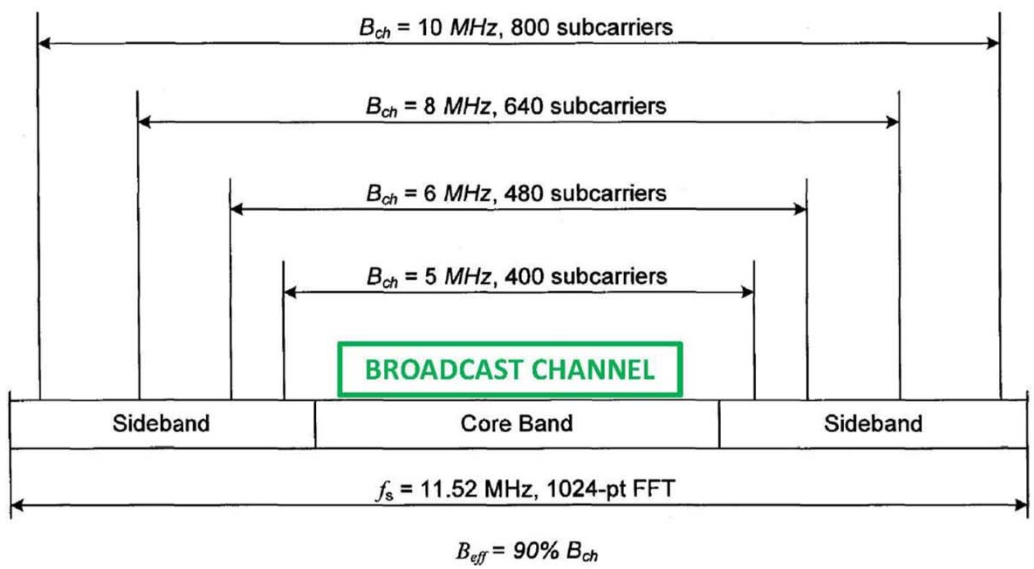


FIG. 6

Ex. 2001, Zeger Declaration at ¶54

Disputed Claim Construction: "transmit[ting] a broadcast channel in an OFDMA core-band"

56. In its Institution Decision, the Board determined that "the plain meaning of transmitting a broadcast channel in a core-band merely requires transmitting some part of the broadcast channel in a core-band and does not exclude transmitting another part of the broadcast channel outside the core-band." *Ericsson Inc. et al. v. Intellectual Ventures II LLC*, IPR2015-01664, Paper 7 at 11 (P.T.A.B. Feb. 11, 2016). I respectfully disagree with the conclusion of the Board.

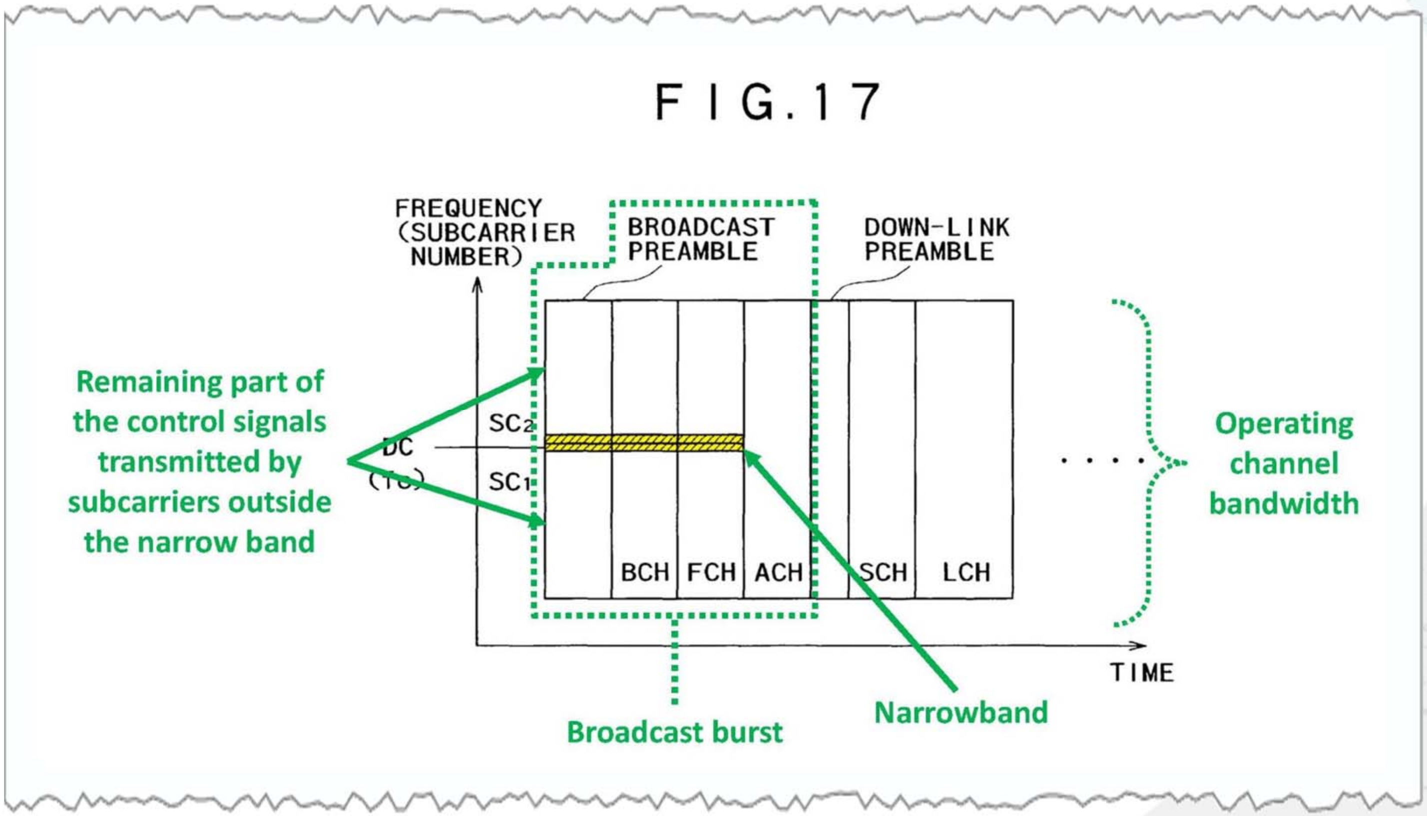
Ex. 2001, Zeger Declaration at ¶56

Disputed Claim Construction: "transmit[ting] a broadcast channel in an OFDMA core-band"

18. In other words, the mobile station receives the core-band to operate in a primary state, then receives the sidebands to transit to normal full-bandwidth operation. A person of ordinary skill in the art would understand that, in the context of the '431 patent, the part of the broadcast channel not transmitted within the core-band is necessarily transmitted within the side-band.

Ex. 2001, Zeger Declaration at ¶57

Only Part of Yamaura's Control Signals Are Transmitted in the Narrow Band



Ex. 2001, Zeger Declaration at ¶115

Yamaura's Broadcast Burst

The broadcast burst consists of BCH for the multiple addressing of broadcast preamble and base station information, FCH to inform each terminal station of the traffic channel allocation in the same frame, and ACH for reply to RCH used for calling from the terminal station. In the case of this embodiment, the two subcarriers SC_1 and SC_2 shown in FIG. **16** are used for transmission of specific control signals in the sections of broadcast preamble, BCH, and FCH in the broadcast burst.

FIG. 16

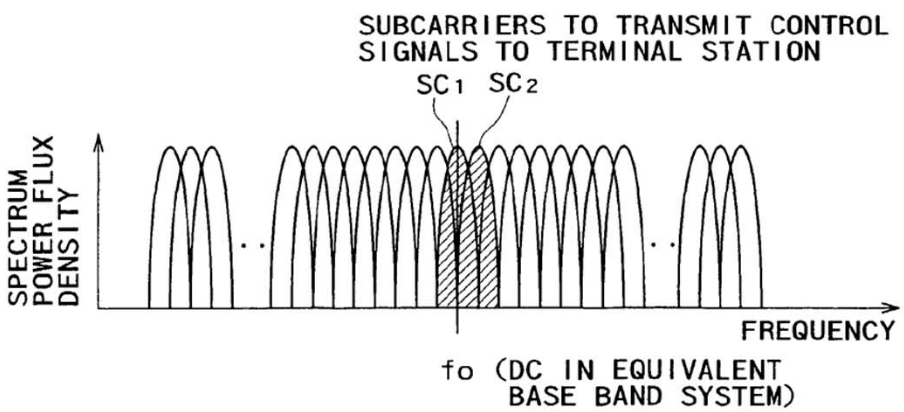
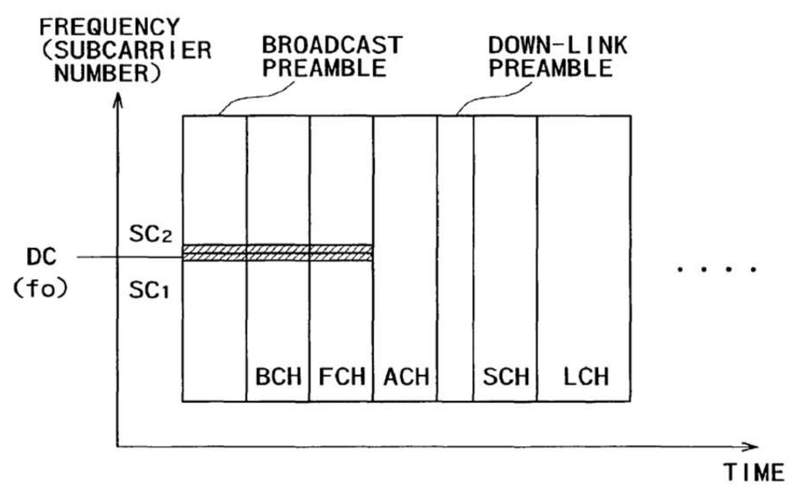


FIG. 17



Ex. 1003, Yamaura, 21:7-15; Fig. 16 and 17

Yamaura's Passing Band Variable Filter

This passing band variable filter **236** is so designed as to vary the passing band according to control by the control unit **202**. At the time of ordinary reception, it is so set up as to pass the wide band including all the subcarriers (**53** in this case) in one transmission band shown in FIG. **16**. At the time of waiting reception, it is so set up as to pass the narrow band including only the two subcarriers SC_1 and SC_2 near the center.

FIG.16

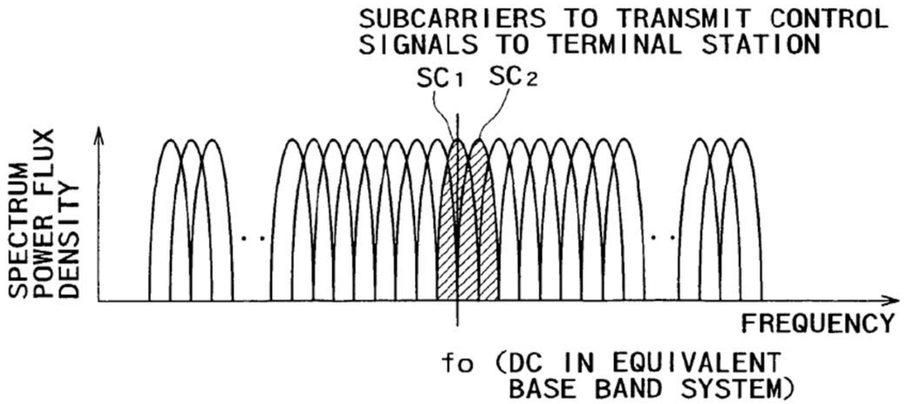
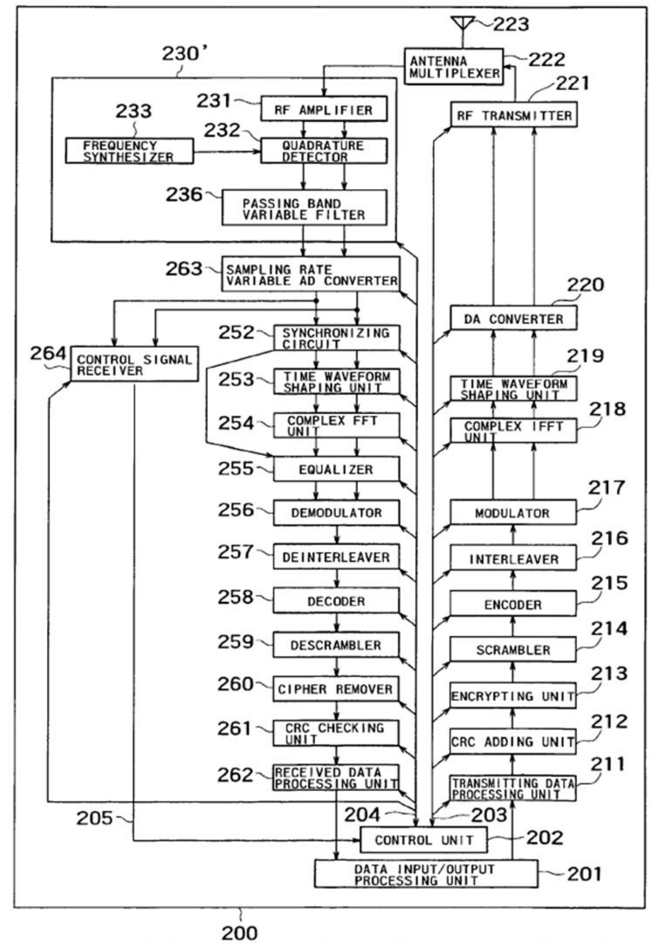


FIG.18



Ex. 1003, Yamaura at 21:60-67; Figs. 16 and 18

Only Part of Yamaura's Control Signals Are Transmitted in the Narrow Band

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output, the control unit **302** instructs the transmitting data processing unit **311** through the transmitting system control line **303** to transmit NAK signal to the base station as the called party of radio communication (not shown). The transmitting data processing unit **311** sends NAK signal after performing multiplexing on the transmitting data. The NAK signal is transmitted to the base station by processing of the transmitting system as explained above. Upon receipt of this transmission, the base station retransmits the block by which NAK signal has been transmitted.

