AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Northern District of Illinois on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
1:22-cv-02176	4/26/2022	Northern District of Illinois

PLAINTIFF	DEFENDANT
Togail Technologies Ltd.	Motorola Mobility LLC

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		See attached
2		
3		
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE
Thomas G. Bruton	Jennifer Kuldanek	4/27/2022

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

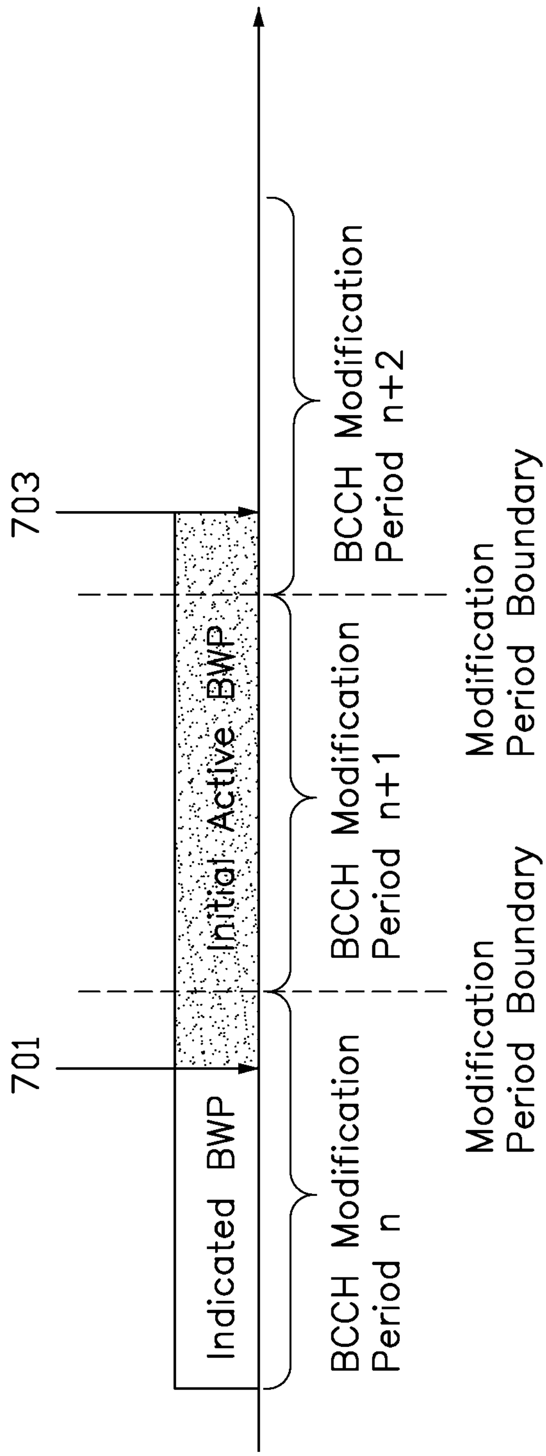
703
701
Indicated BWP
Initial Active BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary

FIG. 7

In some of the present implementations, the BS may indicate at least one sTRP resource set to the UE through at least one of the configuration of the sTRP, the predetermined resource(s) associated with the sTRP ID, and the best compatible channel quality in terms of the pTRP determined by the BS or UE.

In some of the present implementations, the UE may identify different resource(s)/resource set(s) from different TRPs via at least one of the information of QCL assumption(s), the target RS port group(s), and reference RS correlation indication.

For example, the network/BS may indicate target RSs to the UE in terms of two reference RS resource sets. According to the TCI state configuration, the target DMRS may be spatially quasi co-located with the reference RS from a TRP. The DMRS ports may be in different target DMRS port groups. In some other implementations, the UE may be configured with an information element of correlation information, and the UE may use it to determine whether two or more resources are from the same TRP. In this case, a low correlation means that the reference RS resources may have a rich spatial multiplexing/diversity and come from different TRPs, and a high correlation may mean that the reference RS resources may come from the same TRP.

FIG. **6** is a block diagram illustrating a node for wireless communication, in accordance with various aspects of the present disclosure. As shown in FIG. **6**, a node **600** may include a transceiver **620**, a processor **628**, a memory **634**, one or more presentation components **638**, and at least one antenna **636**. The node **600** may also include an RF spectrum band module, a BS communications module, a network communications module, and a system communications management module, Input/Output (I/O) ports, I/O components, and power supply (not explicitly shown in FIG. **6**). Each of these components may be in communication with each other, directly or indirectly, over one or more buses **640**. In one implementation, the node **600** may be a UE or a BS that performs various functions described herein, for example, with reference to FIGS. **1** through **5**.