In the case of stream communication, like voice communication, in which retransmission by the ARQ system is not employed, the received data processing unit **343** functions as follows. If the input signal from the CRC checking unit **342** contains information that the received block contains no errors, it outputs the received block to the received data processing unit **343** as mentioned above. Conversely, if the input signal from the CRC checking unit **342** contains information that the received block contains errors, the received data processing unit **343** discards the received block (handling it as erasure) and performs interpolation by using the received block before one block.

Each part of the transmitting system is connected to the control unit **302** through the transmitting system control line **303**, and the control unit **302** controls and monitors various operations for the transmitting system through it (such as on-off of the transmitting system, control and monitor of the RF transmitter **321**, fine adjustment of transmitting timing, change of the coding system and signal point mapping, and control of retransmitting). Each part of the receiving system is connected to the control unit **302** through the receiving system control line **304**, and the control unit **302** controls and monitors various operations for the receiving system through it (such as on-off of the receiving system, control and monitor of the RF receiver **331**, fine adjustment of receiving timing, change of the coding system and signal point mapping, and control of retransmitting).

The conventional OFDM communication system mentioned above works in such a way that the signal to call a terminal station from a base station is transmitted, with all information placed on subcarriers in the transmission band, and the called terminal station receives all the subcarriers to receive the calling signal. This means that the terminal station has to receive and decode the band signal (corresponding to 20 MHz) every 2 ms regardless of presence or absence of data being transmitted and received. It follows, therefore, that large quantities of signals have to be processed even when no information data is transmitted and received. This leads to a waste of batteries in the case where the terminal station is a battery-driven mobile station.

One known way to address this problem is to thin out the frame intervals to be received by negotiation between a base station and a terminal station, instead of receiving control signal frames in all MAC frames.

However, even in the case where the frame intervals to be received are thinned out, the frame period to be received needs reception in the same way as information transmission and reception. Therefore, loads in a terminal station are not so reduced by the above-mentioned way.

OBJECT AND SUMMARY OF THE INVENTION

The present invention was completed to reduce loads in a base station or a terminal station when control signals are transmitted from a base station to a terminal station in the radio communication system of the type mentioned above.

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The first aspect of the present invention resides in a radio communication method for exchanging information between a base station and a terminal station by means of multi-carrier signals due to OFDM modulation scheme, wherein said radio communication method is characterized in that part of control signals addressed to a terminal station from a base station is transmitted by means of a carrier whose band is narrower than that for said multi-carrier signals, said carrier being arranged near the frequency band used for information transmission, in the case where there exist continuously a plurality of frequency bands used for information transmission.

The advantage of the first aspect of the present invention is that all that is necessary for a terminal station when it receives only part of control signals is to receive the narrow band carrier.

The second aspect of the present invention resides in a radio communication method for exchanging information between a base station and a terminal station by means of multi-carrier signals due to OFDM modulation scheme, wherein said radio communication method is characterized in that part of control signals addressed to a terminal station from a base station is transmitted by means of one or more specific subcarriers in the bandwidth for multi-carrier signals.

The advantage of the second aspect of the present invention is that all that is necessary for a terminal station when it receives only part of control signals is to receive one or more specific subcarriers in the bandwidth for multi-carrier signals.

The third aspect of the present invention resides in a radio communication method for exchanging information between a base station and a terminal station with a frame period by means of multi-carrier signals due to OFDM modulation scheme, wherein said radio communication method is characterized in that part of control signals addressed to a terminal station from a base station is transmitted at a specific position of the frame period.

The advantage of the third aspect of the present invention is that all that is necessary for a terminal station when it receives only part of control signals is to receive the specific position in the frame period.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating an example of the constitution of the system to which the present invention is applied.

FIG. **2** is a block diagram showing an example of the constitution of the transmitting unit of the base station according to the first embodiment of the present invention.

FIG. **3** is a diagram of frequency characteristics showing an example of the arrangement of carriers according to the first embodiment of the present invention.

FIG. **4** is a timing diagram showing an example of the signal transmitting state according to the first embodiment of the present invention.

FIG. **5** is a diagram of frequency characteristics showing another example of the arrangement of subcarriers according to the first embodiment of the present invention.

FIG. **6** is a block diagram showing an example of the constitution of the terminal station according to the first embodiment of the present invention.

FIG. **7** is a diagram illustrating an example (part 1) of the transition of state in the terminal station according to the first embodiment of the present invention.

FIG. **8** is a diagram illustrating an example (part 2) of the transition of state in the terminal station according to the first embodiment of the present invention.

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The first aspect of the present invention resides in a radio communication method for exchanging information between a base station and a terminal station by means of multi-carrier signals due to OFDM modulation scheme, wherein said radio communication method is characterized in that part of control signals addressed to a terminal station from a base station is transmitted by means of a carrier whose band is narrower than that for said multi-carrier signals, said carrier being arranged near the frequency band used for information transmission, in the case where there exist continuously a plurality of frequency bands used for information transmission.

The advantage of the first aspect of the present invention is that all that is necessary for a terminal station when it receives only part of control signals is to receive the narrow band carrier.

Ex. 1003, Yamaura at 6:1-15

Only Part of Yamaura's Control Signals Are Transmitted in the Narrow Band

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FIG. **17** shows the structure of one MAC frame used in this embodiment. Here, the transmission-reception unit is define, which is the MAC frame with a cycle of 2 ms. It is composed mainly of four sections: broadcast burst, down-link phase, up-link phase, and contention phase. Incidentally, FIG. **17** shows the broadcast burst and down-link phase only.

The broadcast burst consists of BCH for the multiple addressing of broadcast preamble and base station information, FCH to inform each terminal station of the traffic channel allocation in the same frame, and ACH for reply to RCH used for calling from the terminal station. In the case of this embodiment, the two subcarriers SC_1 and SC_2 shown in FIG. **16** are used for transmission of specific control signals in the sections of broadcast preamble, BCH, and FCH in the broadcast burst.

In each MAC frame, the section of ACH in the broadcast burst and the two subcarriers SC_1 and SC_2 in the section of the down-link phase and up-link phase are not used for transmission of specific control signals. In these sections which are not used for transmission of specific control signals, the two subcarriers SC_1 and SC_2 may be made null carriers which do not transmit any information or they may be used to transmit whatever information. A possible alternative is to make only the subcarrier SC_1 with a central frequency **f0** null carries in the section after ACH and to use the adjoining subcarrier SC_2 to transmit information in the section after ACH.

Radio transmission from the base station with the above-mentioned subcarrier arrangement may be accomplished by the construction as explained in the first embodiment with reference to FIG. **2**. All that is necessary is to place specific control signals (such as calling signals for the terminal station) in the data in the two subcarriers SC_1 and SC_2. In this case, the signals to be transmitted by using these two subcarriers SC_1 and SC_2 may undergo simple coding, such as M-ary coding, which permits easy processing for power saving, as in the case explained in the first embodiment with reference to FIGS. **9** to **12**. Alternatively, it is possible to transmit repeatedly the same data in inverted form, thereby performing the transmission processing capable of removing DC offset, as explained with reference to FIGS. **13** to **15**. It is also possible to perform transmission using the coding format which is identical with the signal to be transmitted by means of the other carriers.

The terminal station to receive signals transmitted from the base station is constructed as illustrated below by example with reference to FIG. **18**. The terminal station **200'** shown in FIG. **18** is constructed in the same way as the terminal station **200** shown in FIG. **6**. Therefore, its description is omitted here. The receiving system of the terminal station **200'** is constructed as follows. The radio signal from the base station is received by the antenna **223**, and it enters the RF receiver **230'** through the antenna multiplexer **222**. In the RF receiver **230'**, the received signal is amplified by the RF amplifier **231**. The amplified output is mixed with the sinusoidal wave (generated by the frequency synthesizer **233**) in the quadrature detector **232**, and then it is separated into I-component and Q-component, with the center frequency being DC. Only those signals in a specific band are filtered by the passing band variable filter **236**.

This passing band variable filter **236** is so designed as to vary the passing band according to control by the control unit **202**. At the time of ordinary reception, it is so set up as to pass the wide band including all the subcarriers (**53** in this case) in one transmission band shown in FIG. **16**. At the time of waiting reception, it is so set up as to pass the narrow band including only the two subcarriers SC_1 and SC_2 near the center.

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The output from the passing band variable filter **236** enters the AD converter **263**, which performs conversion from analogy waveform into digital waveform. The AD converter **263** used herein is the one capable of changing the sampling rate. Thus, it changes the sampling rate according to ordinary reception and waiting reception. This sample rate is established by control from the control unit **202**.

The output from the AD converter **263** enters the control signal receiver **264** and the synchronizing circuit **252**. The control signal receiving unit **264** detects control signals from the base station and sends the detected signal to the control unit **202** through the control signal line **205** (call-informing signal line mentioned later). The control signal to be detected by the control signal receiver **264** includes, for example, the signal indicating that the base station is calling the terminal station or the group to which the terminal station belongs.

The signal that has entered the synchronizing circuit **252** undergoes frame synchronization and frequency error correction, and the processed signal is output. The processing that is performed in the course from the synchronizing circuit **252** to the received data processing unit **262** is the same as that in the terminal station shown in FIG. **6**. The output from the received data processing unit **262** enters the data input/output processing unit **201**, which outputs the result of conversion into voice signals (in the case of voice communication) or data signals (in the case of data communication by connection to a computer).

The terminal station **200'** of the communication system in this embodiment works at waiting time as explained below with reference to FIG. **19**. Here, the term "waiting" denotes a state in which the terminal station is not performing information communication with the base station but is ready to reply to calling from the base station at any time. Incidentally, in the following description, it is assumed that the control signal transmitted by means of the narrow-band carrier is the signal data (or part thereof) to call the terminal station.

It is assumed that the terminal station **200'**, with its power turned on (in Step S**11**) but with the waiting operation not yet started, performs association with the base station so as to receive beforehand the code for calling or any data corresponding thereto (in Step S**12**). It is also assumed that an agreement that the intervals of frames to be received is thinned out is made by negotiation between the base station and the terminal station. It is assumed that the time interval and reference time have been established in the control unit **202** of the terminal station **200'**.

When the terminal station receives control signals transmitted by means of the narrow-band carrier, with the foregoing settings established, it puts only the fundamental frequency oscillator and the counter in the control unit **202** into action at all times. Then it sets the timer to determine timing for reception. All other parts are in a sleep state, with power turned off, under control from the control unit **202** through the receiving system control line **204** (Step S**13**).

As the time for reception approaches while the system is in this sleep state, the control unit **202** turns on power for the parts necessary for reception of stand-by signals through the control signal line **204** of the receiving system. The timing for power on is slightly earlier than the time at which signals to be received would arrive, in consideration of the frequency errors of the fundamental frequency oscillator and the rise time required for the receiver of the terminal station after it has been turned on.

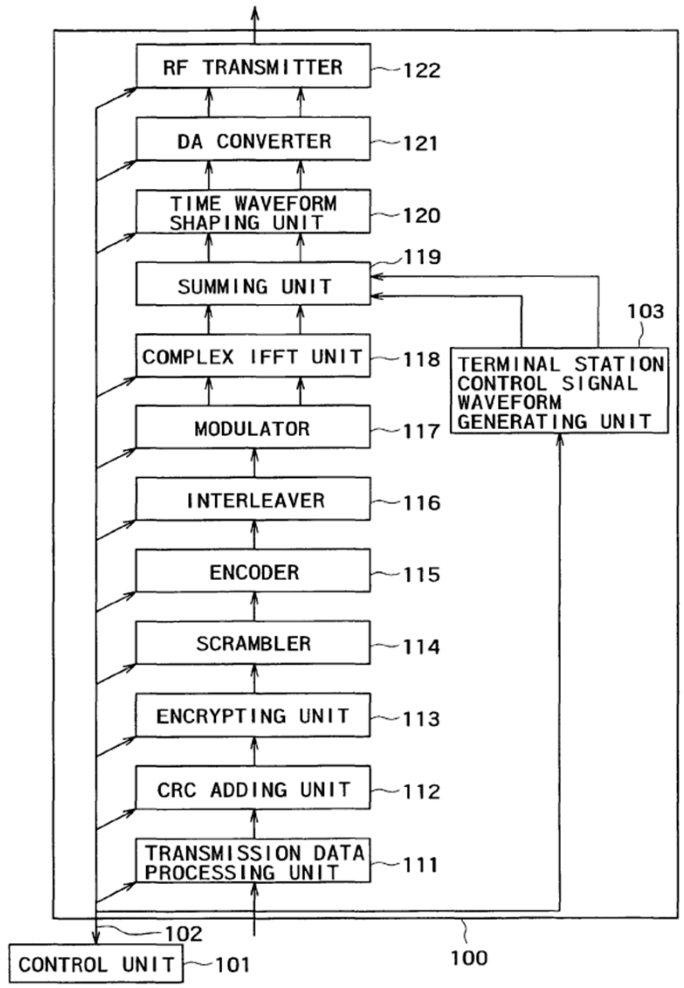
When the timing to receive the control signal transmitted by means of the narrow-band carrier is reached, the filter **236** is set in the narrow band, the sampling rate for waiting reception is established in the AD converter **263**, and only the RF

In each MAC frame, the section of ACH in the broadcast burst and the two subcarriers SC_1 and SC_2 in the section of the down-link phase and up-link phase are not used for transmission of specific control signals. In these sections which are not used for transmission of specific control signals, the two subcarriers SC_1 and SC_2 may be made null carriers which do not transmit any information or they may be used to transmit whatever information. A possible alternative is to make only the subcarrier SC_1 with a central frequency **f0** null carries in the section after ACH and to use the adjoining subcarrier SC_2 to transmit information in the section after ACH.

Ex. 1003, Yamaura at 21:16-26

Only Part of Yamaura's Control Signals Are Transmitted in the Narrow Band

F I G . 2



In other words, it instructs through the transmission control signal line **102** that that portion of data to be transmitted by its subcarrier should be filled with nulls in the bit string generated y the transmission data generating unit **111**, and the transmission data generating unit **401** perform the instructed processing. In the course from the CRC adding unit **112** to the complex IFFT unit **118**, ordinary processing is carried out on the assumption that there exist no data in that portion. The summing unit **119** adds to that portion (in which data is absent) the signal waveform generated by the terminal station control signal waveform generating unit **103**.