The transceiver **620** having a transmitter **622** (e.g., transmitting/transmission circuitry) and a receiver **624** (e.g., receiving/reception circuitry) may be configured to transmit and/or receive time and/or frequency resource partitioning information. In some implementations, the transceiver **620** may be configured to transmit in different types of subframes and slots including, but not limited to, usable, non-usable and flexibly usable subframes and slot formats. The transceiver **620** may be configured to receive data and control channels.

The node **600** may include a variety of computer-readable media. Computer-readable media may be any available media that may be accessed by the node **600** and include both volatile and non-volatile media, removable and non-removable media. By way of example, and not limitation, computer-readable media may comprise computer storage media and communication media. Computer storage media includes both volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or data.

Computer storage media includes RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, Digital Versatile Disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices. Computer storage media does not comprise a propagated data signal. Communication media typically embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of any of the above should also be included within the scope of computer-readable media.

The memory **634** may include computer-storage media in the form of volatile and/or non-volatile memory. The memory **634** may be removable, non-removable, or a combination thereof. Example memory includes solid-state memory, hard drives, optical-disc drives, and etc. As illustrated in FIG. **6**, The memory **634** may store computer-readable, computer-executable instructions **632** (e.g., software codes) that are configured to, when executed, cause the processor **628** to perform various functions described herein, for example, with reference to FIGS. **1** through **5**. Alternatively, the instructions **632** may not be directly executable by the processor **628** but be configured to cause the node **600** (e.g., when compiled and executed) to perform various functions described herein.

The processor **628** (e.g., having processing circuitry) may include an intelligent hardware device, e.g., a Central Processing Unit (CPU), a microcontroller, an ASIC, and etc. The processor **628** may include memory. The processor **628** may process the data **630** and the instructions **632** received from the memory **634**, and information through the transceiver **620**, the base band communications module, and/or the network communications module. The processor **628** may also process information to be sent to the transceiver **620** for transmission through the antenna **636**, to the network communications module for transmission to a core network.

One or more presentation components **638** presents data indications to a person or other device. Examples of presentation components **638** may include a display device, speaker, printing component, vibrating component, etc.

From the above description, it is manifested that various techniques may be used for implementing the concepts described in the present application without departing from the scope of those concepts. Moreover, while the concepts have been described with specific reference to certain implementations, a person of ordinary skill in the art may recognize that changes may be made in form and detail without departing from the scope of those concepts. As such, the described implementations are to be considered in all respects as illustrative and not restrictive. It should also be understood that the present application is not limited to the particular implementations described above, but many rearrangements, modifications, and substitutions are possible without departing from the scope of the present disclosure.

What is claimed is:

1. A user equipment (UE) comprising:

one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to:

receive, in a Physical Download Control Channel (PDCCH), Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data, wherein:

each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups,

the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and

each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

2. The UE of claim **1**, wherein the at least one processor is further configured to execute the computer-executable instructions to:

identify a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

3. The UE of claim **1**, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium Access Control (MAC) Control Element (CE) signaling.

4. The UE of claim **1**, wherein the at least one processor is further configured to execute the computer-executable instructions to:

indicate a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

5. The UE of claim **1**, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive the plurality of DMRS port groups via Radio Resource Control (RRC) signaling, wherein the plurality of DMRS port groups is associated with the plurality of PDSCHs.

6. The UE of claim **1**, wherein each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

7. A method of wireless communications by a user equipment (UE), the method comprising:

receiving, in a Physical Download Control Channel (PDCCH) Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtaining a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data, wherein:

each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups,

the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and

each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

8. The method of claim **7**, further comprising:

identifying a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

9. The method of claim **7**, further comprising:

receiving an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium Access Control (MAC) Control Element (CE) signaling.

10. The method of claim **7**, further comprising:

indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

11. The method of claim **7**, further comprising:

receiving the plurality of DMRS port groups via Radio Resource Control (RRC) signaling, wherein the plurality of DMRS port groups is associated with the plurality of PDSCHs.

12. The method of claim **7**, wherein each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

* * * * *

EXHIBIT 5

U.S. Patent No. 10,743,238 ("'238 Patent")

Defendant's Accused Products, including those which comply with 3GPP Standard TS 38.311 V15.15.0, 3GPP Standard TS 38.331 V16.6.0, 3GPP Standard TS 38.212 V.16.7, 3GPP Standard TS 38.213 V.16.7, and 3GPP Standard TS 38.214 V.16.7, infringe at least claim of the '238 patent as set forth below, which Plaintiff provides without the benefit of information about the Accused Products obtained through discovery.

Claim 1

Claim 1	Accused Products
Element a A method for a user equipment (UE) of a connected state, the method comprising:	
Element b receiving a system information (SI) change indication broadcasted by a paging via a currently active bandwidth part (BWP) during a modification period;	**TS 38.331 V15.15.0 (2021-09)** **Section 5.2.2.2.2 SI change indication and PWS notification** A modification period is used, i.e. updated SI (other than for ETWS and CMAS) is broadcasted in the modification period following the one where SI change indication is transmitted. The modification period boundaries are defined by SFN values for which SFN mod m = 0, where m is th number of radio frames comprising the modification period. The modification period is configured by system information. The UE receives indications about SI modifications and/or PWS notifications using Short Message transmitted with P-RNTI over DCI (see clause 6.5). Repetitions of SI change indication may occur within preceding modification period. For Short Message reception in a paging occasion, the UE monitors the PDCCH monitoring occasion(s) for paging as specified in TS 38.304 [20] and TS 38.213 [13]. If the UE receives a Short Message, the UE shall: 1> if the UE is ETWS capable or CMAS capable, the *etwsAndCmasIndication* bit of Short Message is set, and the UE is provided with *searchSpaceOtherSystemInformation* on the active BWP or the initial BWP: 2> immediately re-acquire the *SIB1*; 2> if the UE is ETWS capable and *si-SchedulingInfo* includes scheduling information for *SIB6*: 3> acquire *SIB6*, as specified in sub-clause 5.2.2.3.2,

Claim 1	Accused Products
	immediately; 2> if the UE is ETWS capable and *si-SchedulingInfo* includes scheduling information for *SIB7*: 3> acquire *SIB7*, as specified in sub-clause 5.2.2.3.2, immediately; 2> if the UE is CMAS capable and *si-SchedulingInfo* includes scheduling information for *SIB8*: 3> acquire *SIB8*, as specified in sub-clause 5.2.2.3.2, immediately; NOTE: In case *SIB6*, *SIB7*, or *SIB8* overlap with a measurement gap it is left to UE implementation how to immediately acquire *SIB6*, *SIB7*, or *SIB8*. 1> if the *systemInfoModification* bit of Short Message is set: 2> apply the SI acquisition procedure as defined in sub-clause 5.2.2.3 from the start of the next modification period.
Element c in response to receiving the SI change indication, switching from the currently active BWP to an initial active BWP for an SI update;	**TS 38.331 (V15.15.0)** **Section 5.2.2.3 Acquisition of System Information** 5.2.2.3.1 Acquisition of *MIB* and *SIB1* The UE shall: 1> apply the specified BCCH configuration defined in 9.1.1.1; 1> if the UE is in RRC_IDLE or in RRC_INACTIVE; or 1> if the UE is in RRC_CONNECTED while T311 is running: 2> acquire the *MIB*, which is scheduled as specified in TS 38.213 [13]; 2> if the UE is unable to acquire the *MIB*; 3> perform the actions as specified in clause 5.2.2.5; 2> else: 3> perform the actions specified in clause 5.2.2.4.1. 1> if the UE is in RRC_CONNECTED with an active BWP with common search space configured by *searchSpaceSIB1* and *pagingSearchSpace* and has received an indication about change of system information; or 1> if the UE is in RRC_IDLE or in RRC_INACTIVE; or 1> if the UE is in RRC_CONNECTED while T311 is running: 2> if *ssb-SubcarrierOffset* indicates *SIB1* is transmitted in the cell (TS 38.213