Ex. 1003, Yamaura 9:33-44; Fig. 2

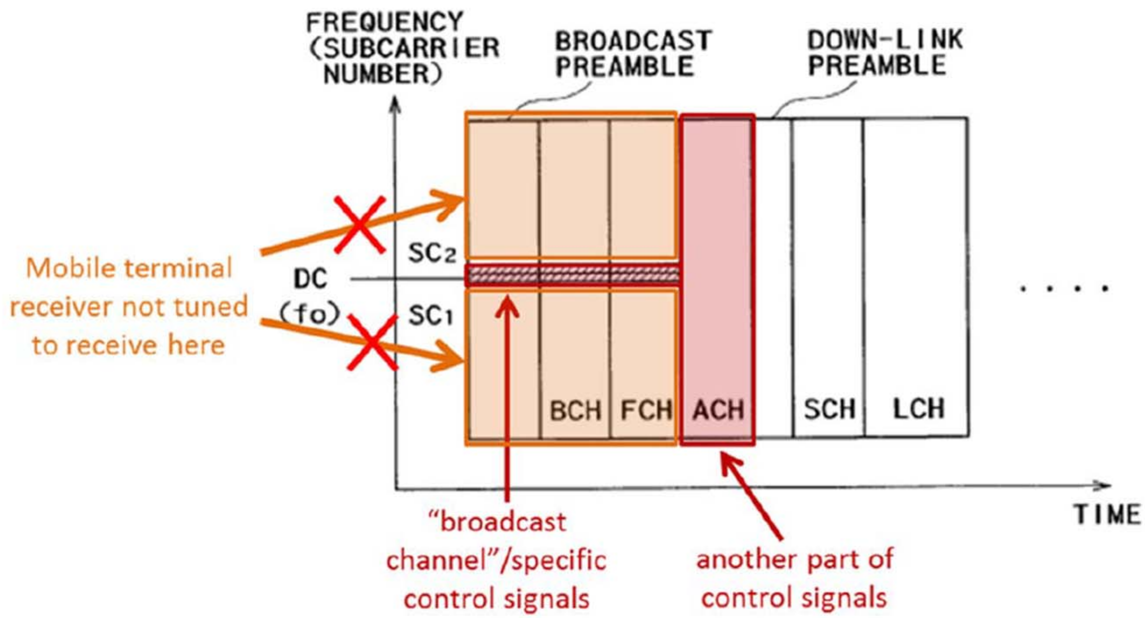
Only Part of Yamaura's Control Signals Are Transmitted in the Narrow Band

A person of ordinary skill in the art would understand that the other control signals addressed to the terminals are transmitted by means of the other subcarriers during the broadcast burst period of the frame. Thus, although the base station in Yamaura broadcasts additional control signals in the other subcarriers of the operating channel bandwidth during the broadcast preamble, BCH, and FCH periods of the frame, the mobile station or subscriber "receives only part of control signals[,]" namely, the narrow-band control signals, during these periods. *See id.* at 28:43.

Ex. 2001, Zeger Declaration at ¶107

Only Part of Yamaura's Control Signals Are Transmitted in the Narrow Band

FIG. 17



Yamaura, Figure 17 (annotated); *see* ERIC-1020, ¶ 12.

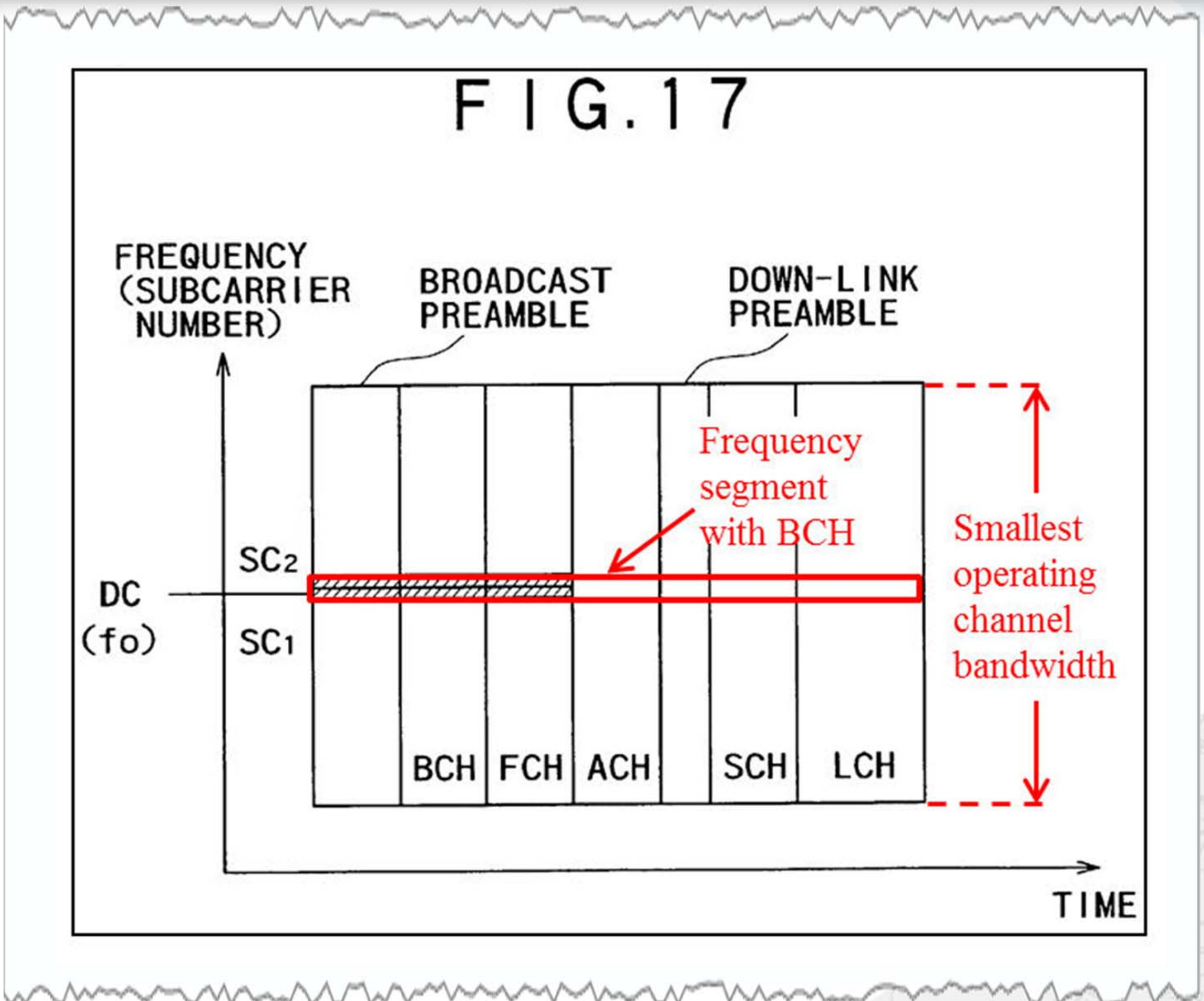
Petitioner Reply at p. 14

Missing Element: Claim Element 8.1 Petitioner's Analysis

8.1	circuitry configured to transmit a broadcast channel in an orthogonal frequency division multiple access (OFDMA) core-band,	The combination of Dulin, Yamaura, and Hwang discloses the features recited in [8.1]. Dulin discloses an OFDMA base station having circuitry including framing units and modems, Yamaura discloses an OFDM base station having circuitry for transmission of a broadcast channel in a frequency segment not greater than an operating channel bandwidth, and Hwang discloses an OFDMA system having multiple possible operating channel bandwidths. Thus, the combined teachings of Hwang and Yamaura result in a system having a plurality of operating channel bandwidths.

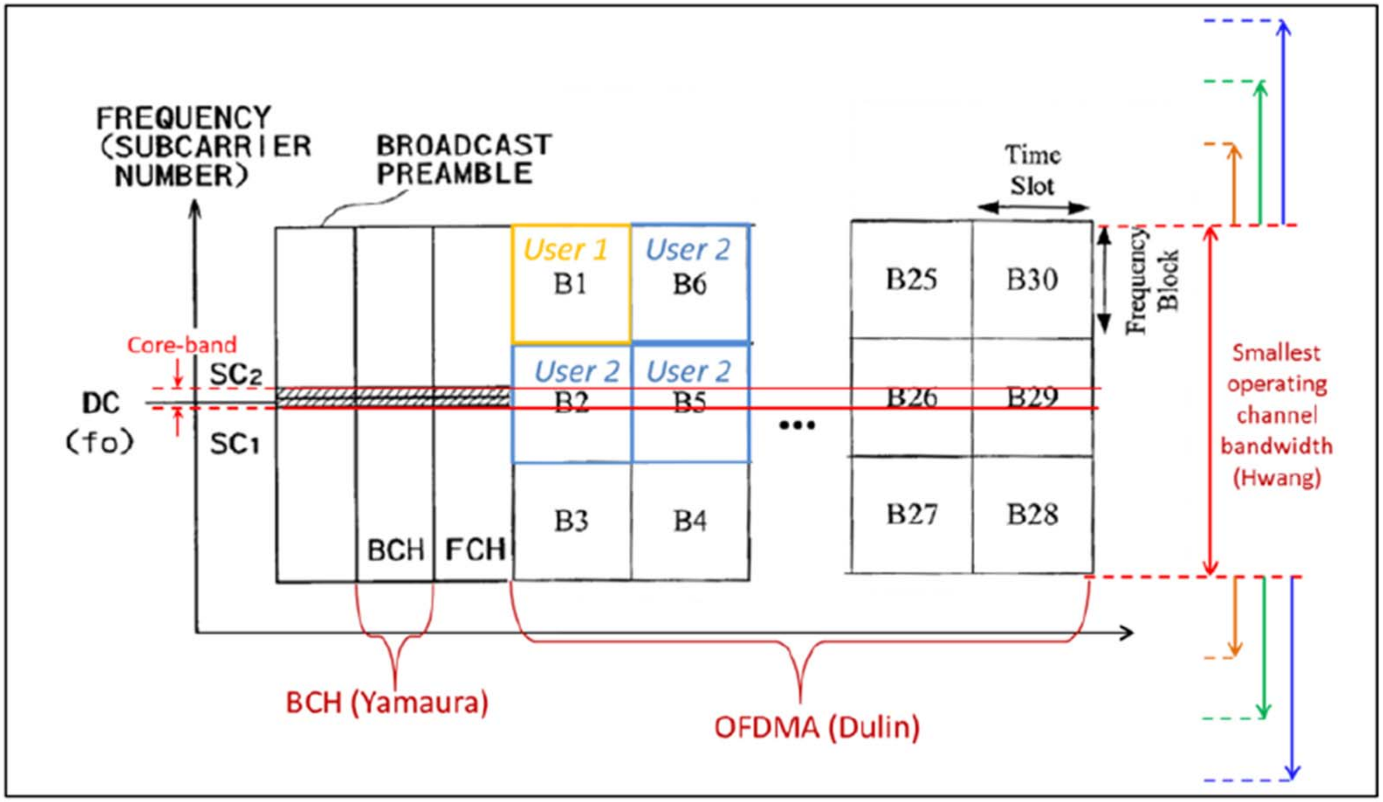
Ex. 1012, Haas Declaration at p. 63

Missing Element: Claim Element 8.1 Petitioner's Analysis



Ex. 1012, Haas Declaration at p. 70

Petitioner's Analysis of Claim Element 8.1



Combined Yamaura Fig. 17, Dulin Fig. 13A, Hwang Table 1 (annotated)

Petition at p. 31

Claim Element 8.9: "circuitry configured to transmit control and data channels using a variable band including a second plurality of subcarrier groups"

Element	Claim 8
8.9	circuitry configured to transmit control and data channels using a variable band including a second plurality of subcarrier groups, wherein the variable band includes at least the core-band.

Alleged prior art

Green	Dulin
Purple	Yamaura
Red	Hwang
Blue	Zhuang

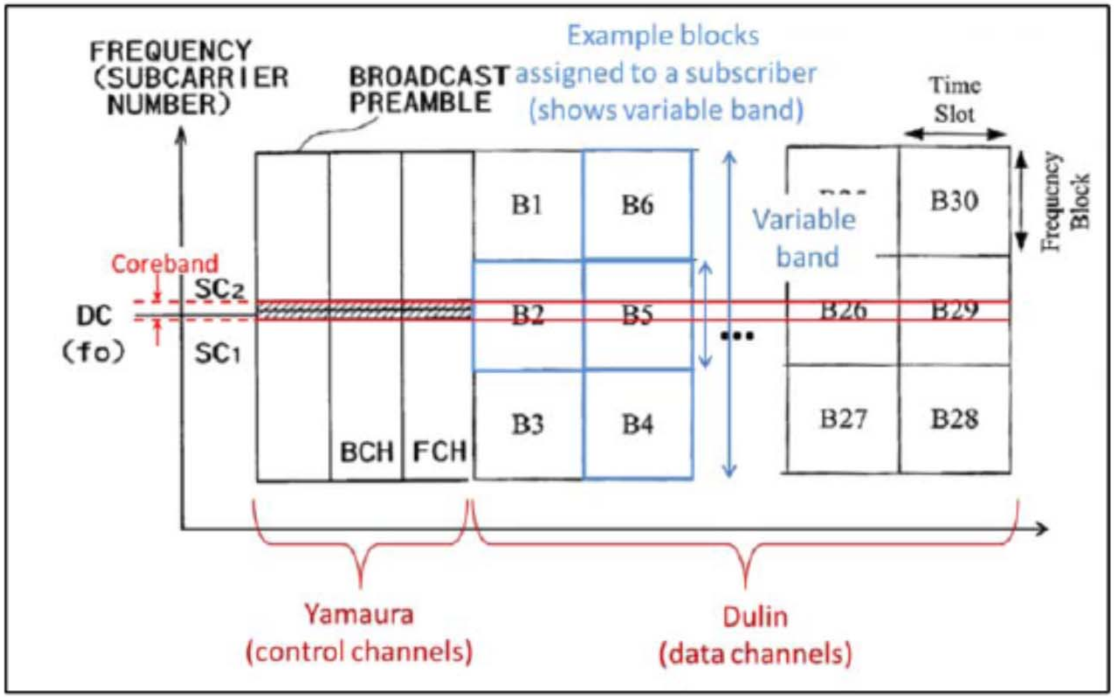
Patent Owner Response at pp. 24-25

Petitioner's Analysis of Claim Element 8.9

8.9	circuitry configured to transmit control and data channels using a variable band including a second plurality of subcarrier groups, wherein the variable band includes at least the	Dulin and Yamaura disclose the features recited in [8.9] (as per [8.1], the core-band is disclosed by the combination of Yamaura and Hwang). As discussed in [8.2], the combination of Yamaura and Hwang discloses the circuitry for transmitting control channels using subcarrier groups. Also, Dulin discloses transmitting data channels using a variable band with frequency blocks, each of which is a subcarrier group. Finally, when Yamaura is combined with Dulin, Dulin's variable band includes a core-band of Yamaura/Hwang.