Claim 1	Accused Products
	[13]) and if *SIB1* acquisition is required for the UE: 3> acquire the *SIB1,* which is scheduled as specified in TS 38.213 [13]; 3> if the UE is unable to acquire the *SIB1*: 4> perform the actions as specified in clause 5.2.2.5; 3> else: 4> upon acquiring *SIB1*, perform the actions specified in clause 5.2.2.4.2. 2> else if *SIB1* acquisition is required for the UE and *ssb-SubcarrierOffset* indicates that *SIB1* is not scheduled in the cell: 3> perform the actions as specified in clause 5.2.2.5. NOTE: The UE in RRC_CONNECTED is only required to acquire broadcasted *SIB1* if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located. **Section 5.2.2.4.2 Actions upon reception of the *SIB1*** Upon receiving the *SIB1* the UE shall: ……. 4> if the UE has not stored a valid version of a SIB, in accordance with sub- clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub- clause 5.2.2.1: 5> for the SI message(s) that, according to the *si-SchedulingInfo*, contain at least one required SIB and for which *si-BroadcastStatus* is set to broadcasting: 6> acquire the SI message(s) as defined in sub-clause 5.2.2.3.2; **– *PDCCH-ConfigCommon*** The IE *PDCCH-ConfigCommon* is used to configure cell specific PDCCH parameters provided in SIB as well as in dedicated signalling. ***PDCCH-ConfigCommon* information element** -- ASN1START -- TAG-PDCCH-CONFIGCOMMON-START PDCCH-ConfigCommon ::= SEQUENCE { controlResourceSetZero ControlResourceSetZero

Claim 1	Accused Products
	OPTIONAL, -- Cond InitialBWP-Only commonControlResourceSet ControlResourceSet OPTIONAL, -- Need R searchSpaceZero SearchSpaceZero OPTIONAL, -- Cond InitialBWP-Only commonSearchSpaceList SEQUENCE (SIZE(1..4)) OF SearchSpace OPTIONAL, -- Need R searchSpaceSIB1 SearchSpaceId OPTIONAL, -- Need S searchSpaceOtherSystemInformation SearchSpaceId OPTIONAL, -- Need S pagingSearchSpace SearchSpaceId OPTIONAL, -- Need S ra-SearchSpace SearchSpaceId OPTIONAL, -- Need S ..., [[firstPDCCH-MonitoringOccasionOfPO CHOICE { sCS15KHZoneT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..139), sCS30KHZoneT-SCS15KHZhalfT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..279), sCS60KHZoneT-SCS30KHZhalfT-SCS15KHZquarterT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..559), sCS120KHZoneT-SCS60KHZhalfT-SCS30KHZquarterT-SCS15KHZoneEighthT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..1119), sCS120KHZhalfT-SCS60KHZquarterT-SCS30KHZoneEighthT-SCS15KHZoneSixteenthT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..2239), sCS120KHZquarterT-SCS60KHZoneEighthT-SCS30KHZoneSixteenthT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..4479),

Claim 1	Accused Products
	sCS120KHZoneEighthT-SCS60KHZoneSixteenthT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..8959), sCS120KHZoneSixteenthT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..17919) } OPTIONAL -- Cond OtherBWP]] } -- TAG-PDCCH-CONFIGCOMMON-STOP -- ASN1STOP ***searchSpaceSIB1*** ID of the search space for *SIB1* message. In the initial DL BWP of the UE's PCell, the network sets this field to 0. If the field is absent, the UE does not receive *SIB1* in this BWP. (see TS 38.213 [13], clause 10)
Element d receiving remaining minimum SI (RMSI) via the initial active BWP during a next modification period that immediately follows the modification period wherein the RMSI includes information associated with changed system information blocks (SIBs);	**TS 38.331 (V15.15.0)** **Section 5.2.2.2.2 SI change indication and PWS notification** A modification period is used, i.e. updated SI (other than for ETWS and CMAS) is broadcasted in the modification period following the one where SI change indication is transmitted. The modification period boundaries are defined by SFN values for which SFN mod m = 0, where m is th number of radio frames comprising the modification period. The modification period is configured by system information. The UE receives indications about SI modifications and/or PWS notifications using Short Message transmitted with P-RNTI over DCI (see clause 6.5). Repetitions of SI change indication may occur within preceding modification period. **Section 5.2.2.3.1 Acquisition of *MIB* and *SIB1*** The UE shall: 1> apply the specified BCCH configuration defined in 9.1.1.1; 1> if the UE is in RRC_IDLE or in RRC_INACTIVE; or 1> if the UE is in RRC_CONNECTED while T311 is running:

Claim 1	Accused Products
	2> acquire the *MIB*, which is scheduled as specified in TS 38.213 [13]; 2> if the UE is unable to acquire the *MIB*; 3> perform the actions as specified in clause 5.2.2.5; 2> else: 3> perform the actions specified in clause 5.2.2.4.1. 1> if the UE is in RRC_CONNECTED with an active BWP with common search space configured by *searchSpaceSIB1* and *pagingSearchSpace* and has received an indication about change of system information; or 1> if the UE is in RRC_IDLE or in RRC_INACTIVE; or 1> if the UE is in RRC_CONNECTED while T311 is running: 2> if *ssb-SubcarrierOffset* indicates *SIB1* is transmitted in the cell (TS 38.213 [13]) and if *SIB1* acquisition is required for the UE: 3> acquire the *SIB1*, which is scheduled as specified in TS 38.213 [13]; 3> if the UE is unable to acquire the *SIB1*: 4> perform the actions as specified in clause 5.2.2.5; 3> else: 4> upon acquiring *SIB1*, perform the actions specified in clause 5.2.2.4.2. 2> else if *SIB1* acquisition is required for the UE and *ssb-SubcarrierOffset* indicates that *SIB1* is not scheduled in the cell: 3> perform the actions as specified in clause 5.2.2.5. NOTE: The UE in RRC_CONNECTED is only required to acquire broadcasted *SIB1* if the UE can acquire it without disrupting unicast data reception, i.e. the broadcast and unicast beams are quasi co-located. **Section 5.2.2.4.2 Actions upon reception of the *SIB1*** Upon receiving the *SIB1* the UE shall: ……. 4> if the UE has not stored a valid version of a SIB, in accordance with sub- clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub- clause 5.2.2.1: 5> for the SI message(s) that, according to the *si-SchedulingInfo* contain at least one required SIB and for which *si-BroadcastStatus*

Claim 1	Accused Products

	is set to broadcasting:
	6> acquire the SI message(s) as defined in sub-clause 5.2.2.3.2;
	
	SIB1
	SIB1 contains information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information. It also contains radio resource configuration information that is common for all UEs and barring information applied to the unified access control.
	Signalling radio bearer: N/A
	RLC-SAP: TM
	Logical channels: BCCH
	Direction: Network to UE
	SIB1 message
	-- ASN1START
	-- TAG-SIB1-START
	
	SIB1 ::= SEQUENCE {
	cellSelectionInfo SEQUENCE {
	q-RxLevMin Q-RxLevMin,
	q-RxLevMinOffset INTEGER (1..8)
	OPTIONAL, -- Need S
	q-RxLevMinSUL Q-RxLevMin
	OPTIONAL, -- Need R
	q-QualMin Q-QualMin
	OPTIONAL, -- Need S
	q-QualMinOffset INTEGER (1..8)
	OPTIONAL -- Need S
	}
	OPTIONAL, -- Cond Standalone
	cellAccessRelatedInfo CellAccessRelatedInfo,
	connEstFailureControl ConnEstFailureControl