Ex. 1012, Haas Declaration at p. 100

Petitioner's Analysis of Claim Element 8.9



Portions of Yamaura's Fig. 17 and Dulin's Fig. 13A (annotated)

Petition at p. 51

Disputed Claim Construction: "variable band"

'431 Patent Claim Term	Patent Owner's Proposed Construction	Petitioner's Proposed Construction
variable band	a frequency band having variable operating channel bandwidth	No construction necessary/ variable bandwidth

Patent Owner Response at pp. 21-22
Petitioner Reply at pp. 5-8

Disputed Claim Construction: "variable band"

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of this application. When the claims use the word "or" in reference to a list of two or more items, that word covers all of the following interpretations of the word: any of the items in the list, all of the items in the list and any combination of the items in the list.

Multi-Carrier Communication System

The physical media resource (e.g., radio or cable) in a multi-carrier communication system can be divided in both the frequency and time domains. This canonical division provides a high flexibility and fine granularity for resource sharing. FIG. **1** presents a radio resource divided into small units in both the frequency and time domains—subchannels and time slots. The subchannels are formed by subcarriers.

The basic structure of a multi-carrier signal in the frequency domain is made up of subcarriers. For a given bandwidth of a spectral band or channel (B_{ch}) the number of usable subcarriers is finite and limited, whose value depends on a size of an FFT (Fast Fourier Transform) employed, a sampling frequency (f_s), and an effective bandwidth (B_{eff}). FIG. **2** illustrates a schematic relationship between the sampling frequency, the channel bandwidth, and the usable subcarriers. As shown, the B_{eff} is a percentage of B_{ch}.

A basic structure of a multi-carrier signal in the frequency domain is made up of subcarriers and, illustrated in FIG. **3**, which shows three types of subcarriers as follow:

1. Data subcarriers, which carry information data;
2. Pilot subcarriers, whose phases and amplitudes are predetermined and made known to all receivers, and which are used for assisting system functions such as estimation of system parameters; and
3. Silent subcarriers, which have no energy and are used as guard bands and DC carriers.

The data subcarriers can be arranged into groups called subchannels to support scalability and multiple-access. Each subchannel may be set at a different power level. The subcarriers forming one subchannel may or may not be adjacent to each other. Each user may use some or all of the subchannels. A subchannel formed by the contiguous subcarriers is called a congregated or clustered subchannel. A congregated subchannel may have a different power level from others.

FIG. **4** illustrates the basic structure of a multi-carrier signal in the time domain which is generally made up of time frames, time slots, and OFDM symbols. A frame consists of a number of time slots, whereas each time slot is comprised of one or more OFDM symbols. The OFDM time domain waveform is generated by applying the inverse-fast-Fourier-transform (IFFT) to the OFDM signals in the frequency domain. A copy of the last portion of the time waveform, known as the cyclic prefix (CP), is inserted at the beginning of the waveform itself to form an OFDM symbol.

The downlink transmission in each frame begins with a downlink preamble, which can be the first or more of the OFDM symbols in the first downlink (DL) slot. The DL preamble is used at a base station to broadcast radio network information such as synchronization and cell identification.

Similarly, uplink transmission can begin with an uplink preamble, which can be the first or more of the OFDM symbols in the first uplink (UL) slot. The UL preamble is used by mobile stations to carry out the functions such as initial ranging during power up and handoff, periodic ranging and bandwidth request, channel sounding to assist downlink scheduling or advanced antenna technologies, and other radio functions.

Cellular Wireless Networks

In a cellular wireless network, the geographical region to be serviced by the network is normally divided into smaller

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areas called cells. In each cell the coverage is provided by a base station. This type of structure is normally referred to as the cellular structure. FIG. **5** depicts a cellular wireless network comprised of a plurality of cells. In each of these cells the coverage is provided by a base station (BS).

A base station is connected to the backbone of the network via a dedicated link and also provides radio links to the mobile stations within its coverage. Within each coverage area, there are located mobile stations to be used as an interface between the users and the network. A base station also serves as a focal point to distribute information to and collect information from its mobile stations by radio signals. If a cell is divided into sectors, from system engineering point of view each sector can be considered as a cell. In this context, the terms "cell" and "sector" are interchangeable.

Variable Bandwidth OFDMA

In accordance with aspects of certain embodiments of the invention, a variable bandwidth system is provided, while the time-domain signal structure (such as the OFDM symbol length and frame duration) is fixed regardless of the bandwidths. This is achieved by keeping the ratio constant between the sampling frequency and the length of FFT/IFFT. Equivalently, the spacing between adjacent subcarriers is fixed.

In some embodiments, the variable channel bandwidth is realized by adjusting the number of usable subcarriers. In the frequency domain, the entire channel is aggregated by subchannels. (The structure of a subchannel is designed in a certain way to meet the requirements of FEC (Forward Error Correction) coding and, therefore, should be maintained unchanged.) However, the number of subchannels can be adjusted to scale the channel in accordance with the given bandwidth. In such realization, a specific number of subchannels, and hence the number of usable subcarriers, constitute a channel of certain bandwidth.

For example, FIG. **6** illustrates the signal structure in the frequency domain for a communication system with parameters specified in Table 1 below. The numbers of usable subcarriers are determined based on the assumption that the effective bandwidth B_{eff} is 90% of the channel bandwidth B_{ch}. The variable channel bandwidth is realized by adjusting the number of usable subcarriers, whose spacing is set constant. The width of a core-band is less than the smallest channel bandwidth in which the system is to operate.

TABLE 1

Sample System Parameters

Sampling freq.	11.52 MHz			
FFT size	1024 points			
Subcarrier spacing	11.25 kHz			
Channel bandwidth	10 MHz	8 MHz	6 MHz	5 MHz
# of usable subcarriers	800	640	480	400

In this realization, using the invariant OFDM symbol structure allows the use of same design parameters for signal manipulation in the time-domain for a variable bandwidth. For example, in an embodiment depicted in FIG. **7**, a particular windowing design shapes the spectrum to conform to a given spectral mask and is independent of the operating bandwidth.

Radio Operation Via Core-Band

To facilitate the user terminals to operate in a variable bandwidth (VB) environment, specific signaling and control methods are required. Radio control and operation signaling is realized through the use of a core-band (CB). A core-band,

Variable Bandwidth OFDMA

In accordance with aspects of certain embodiments of the invention, a variable bandwidth system is provided, while the time-domain signal structure (such as the OFDM symbol length and frame duration) is fixed regardless of the bandwidths. This is achieved by keeping the ratio constant between the sampling frequency and the length of FFT/IFFT. Equivalently, the spacing between adjacent subcarriers is fixed.

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Ex. 1001, '431 patent at 4:16-62

Disputed Claim Construction: "variable band"

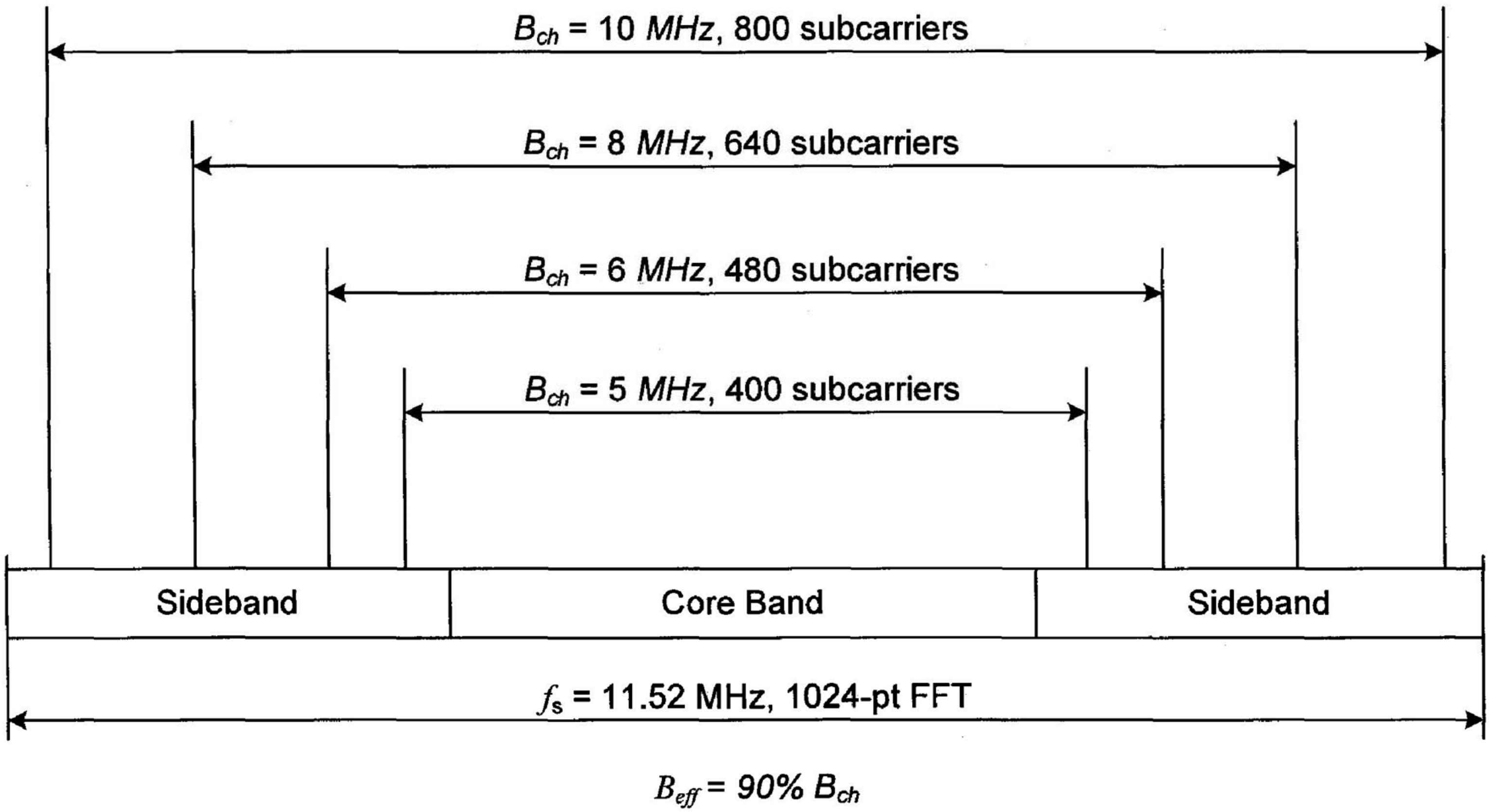


FIG. 6

Ex. 1001, '431 patent

Disputed Claim Construction: "variable band"

75. FIG. 6 reproduced below from the '431 patent "illustrates a variable channel bandwidth being realized by adjusting a number of usable subcarriers, whose spacing is set constant." *Id.* at 2:19-21; *See also, id.* at 4:25-28 ("the variable channel bandwidth is realized by adjusting the number of usable subcarriers[.]"). Several "operating channel bandwidths" – 5, 6, 8 and 10 MHz – are disclosed. *Id.* at 5:3-4.

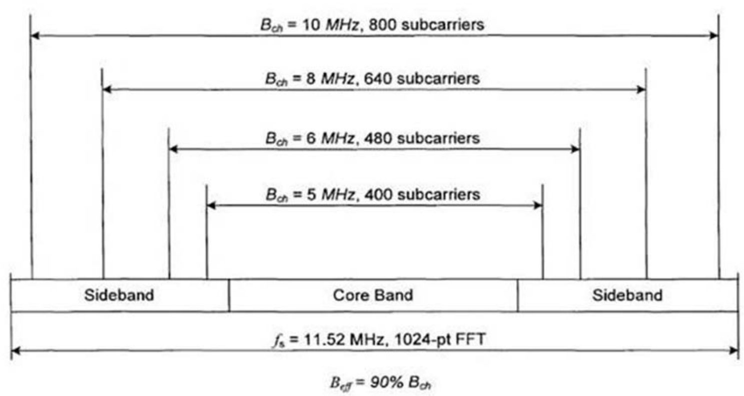


FIG. 6

Ex. 2001, Zeger Declaration at ¶75

Disputed Claim Construction: "variable band"

77. The '431 patent discloses, as illustrated above, a fixed bandwidth core-band within each of the operating channel bandwidths. *See id.* at 4:65-5:6 (stating "that for a system that is intended to work at 5-,6-,8-, and 10-Mhz, the width of the CB can be 4 MHz, as shown in FIG. 6."). "The rest of the [operating channel] bandwidth is called sideband (SB)." *Id.* at 5:7. As illustrated above, for a particular operating channel bandwidth the size of the frequency band that constitutes the side band is scaled "in accordance with the given bandwidth" to realize the full operating channel bandwidth.

Ex. 2001, Zeger Declaration at ¶77

Disputed Claim Construction: “variable band”

Petitioner’s Analysis

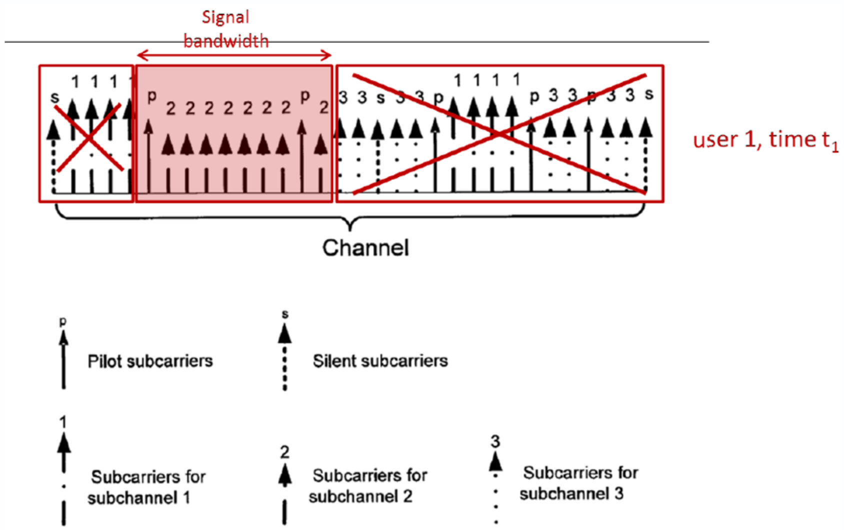


FIG. 3
Prior Art

“Each user may use some or all of the subchannels.” ’431 patent, 3:37

’431 patent, Figure 3 (annotated, user 1, time t_1)

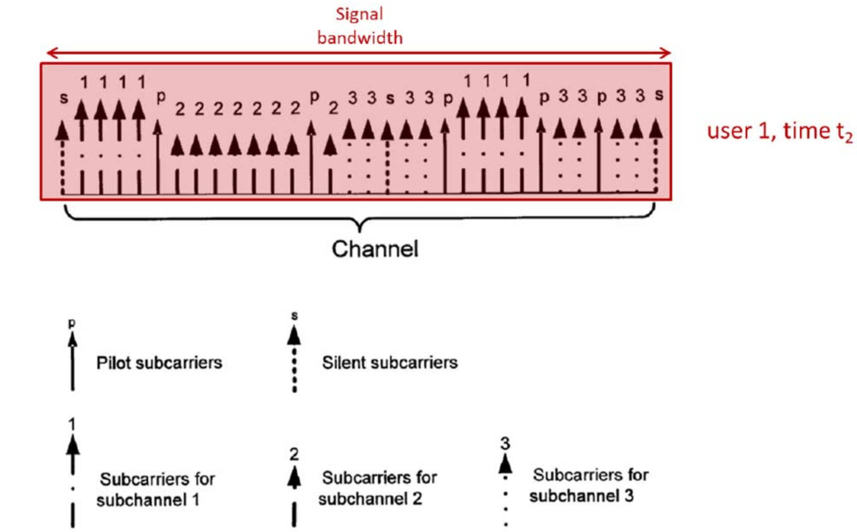


FIG. 3
Prior Art

“Each user may use some or all of the subchannels.” ’431 patent, 3:37

’431 patent, Figure 3 (annotated, user 1, time t_2)

Ex. 1020, Supplemental Haas Declaration at pp. 5-6

Disputed Claim Construction: "variable band"

Petitioner's Analysis

9. This understanding is consistent with other parts of the '431 patent. In one example, a mobile station is described as sending a "bandwidth request" to a base station, which is consistent with a mobile station requesting and thereafter receiving a varying signal bandwidth. As another example, the '431 patent states: "In some embodiments, the ***variable channel bandwidth*** is realized by adjusting the number of usable subcarriers." Ex. 1001, 4:25-26 (emphasis added).

Ex. 1020, Supplemental Haas Declaration at ¶9

Disputed Claim Construction: "variable band"

The variable channel bandwidth is realized by adjusting the number of usable subcarriers, whose spacing is set constant. The width of a core-band is less than the smallest channel bandwidth in which the system is to operate.

TABLE 1

Sample System Parameters				
Sampling freq.	11.52 MHz			
FFT size	1024 points			
Subcarrier spacing	11.25 kHz			
Channel bandwidth	10 MHz	8 MHz	6 MHz	5 MHz
# of usable subcarriers	800	640	480	400

Ex. 1001, '431 patent at 4:42-55

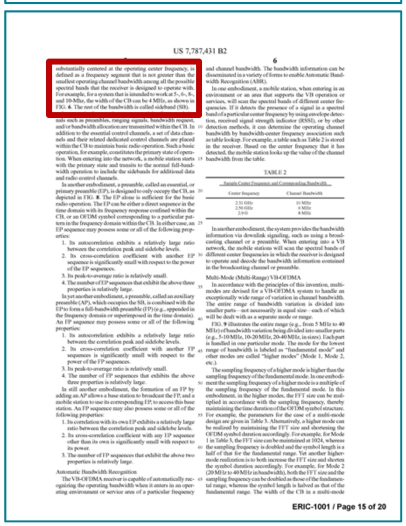
Disputed Claim Construction: “variable band”

Variable Bandwidth OFDMA

In accordance with aspects of certain embodiments of the invention, a variable bandwidth system is provided, while the time-domain signal structure (such as the OFDM symbol length and frame duration) is fixed regardless of the bandwidths. This is achieved by keeping the ratio constant between the sampling frequency and the length of FFT/IFFT. Equivalently, the spacing between adjacent subcarriers is fixed.

Ex. 1001, ‘431 patent at 4:16-24

The '431 Patent Describes a Core-Band and Side-Band to Facilitate Operation in Variable Bandwidth Environment



Radio Operation Via Core-Band

To facilitate the user terminals to operate in a variable bandwidth (VB) environment, specific signaling and control methods are required. Radio control and operation signaling is realized through the use of a core-band (CB). A core-band, substantially centered at the operating center frequency, is defined as a frequency segment that is not greater than the smallest operating channel bandwidth among all the possible spectral bands that the receiver is designed to operate with. For example, for a system that is intended to work at 5-, 6-, 8-, and 10-Mhz, the width of the CB can be 4 MHz, as shown in FIG. 6. The rest of the bandwidth is called sideband (SB).

Ex. 1001, '431 Patent at 4:63-5:7

The '431 Patent Describes Transit from Primary State to Full-Bandwidth Operation

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substantially centered at the operating center frequency, is defined as a frequency segment that is not greater than the smallest operating channel bandwidth among all the possible spectral bands that the receiver is designed to operate with. For example, for a system that is intended to work at 5-, 6-, 8-, and 10-Mhz, the width of the CB can be 4 MHz, as shown in FIG. 6. The rest of the bandwidth is called sideband (SB).

In one embodiment relevant or essential radio control signals such as preambles, ranging signals, bandwidth request, and/or bandwidth allocation are transmitted within the CB. In addition to the essential control channels, a set of data channels and their related dedicated control channels are placed within the CB to maintain basic radio operation. Such a basic operation, for example, constitutes the primary state of operation. When entering into the network, a mobile station starts with the primary state and transits to the normal full-bandwidth operation to include the sidebands for additional data and radio control channels.

In another embodiment, a preamble, called an essential, or primary preamble (EP), is designed to only occupy the CB, as depicted in FIG. **8**. The EP alone is sufficient for the basic radio operation. The EP can be either a direct sequence in the time domain with its frequency response confined within the CB, or an OFDM symbol corresponding to a particular pattern in the frequency domain within the CB. In either case, an EP sequence may possess some or all of the following properties:

1. Its autocorrelation exhibits a relatively large ratio between the correlation peak and sidelobe levels.
2. Its cross-correlation coefficient with another EP sequence is significantly small with respect to the power of the EP sequences.
3. Its peak-to-average ratio is relatively small.
4. The number of EP sequences that exhibit the above three properties is relatively large.

In yet another embodiment, a preamble, called an auxiliary preamble (AP), which occupies the SB, is combined with the EP to form a full-bandwidth preamble (FP) (e.g., appended in the frequency domain or superimposed in the time domain). An FP sequence may possess some or all of the following properties:

1. Its autocorrelation exhibits a relatively large ratio between the correlation peak and sidelobe levels.
2. Its cross-correlation coefficient with another FP sequences is significantly small with respect to the power of the FP sequences.
3. Its peak-to-average ratio is relatively small.
4. The number of FP sequences that exhibits the above three properties is relatively large.

In still another embodiment, the formation of an FP by adding an AP allows a base station to broadcast the FP, and a mobile station to use its corresponding EP, to access this base station. An FP sequence may also possess some or all of the following properties:

1. Its correlation with its own EP exhibits a relatively large ratio between the correlation peak and sidelobe levels.
2. Its cross-correlation coefficient with any EP sequence other than its own is significantly small with respect to its power.
3. The number of FP sequences that exhibit the above two properties is relatively large.

Automatic Bandwidth Recognition

The VB-OFDMA receiver is capable of automatically recognizing the operating bandwidth when it enters in an operating environment or service area of a particular frequency

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and channel bandwidth. The bandwidth information can be disseminated in a variety of forms to enable Automatic Bandwidth Recognition (ABR).

In one embodiment, a mobile station, when entering in an environment or an area that supports the VB operation or services, will scan the spectral bands of different center frequencies. If it detects the presence of a signal in a spectral band of a particular center frequency by using envelope detection, received signal strength indicator (RSSI), or by other detection methods, it can determine the operating channel bandwidth by bandwidth-center frequency association such as table lookup. For example, a table such as Table 2 is stored in the receiver. Based on the center frequency that it has detected, the mobile station looks up the value of the channel bandwidth from the table.

TABLE 2

Sample Center Frequency and Corresponding Bandwidth

Center frequency	Channel Bandwidth
2.31 GHz	10 MHz
2.56 GHz	6 MHz
2.9 G	8 MHz

In another embodiment, the system provides the bandwidth information via downlink signaling, such as using a broadcasting channel or a preamble. When entering into a VB network, the mobile stations will scan the spectral bands of different center frequencies in which the receiver is designed to operate and decode the bandwidth information contained in the broadcasting channel or preamble.

Multi-Mode (Multi-Range) VB-OFDMA

In accordance with the principles of this invention, multi-modes are devised for a VB-OFDMA system to handle an exceptionally wide range of variation in channel bandwidth. The entire range of bandwidth variation is divided into smaller parts—not necessarily in equal size—each of which will be dealt with as a separate mode or range.

FIG. **9** illustrates the entire range (e.g., from 5 MHz to 40 MHz) of bandwidth variation being divided into smaller parts (e.g., 5-10 MHz, 10-20 MHz, 20-40 MHz, in sizes). Each part is handled in one particular mode. The mode for the lowest range of bandwidth is labeled as "fundamental mode" and other modes are called "higher modes" (Mode 1, Mode 2, etc.).

The sampling frequency of a higher mode is higher than the sampling frequency of the fundamental mode. In one embodiment the sampling frequency of a higher mode is a multiple of the sampling frequency of the fundamental mode. In this embodiment, in the higher modes, the FFT size can be multiplied in accordance with the sampling frequency, thereby maintaining the time duration of the OFDM symbol structure. For example, the parameters for the case of a multi-mode design are given in Table 3. Alternatively, a higher mode can be realized by maintaining the FFT size and shortening the OFDM symbol duration accordingly. For example, for Mode 1 in Table 3, the FFT size can be maintained at 1024, whereas the sampling frequency is doubled and the symbol length is a half of that for the fundamental range. Yet another higher-mode realization is to both increase the FFT size and shorten the symbol duration accordingly. For example, for Mode 2 (20 MHz to 40 MHz in bandwidth), both the FFT size and the sampling frequency can be doubled as those of the fundamental range, whereas the symbol length is halved as that of the fundamental range. The width of the CB in a multi-mode

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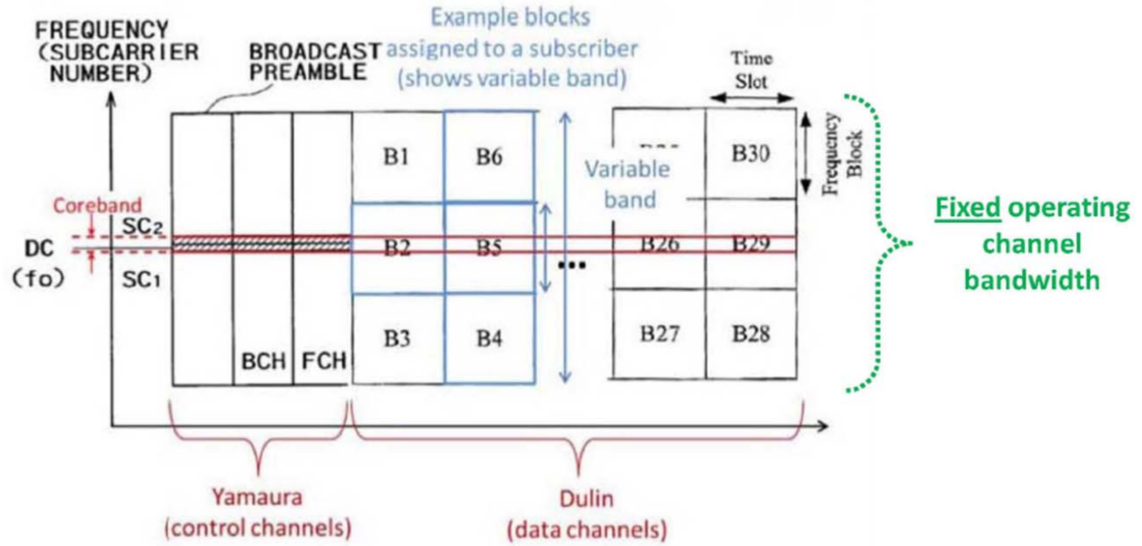
In one embodiment relevant or essential radio control signals such as preambles, ranging signals, bandwidth request, and/or bandwidth allocation are transmitted within the CB. In addition to the essential control channels, a set of data channels and their related dedicated control channels are placed within the CB to maintain basic radio operation. Such a basic operation, for example, constitutes the primary state of operation. When entering into the network, a mobile station starts with the primary state and transits to the normal full-bandwidth operation to include the sidebands for additional data and radio control channels.

Ex. 1001, '431 Patent at 5:8-17

Dulin and Yamaura Are Fixed Bandwidth Systems

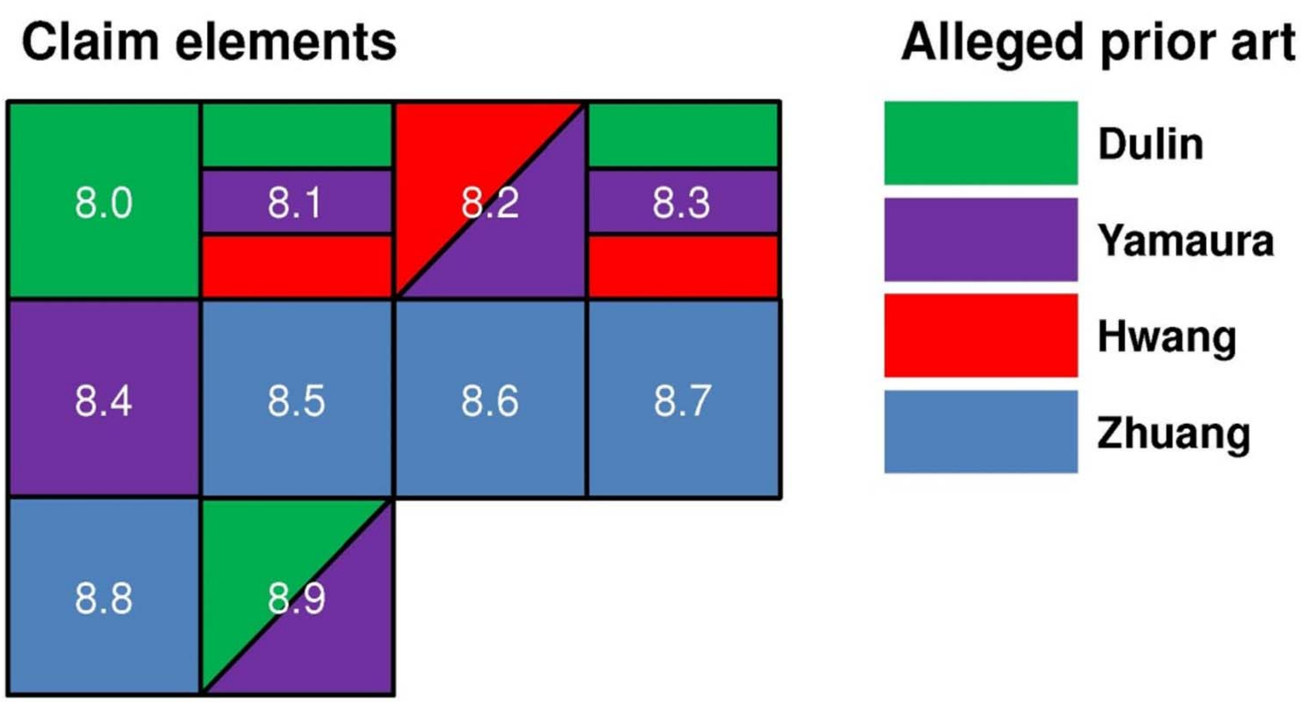
119. With respect to the "variable band" limitation, as previously discussed, Dulin and Yamaura are fixed bandwidth systems. *See* Exhibit 1002 at ¶ 126 and Exhibit 1003 at 1:38-39. The figure below includes an annotation of Petitioner's annotated Figure 17 from page 51 of the Petition.



Portions of Yamaura's Fig. 17 and Dulin's Fig. 13A (annotated)

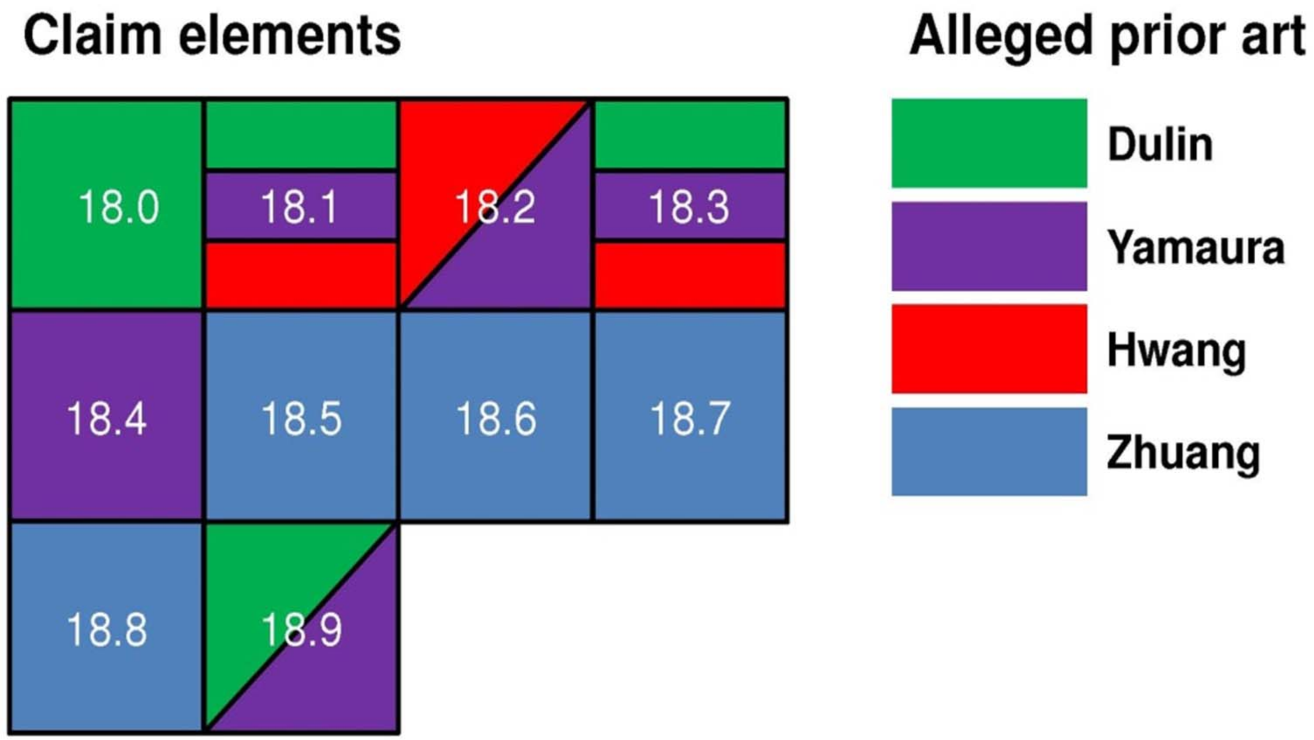
Ex. 2001, Zeger Declaration at ¶119

Petitioner’s Obviousness Analysis



Patent Owner Response at p. 23

Petitioner's Obviousness Analysis



Patent Owner Response at p. 25

No Reason To Combine Dulin, Yamaura, Zhuang, and Hwang

125. In my opinion, a person of ordinary skill in the art at the relevant time would have had no reason or motivation to combine Dulin, Yamaura, Zhuang, and Hwang in the manner suggested by Petitioner to achieve the inventions set forth in claims 8-12 and 18-22 of the '431 patent.

Ex. 2001, Zeger Declaration at ¶125

Dulin Teaches Away From Yamaura

Petitioner's Analysis

Likewise, Dulin recites: "As previously mentioned, the map of the schedule of each frame is transmitted to all subscriber units at the beginning of the transmission of a frame." *Id.* at ¶ [0163]. That is, a subscriber unit would need to know, prior to, or at the beginning of, each frame, which frequency data blocks are intended for it so that it would know which blocks to attempt to receive. However, Dulin is not concerned with details of how the map schedule is communicated and is therefore silent regarding those aspects, leaving those details to a person of ordinary skill in the art to determine.

Ex. 1012, Haas Declaration at p. 31

Dulin Teaches Away From Yamaura

Petitioner's Analysis

		The same type of information as transmitted in Yamaura's BCH and FCH is needed in Dulin's system. For example, the "base station information" carried in Yamaura's BCH refers to at least the base station identification. Such base station identification was well-known in cellular systems for allowing a mobile station to determine the parameters and the setup information of the system that the mobile station is currently attached to. *See, e.g.*, Cosentino, 3:50-4:25. Such information may be used for various purposes; e.g., to facilitate the registration process. *See*, *e.g.*, *id*. As another example, Dulin's frame map would be transmitted in Yamaura's FCH channel, because the FCH is used to transmit traffic channel allocation (analogous to a Dulin's frame map).

Ex. 1012, Haas Declaration at pp. 78-79

Dulin Teaches Away From Yamaura

Q And so what happens if in a Dulin-type system a map of the schedule of each frame is not transmitted prior to or at the beginning of each frame?

A Then a user would not be able to understand which data blocks in this frame -- excuse me -- are destined -- are to be used by that user.

Q Okay. So basically Dulin wouldn't work then --

A If the map --

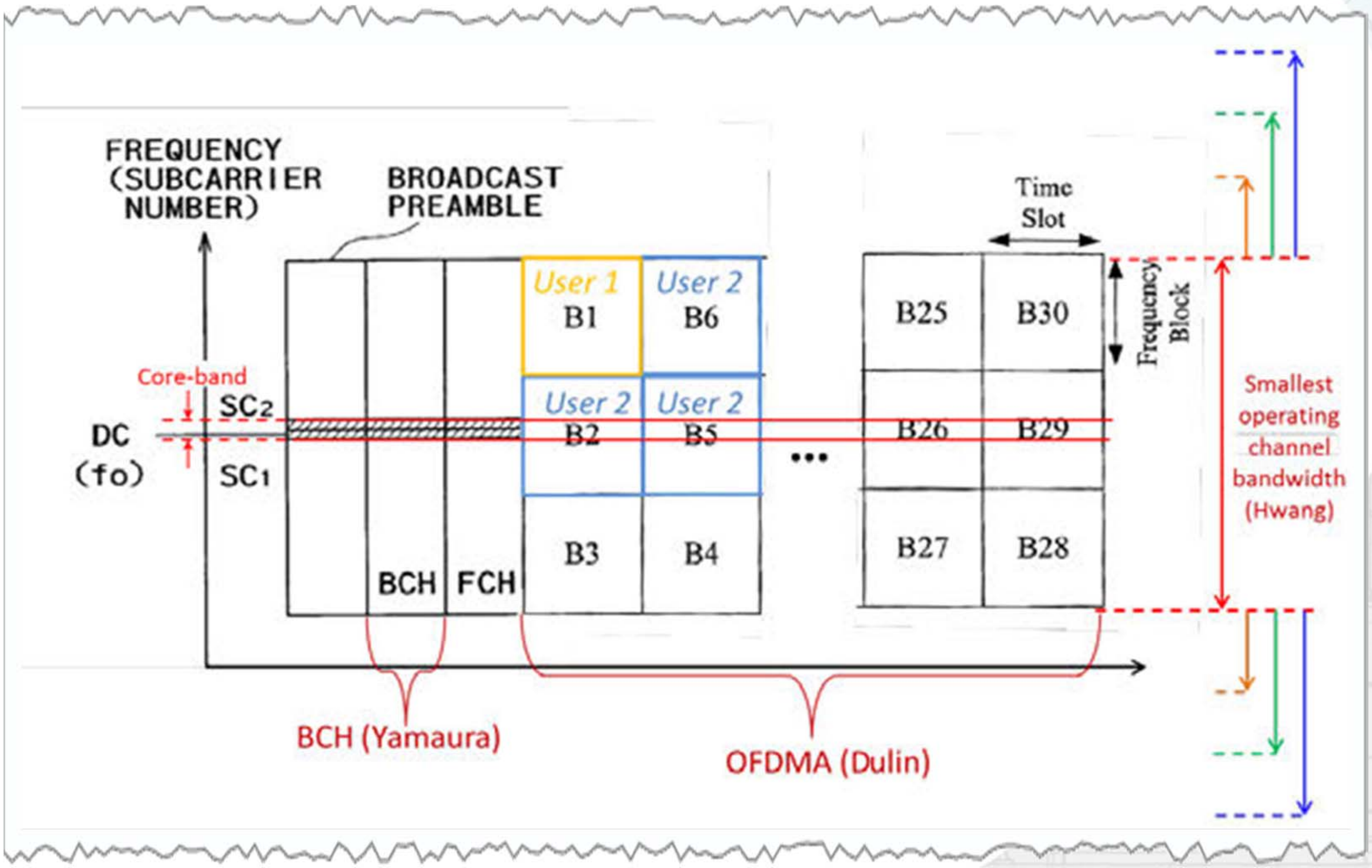
Q -- if the map was not transmitted prior to or at the beginning of each frame.

A If the map is not transmitted at the beginning of each frame, unless some other arrangements were made, then the user would not -- then Dulin would not work, again, unless other arrangements were made.

Ex. 2003, Haas Deposition at 102:10-103:1

Dulin Teaches Away From Yamaura

Petitioner's Analysis



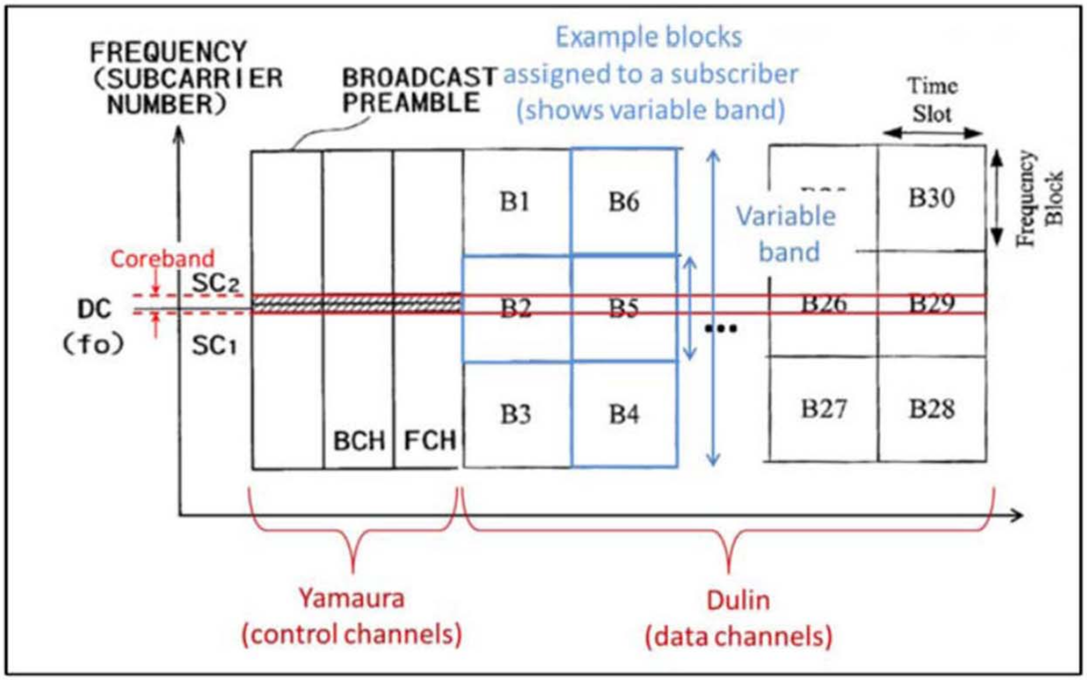
Ex. 1012, Haas Declaration at p. 76

Dulin Teaches Away From Yamaura

131. In my opinion, a person of ordinary skill in the art would not have combined Dulin and Yamaura to transmit Dulin's frame map during Yamaura's FCH because, as conceded by Dr. Haas, Dulin would not work as contemplated and therefore the resulting combination of Dulin, Yamaura, Zhuang, and Hwang would be rendered inoperable for its intended purpose of communicating data between a base station and mobile terminal.

Ex. 2001, Zeger Declaration at ¶131

Dulin Teaches Away From Yamaura



Portions of Yamaura's Fig. 17 and Dulin's Fig. 13A (annotated)

Patent Owner Response at p. 44

Yamaura and Dulin are Fundamentally Different

136. Yamaura teaches using a single base station to communicate with a mobile terminal during a time frame, whereas in contrast, Dulin repeatedly emphasizes using two or more base stations to communicate with a mobile terminal during a time frame. *See e.g.*, Exhibit 1002, Title, Abstract, Figs. 3 and 4 and ¶¶ 0002, 0015 and 0055. The entire premise behind using Dulin's map of frequency blocks is to schedule communications between a mobile terminal and two or more base stations. Dulin repeatedly emphasizes that the mobile terminal communicates with a plurality of base stations.

Ex. 2001, Zeger Declaration at ¶ 136

Yamaura and Dulin are Fundamentally Different

On the other hand, Yamaura specifically is directed towards a mobile terminal only communicating with a single base station. The use of subcarriers SC_1 and SC_2 in Yamaura to carry control information would alter the allocation of data blocks in Dulin's map in an unknown way. Dr. Haas does not explain how to alter Dulin's map in order to accommodate control information carried in SC_1 and SC_2 and how this would affect the scheduling operations in Dulin.

Ex. 2001, Zeger Declaration at ¶ 136

Yamaura and Dulin are Fundamentally Different

132. A person of ordinary skill in the art would not be motivated to combine Yamaura with Dulin because combining Yamaura with Dulin would require adding complexity and a redesign of Dulin's already complex system. In my opinion, a person of ordinary skill in the art would not be motivated to combine disclosures from systems having such disparate system architectures.

Ex. 2001, Zeger Declaration at ¶ 132

Dulin Is Directed To Multiple Base Stations

US 20020055356A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2002/0055356 A1
Dulin et al. (43) Pub. Date: May 9, 2002

(54) **SYSTEM AND METHOD FOR SYNCHRONIZING DATA TRANSMISSION FROM MULTIPLE WIRELESS BASE TRANSCEIVER STATIONS TO A SUBSCRIBER UNIT**

(76) Inventors: **David R. Dulin**, San Francisco, CA (US); **Sanjay Kasturia**, Palo Alto, CA (US); **Partho Mishra**, Cupertino, CA (US); **Arogyaswami J. Paulraj**, Stanford, CA (US); **Matthew S. Peters**, Mountain View, CA (US)

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San Jose, CA 95164-1867 (US)

(21) Appl. No.: **09/729,886**

(22) Filed: **Dec. 4, 2000**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/708,170, filed on Nov. 7, 2000.

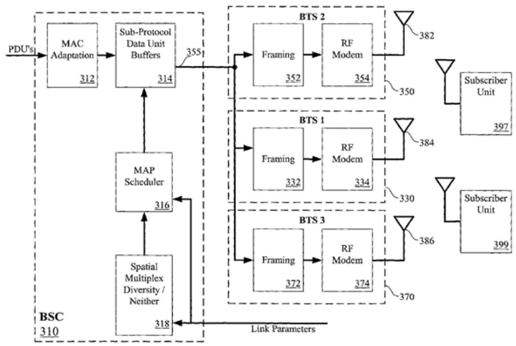
Publication Classification

(51) **Int. Cl.**[7] **H04Q 7/20**

(52) **U.S. Cl.** **455/422**; 455/452; 455/456; 455/502

(57) **ABSTRACT**

The invention includes an apparatus and a method for transmitting sub-protocol data units from a plurality of base transceiver stations to a subscriber unit. The method includes estimating time delays required for transferring the sub-protocol data units between a scheduler unit and each of the base transceiver stations. The method further includes the scheduler unit generating a schedule of time slots and frequency blocks in which the sub-protocol data units are to be transmitted from the base transceiver stations to the subscriber unit. The time delays are used to generate the schedule. The time delays can be used to generate a look ahead schedule that compensates for the timing delays of the sub-protocol data units from the scheduler unit to the base transceiver stations. The sub-protocol data units are wirelessly transmitted from the base transceiver stations to the subscriber unit according to the schedule. The time delays can be estimated by time-stamping sub-protocol data units before sub-protocol data units are transferred from the scheduler unit to the base transceiver stations, and estimating the time delays by comparing the times the sub-protocol data units are actually received by the base transceiver stations with the time-stamping.



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SYSTEM AND METHOD FOR SYNCHRONIZING DATA TRANSMISSION FROM MULTIPLE WIRELESS BASE TRANSCEIVER STATIONS TO A SUBSCRIBER UNIT

The invention includes an apparatus and a method for transmitting sub-protocol data units from a plurality of base transceiver stations to a subscriber unit. The method

Ex. 1002, Dulin

Dulin Is Directed To Multiple Base Stations

can be compensated for by periodically sampling the delay times and adjusting the look ahead time T accordingly. The look ahead time T can be set to a mean or average value of the measured time delays. Additionally, an extra bit of margin can be added to the time T to make absolutely sure that the look ahead time T is greater than the delay times between the base controller station and the base transceiver stations. The margin can be base upon a statistical estimation. For example, the margin can be two or three sigmas greater than a mean of several different measured delay times.

[0071] The discussion above for estimating the delay time between a base controller station and transmitting base transceiver stations is also applicable for estimating the delay between a home base transceiver station and transmitting base transceiver stations.

[0072] It should be understood that the look ahead scheduling is only required when transmitting simultaneously from more than one base transceiver station to a single subscriber (receiver) unit. If communication diversity or spatial multiplexing is required for transmission, then look ahead scheduling is required because more than one base transceiver station is transmitting to a subscriber (receiver) unit. If transmission is between only a single base transceiver station and a single subscriber unit, then look ahead scheduling is not required.

[0073] Generally, there are three modes of transmission. A first mode includes transmission between a single base transceiver station and a single subscriber unit. This mode does not require look ahead scheduling. A second mode includes diversity or spatial multiplexing transmission, and requires look ahead scheduling. A third mode includes both single base station and multiple base transceiver station transmission. The third mode is useful for transmitting sub-protocol data units through a single base transceiver station during an initial period of transmission before spatial multiplexing through multiple base transceiver stations can be initiated.

[0074] Radio Frequency (RF) signals are coupled between the transmitter antennae and the receiver antennae. The RF signals are modulated with data streams comprising the transmitted symbols. The signals transmitted from the transmitter antennae can be formed from different data streams (spatial multiplexing) or from one data stream (communication diversity) or both.

[0075] **FIG. 4** shows another embodiment of the invention. The embodiment of **FIG. 4** includes a home base transceiver station **410**. The home base transceiver station **410** includes the functionality of both the base controller station **310** and the first base transceiver station **330** of **FIG. 3**.

[0076] By combining the functionality of the base controller station and a base transceiver station, the overall complexity of the system can be reduced because an interconnection between the base controller station and one base transceiver station is eliminated. Additionally, compensation for the delay between the base controller station and the one base transceiver station no longer required.

[0077] An embodiment of the invention includes the home base transceiver station being the base transceiver station that has the best quality link with the receiver unit. The link quality can change with time. Therefore, the base transceiver station designated as the home base transceiver station can change with time.

[0078] Typically, the base transceiver station that has the highest quality transmission link with the receiver unit is scheduled to transmit the greatest amount of information to the receiver unit. This configuration limits the amount of sub-protocol data units that must be transferred from the home base transceiver station to the other base transceiver stations.

[0079] Base Transceiver Station Interface

[0080] **FIG. 3** shows a base station controller that interfaces with several base transceiver stations. **FIG. 4** shows a base transceiver station that interfaces with several other base transceiver stations. As previously mentioned, these network interfaces can be implemented with either asynchronous transmission mode (ATM) or internet protocol (IP) technology. It is to be understood that ATM and IP technologies are provided as examples. Any packet switched network protocol can be used.

[0081] **FIG. 5** shows the time delays between the base station controller **310** and the base transceiver stations **330**, **350**, **370** of **FIG. 3**. A first time delay t_1 indicates the time delay required for transferring sub-protocol data units from the base station controller **310** to the first base transceiver station **330**. A second time delay t_2 indicates the time delay required for transferring sub-protocol data units from the base station controller **310** to the second base transceiver station **350**. A third time delay t_3 indicates the time delay required for transferring sub-protocol data units from the base station controller **310** to the third base transceiver station **370**. Generally, the time delays t_1, t_2, and t_3 are not equal. As mentioned previously, to compensate for the variable delays, the scheduler computes a schedule for a particular frame, T units of time prior to the actual transmission time of that frame. Generally, T is greater than the greatest transmission time delay t_1, t_2, and t_3.

[0082] As previously described, the variable delays through the network between the base controller station and the base transceiver stations can be compensated for by periodically sampling the delay times and adjusting the look ahead time T accordingly. The look ahead time T can be set to a mean or average value of the measured time delays. Additionally, an extra bit of margin can be added to the time T to make absolutely sure that the look ahead time T is greater than the delay times between the base controller station and the base transceiver stations. The margin can be base upon a statistical estimation. For example, the margin can be two or three sigmas greater than a mean of several different measured delay times.

[0083] **FIG. 6** shows the time delays between the home base transceiver station **410** and the base transceiver stations **450**, **470** of **FIG. 4**. A fourth time delay t_4 indicates the time delay required for transferring sub-protocol data units from the home base transceiver station **410** to the base transceiver station **450**. A fifth time delay t_5 indicates the time delay required for transferring sub-protocol data units from home base transceiver station **410** to the base transceiver station **470**. Generally, the time delays t_4 and t_5 are not equal. As mentioned previously, to compensate for the variable delays, the scheduler computes a schedule for a particular frame, T

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If transmission is between only a single base transceiver station and a single subscriber unit, then look ahead scheduling is not required.

Ex. 1002, Dulin at ¶72

Dulin Is Directed To Multiple Base Stations

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can be compensated for by periodically sampling the delay times and adjusting the look ahead time T accordingly. The look ahead time T can be set to a mean or average value of the measured time delays. Additionally, an extra bit of margin can be added to the time T to make absolutely sure that the look ahead time T is greater than the delay times between the base controller station and the base transceiver stations. The margin can be base upon a statistical estimation. For example, the margin can be two or three sigmas greater than a mean of several different measured delay times.

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[0075] **FIG. 4** shows another embodiment of the invention. The embodiment of **FIG. 4** includes a home base transceiver station **410**. The home base transceiver station **410** includes the functionality of both the base controller station **310** and the first base transceiver station **330** of **FIG. 3**.

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[0077] An embodiment of the invention includes the home base transceiver station being the base transceiver station that has the best quality link with the receiver unit. The link quality can change with time. Therefore, the base transceiver station designated as the home base transceiver station can change with time.

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[0080] **FIG. 3** shows a base station controller that interfaces with several base transceiver stations. **FIG. 4** shows a base transceiver station that interfaces with several other base transceiver stations. As previously mentioned, these network interfaces can be implemented with either asynchronous transmission mode (ATM) or internet protocol (IP) technology. It is to be understood that ATM and IP technologies are provided as examples. Any packet switched network protocol can be used.

[0081] **FIG. 5** shows the time delays between the base station controller **310** and the base transceiver stations **330**, **350**, **370** of **FIG. 3**. A first time delay t_1 indicates the time delay required for transferring sub-protocol data units from the base station controller **310** to the first base transceiver station **330**. A second time delay t_2 indicates the time delay required for transferring sub-protocol data units from the base station controller **310** to the second base transceiver station **350**. A third time delay t_3 indicates the time delay required for transferring sub-protocol data units from the base station controller **310** to the third base transceiver station **370**. Generally, the time delays t_1, t_2, and t_3 are not equal. As mentioned previously, to compensate for the variable delays, the scheduler computes a schedule for a particular frame, T units of time prior to the actual transmission time of that frame. Generally, T is greater than the greatest transmission time delay t_1, t_2, and t_3.

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[0083] **FIG. 6** shows the time delays between the home base transceiver station **410** and the base transceiver stations **450**, **470** of **FIG. 4**. A fourth time delay t_4 indicates the time delay required for transferring sub-protocol data units from the home base transceiver station **410** to the base transceiver station **450**. A fifth time delay t_5 indicates the time delay required for transferring sub-protocol data units from home base transceiver station **410** to the base transceiver station **470**. Generally, the time delays t_4 and t_5 are not equal. As mentioned previously, to compensate for the variable delays, the scheduler computes a schedule for a particular frame, T

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[0073] Generally, there are three modes of transmission. A first mode includes transmission between a single base transceiver station and a single subscriber unit. This mode does not require look ahead scheduling. A second mode includes diversity or spatial multiplexing transmission, and requires look ahead scheduling. A third mode includes both single base station and multiple base transceiver station transmission. The third mode is useful for transmitting sub-protocol data units through a single base transceiver station during an initial period of transmission before spatial multiplexing through multiple base transceiver stations can be initiated.

Ex. 1002, Dulin at ¶73

Yamaura and Dulin are Fundamentally Different

137. Dulin is a very complex system, containing such features not taught in Yamaura as: extra buffers needed to store sub-protocol units [0053], map transmission once per frame [0054], multiple antennas [0059], base stations needing synchronization so that a receiver can receive data from multiple base stations [0063], simultaneous transmission of sub-protocol data units from multiple base stations using a reference clock [0066], a reference clock using GPS [0095], estimates of propagation delay [0103], and priority determination [0142]. *See* Exhibit 1002 at ¶¶ 53, 54, 59, 63, 66, 95, 103 and 142.

Ex. 2001, Zeger Declaration at ¶137

Yamaura and Dulin are Fundamentally Different

138. Yamaura teaches that the carriers SC_1 and SC_2 are detected by using an adaptive filter that can either pick out these two subcarriers or a much wider band of frequencies. *See* Exhibit 1003 at 21:57-67, 23:20. In one case, the wide band is passed during "ordinary reception," whereas at the time of a "waiting reception" only the narrow band is passed. *See* Exhibit 1003 at 21:60-67. Such adaptive filters are neither easy nor cheap to design and can require extensive testing with actual data to be sure they function properly. Dulin does not teach any such adaptive filtering. A person of ordinary skill in the art would understand that Dulin teaches only the use of non-adaptive filtering. A person of ordinary skill in the art would not be motivated to add the necessary adaptive filter from Yamaura to Dulin since it would further increase complexity and cost.

Ex. 2001, Zeger Declaration at ¶138

Yamaura and Dulin are Fundamentally Different

The terminal station to receive signals transmitted from the base station is constructed as illustrated below by example with reference to FIG. **18**. The terminal station **200'** shown in FIG. **18** is constructed in the same way as the terminal station **200** shown in FIG. **6**. Therefore, its description is omitted here. The receiving system of the terminal station **200'** is constructed as follows. The radio signal from the base station is received by the antenna **223**, and it enters the RF receiver **230'** through the antenna multiplexer **222**. In the RF receiver **230'**, the received signal is amplified by the RF amplifier **231**. The amplified output is mixed with the sinusoidal wave (generated by the frequency synthesizer **233**) in the quadrature detector **232**, and then it is separated into I-component and Q-component, with the center frequency being DC. Only those signals in a specific band are filtered by the passing band variable filter **236**.

Ex. 1003, Yamaura at 21:44-59

Yamaura and Dulin are Fundamentally Different

139. Yamaura also teaches the use of encryption in its communication system. *See id.* at FIG. 2 and 32, 2:67-3:1, 8:42-43 and 12:16-17. Encryption can be a very complex, time-consuming operation, and is not conducive to power savings. Dulin does not teach encryption and adding Yamaura's encryption to Dulin's system would further increase cost, complexity, and power consumption.

Ex. 2001, Zeger Declaration at ¶139

No Reason to Combine Dulin and Yamaura

140. In my opinion, the level of experimentation required to combine Dulin with Yamaura would not motivate, and would instead dissuade, a person of ordinary skill in the art from combining Dulin with Yamaura.

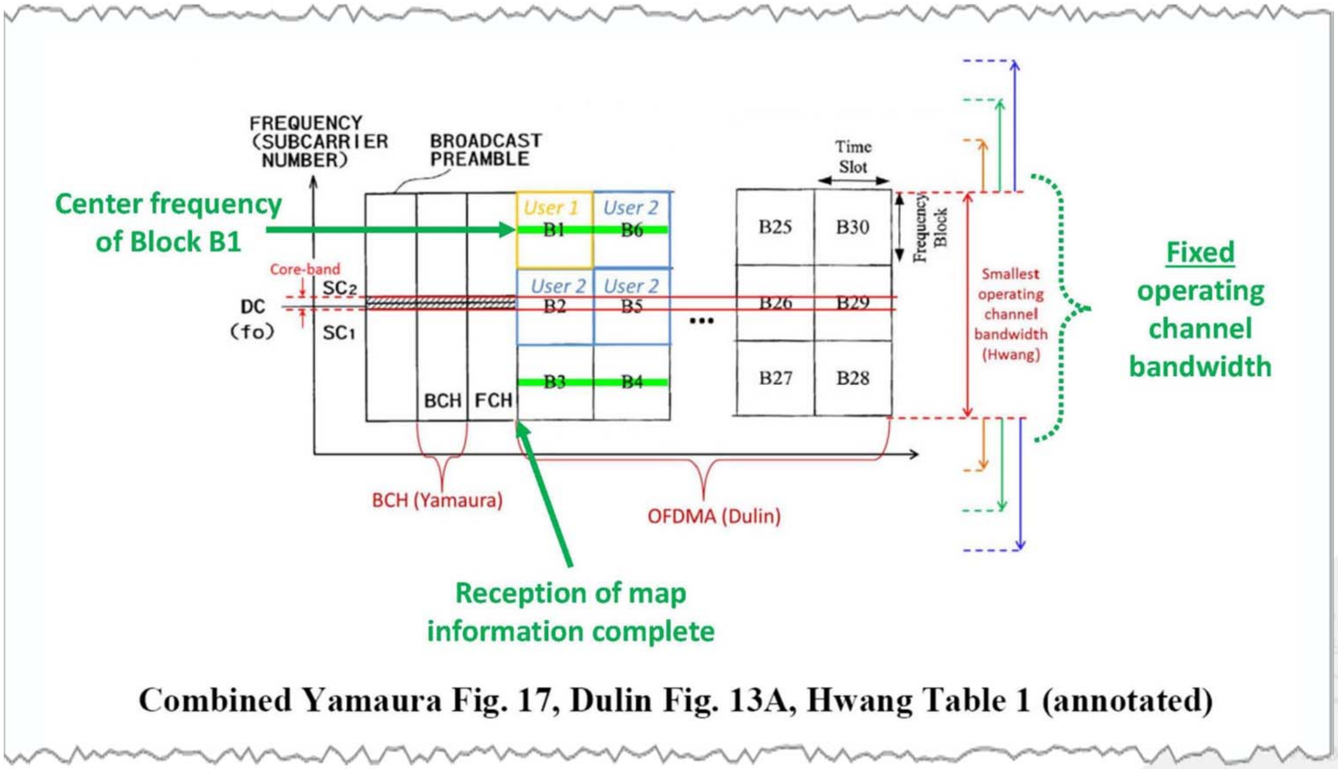
Ex. 2001, Zeger Declaration at ¶140

No Reason to Combine Dulin and Yamaura

5. Assuming, as Dr. Haas suggests, that the base station disclosed in Yamaura uses only the narrow-band subcarriers during the "broadcast burst" but switches to the full bandwidth for the uplink and downlink periods of the frame, the base station would have to vary the bandwidth of the Yamaura system intra-frame and for each frame. *See* Exhibit 2003 at 133:12-13. This means that the size of the FFT used to generate the transmitted signal would be different during the "broadcast burst" and the other periods of the frame. This would add complexity to the signal processing required on the base station to implement this scheme.

Ex. 2001, Zeger Declaration at ¶135

No Reasonable Expectation of Success



Combined Yamaura Fig. 17, Dulin Fig. 13A, Hwang Table 1 (annotated)

Ex. 2001, Zeger Declaration at ¶141

No Reasonable Expectation of Success

147. A person of ordinary skill in the art would recognize that some time will elapse between decoding the received map information and tuning the receiver to the center frequency of the assigned frequency block. Because the frame is continuing to be transmitted by the base station while User 1 retunes the receiver, User 1, will miss some, if not all of the data transmitted to it in frequency block B1 before the receiver User 1 can tune to the center frequency of the frequency block, B1.

Ex. 2001, Zeger Declaration at ¶147

Petitioner Relies on Struhsaker

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subscribers using a common scheme consisting of one or more of modulation format, FEC codes, and physical beam forming.

[0121] U uplink slots—The U uplink slots, including exemplary uplink slots **361-363**, contain subscriber-to-transceiver base station transmissions of user traffic and/or control signals. Again, the modulation format (modulation index) is optimized for maximum possible data transmission rates. Generally, the modulation format and FEC codes in the uplink slots are less complex than in the downlink slots. This moves complexity to the receivers in the base stations and lowers the cost and complexity of the subscriber access device. Uplink slots may be grouped in blocks to form sub-burst groups as shown in **FIG. 5A**. Subscribers who transmit data using the same modulation format (or modulation index) and the same forward error correction (FEC) codes are grouped together in the same sub-burst group. In some embodiments of the present invention, two or more sub-burst groups may have the same modulation format and FEC codes. In other embodiments of the present invention, uplink slots may be grouped in blocks based on physical beam forming, rather than on modulation format and FEC codes. In other embodiments, uplink slots may be grouped in blocks based on any combination of two or more of: 1) physical beam forming, 2) modulation format, and 3) FEC codes. For the purpose of simplicity, the term "sub-burst group" shall be used hereafter to refer to a group of uplink slots that are transmitted to one or more subscribers using a common scheme consisting of one or more of modulation format, FEC codes, and physical beam forming.

[0122] Contention slots **360**—Contention slots **360** precede the U uplink slots and comprise a small number of subscriber-to-base transmissions that handle initial requests for service. A fixed format length and a single modulation format suitable for all subscriber access devices are used during contention slots **360**. Generally, this means that contention slots **360** are transmitted in a very low complexity modulation format, such as binary phase shift keying (BPSK or 2-BPSK), or perhaps quadrature phase shift keying (QPSK or 4-BPSK). Collisions (more than one user on a time slot) result in the use of back-off procedures similar to CSMA/CD (Ethernet) in order to reschedule a request.

[0123] TDD transition period **350**—TDD transition period **350** separates the uplink portion and the downlink portion and allows for transmitter (TX) to receiver (RX) propagation delays for the maximum range of the cell link and for delay associated with switching hardware operations from TX to RX or from RX to TX. The position of TDD transition period **350** may be adjusted, thereby modifying the relative sizes of the uplink portion and the downlink portion to accommodate the asymmetry between data traffic in the uplink and the downlink.

[0124] A key aspect of the present invention is that the timing of the downlink and uplink portions of each TDD frame must be precisely aligned in order to avoid interference between sectors within the same cell and/or to avoid interference between cells. It is recalled from above that each sector of a cell site is served by an individual RF modem in RF modem shelves **140A-140D** and the internal RF modem shelves of central office facilities **160A** and **160B**. Each RF modem uses an individual antenna to transmit and to receive in its assigned sector. The antennas for different sectors in the same cell site are mounted on the same tower and are located only a few feet apart. If one RF modem (and antenna) are transmitting in the downlink while another RF modem (and antenna) are receiving in the uplink, the power of the downlink transmission will overwhelm the downlink receiver.

[0125] Thus, to prevent interference between antennas in different sectors of the same cell site, the present invention uses a highly accurate distributed timing architecture to align the start points of the downlink transmissions. The present invention also determines the length of the longest downlink transmission and ensures that none of the uplink transmissions begin, and none of the base station receivers begin to receive, until after the longest downlink is completed.

[0126] Furthermore, the above-described interference between uplink and downlink portions of TDD frames can also occur between different cell sites. To prevent interference between antennas in different cell sites, the present invention also uses the highly accurate distributed timing architecture to align the start points of the downlink transmissions between cell sites. The present invention also determines the length of the longest downlink transmission among two or more cell sites and ensures that none of the base station receivers in any of the cells begins to receive in the uplink until after the longest downlink transmission is completed.

[0127] Within a cell site, a master interface control processor (ICP), as described below in **FIG. 4**, may be used to align and allocate the uplink and downlink portions of the TDD frames for all of the RF modems in an RF modem shelf. Between cell sites, the access processor may communicate with several master ICPs to determine the longest downlink. The access processor may then allocated the uplinks and downlinks across several cell sites in order to minimize interference between cell sites and may designate on master ICP to control the timing of all of the master ICPs.

[0128] **FIG. 4** illustrates the timing recovery and distribution circuitry in exemplary RF modem shelf **140** according to one embodiment of the present invention. RF modem shelf **140** comprises front panel interface **410** having connectors **411-414** for receiving input clock references and transmitting clock references. Exemplary connector **411** receives a first clock signal from a first external source (External Source A) and exemplary connector **414** receives a second clock signal from a second external source (External Source B) . Connector **412** outputs an internally generated clock signal (Master Source Out) and connector **413** receives an external one second system clock signal (External 1 Second Clock) RF modem shelf **140** also comprises a plurality of interface control processor (ICP) cards, including exemplary ICP cards **450, 460, 470** and **480**. ISP card **450** is designated as a master ICP card and ICP card **480** is designated as a spare ICP card in case of a failure of master ICP card **450**. Within RF modem shelf **140**, the ICP cards provide for control functions, timing recovery and distribution, network interface, backhaul network interface, protocol conversion, resource queue management, and a proxy manager for EMS for the shelf. The ICP cards are based on network processor(s) that allow software upgrade of network interface protocols. The ICP cards may be reused for

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[0123] TDD transition period **350**—TDD transition period **350** separates the uplink portion and the downlink portion and allows for transmitter (TX) to receiver (RX) propagation delays for the maximum range of the cell link and for delay associated with switching hardware operations from TX to RX or from RX to TX. The position of TDD transition period **350** may be adjusted, thereby modifying the relative sizes of the uplink portion and the downlink portion to accommodate the asymmetry between data traffic in the uplink and the downlink.

Ex. 1021, Struhsaker at ¶123

No Reasonable Expectation of Success

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Arranging the narrow-band carriers as shown in FIG. **3** permits the terminal station to receive narrow-band carriers by using a frequency synthesizer (to determine the receiving channel of the terminal station) which varies the frequency intervals of carriers for information communication at 10 MHz steps unlike the conventional one which varies at 20 MHz steps. The typical construction of the terminal station will be described later. The signal bandwidth of the narrow-band carriers should preferably be a submultiple of the symbol rate or sample rate of the carrier for information communication. The band in which the narrow-band carriers are arranged is the frequency band corresponding to the guard band, and it does not interfere with communication in other bands so long as there is no power leakage into the adjoining bands.

Ex. 1003, Yamaura at 10:4-18

Petitioner's POSA Has Extraordinary Skill

41. As discussed above, one of ordinary skill in the art would have a B.S. degree in Electrical Engineering, Computer Engineering, Computer Science, or equivalent training, as well as three to five years of technical experience in the field of digital communication systems, such as wireless cellular communication systems and networks. Such a person would be familiar with various well-known communication methodologies, protocols, and techniques ("techniques"), such as OFDM. Also, one of ordinary skill in the art would know how to apply these different techniques to different communication systems and networks. Each technique is associated with known advantages and disadvantages, such as speed, power consumption, and cost, and a person of ordinary skill in the art would know how to choose between the different methodologies, protocols, and techniques to balance the various goals of the communication systems and networks under consideration.

Ex. 1012, Haas Declaration at ¶41

Conclusion: Petitioner Failed to Prove Unpatentability

- Missing Claim Elements
  - ❑ Claim element 8.1
  - ❑ Claim element 8.9
- Hindsight
- No Reason To Combine All Four References
  - ❑ Dulin teaches away from Yamaura
  - ❑ Dulin and Yamaura are fundamentally different
  - ❑ No reasonable expectation of success
- Level of Skill Too High

Patent Owner Response at pp. 27-62