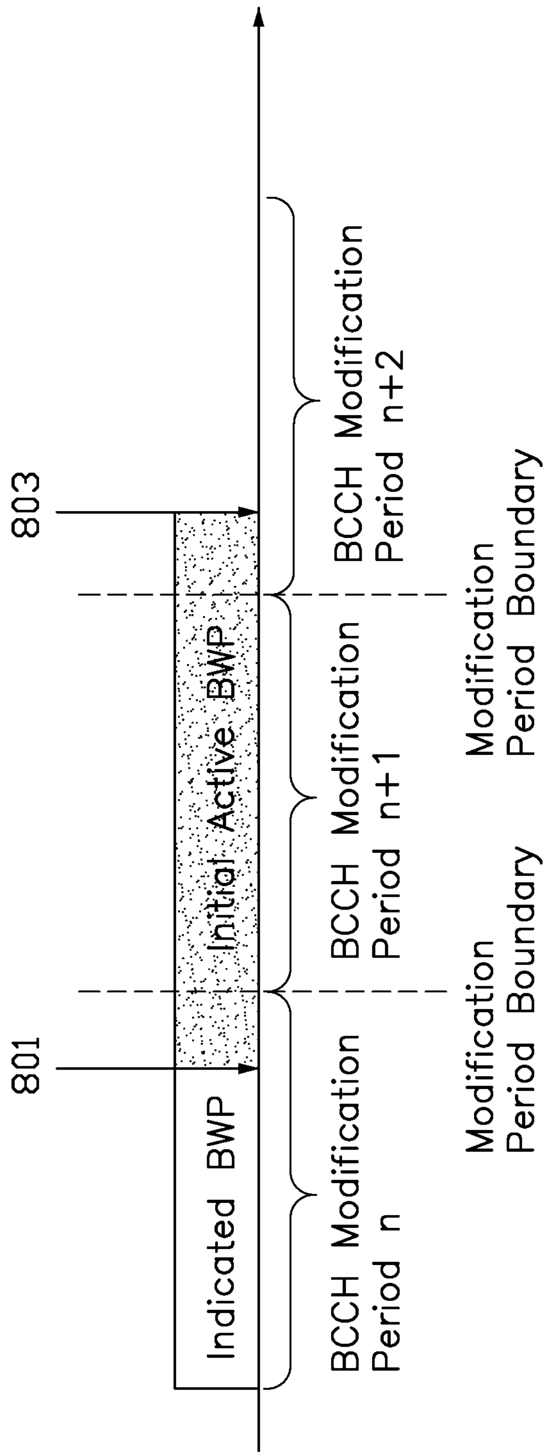
801
803
Indicated BWP
Initial Active BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary

FIG. 8

Claim 1	Accused Products

	OPTIONAL, -- Need R
	
	OPTIONAL, -- Need R
	servingCellConfigCommon ServingCellConfigCommonSIB
	OPTIONAL, -- Need R
	ims-EmergencySupport ENUMERATED {true}
	OPTIONAL, -- Need R
	eCallOverIMS-Support ENUMERATED {true}
	OPTIONAL, -- Cond Absent
	ue-TimersAndConstants UE-TimersAndConstants
	OPTIONAL, -- Need R
	
	uac-BarringInfo SEQUENCE {
	uac-BarringForCommon UAC-BarringPerCatList
	OPTIONAL, -- Need S
	uac-BarringPerPLMN-List UAC-BarringPerPLMN-List
	OPTIONAL, -- Need S
	uac-BarringInfoSetList UAC-BarringInfoSetList, uac-AccessCategory1-SelectionAssistanceInfo CHOICE {
	plmnCommon UAC-AccessCategory1-SelectionAssistanceInfo,
	individualPLMNList SEQUENCE (SIZE (2..maxPLMN)) OF UAC-AccessCategory1-SelectionAssistanceInfo
	}
	OPTIONAL -- Need S
	}
	OPTIONAL, -- Need R
	
	useFullResumeID ENUMERATED {true}
	OPTIONAL, -- Need R
	
	lateNonCriticalExtension OCTET STRING

Claim 1	Accused Products

	OPTIONAL,
	    nonCriticalExtension SEQUENCE{}
	OPTIONAL
	}
	
	        SI-SchedulingInfo
	The IE *SI-SchedulingInfo* contains information needed for acquisition of SI messages.
	***SI-SchedulingInfo* information element**
	-- ASN1START
	-- TAG-SI-SCHEDULINGINFO-START
	
	SI-SchedulingInfo ::= SEQUENCE {
	    schedulingInfoList SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo,
	    si-WindowLength ENUMERATED {s5, s10, s20, s40, s80, s160, s320, s640, s1280},
	    si-RequestConfig SI-RequestConfig
	OPTIONAL, -- CondMSG-1
	    si-RequestConfigSUL SI-RequestConfig
	OPTIONAL, -- Cond SUL-MSG-1
	    systemInformationAreaID BIT STRING (SIZE (24))
	OPTIONAL, -- Need R
	    ...
	}
	SchedulingInfo ::= SEQUENCE {
	    si-BroadcastStatus ENUMERATED {broadcasting, notBroadcasting},
	    si-Periodicity ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},
	    sib-MappingInfo SIB-Mapping
	}

Claim 1	Accused Products

	SIB-Mapping ::= SEQUENCE (SIZE (1..maxSIB)) OF SIB-TypeInfo
	SIB-TypeInfo ::= SEQUENCE {
	type ENUMERATED {sibType2, sibType3, sibType4, sibType5, sibType6, sibType7, sibType8, sibType9,
	spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1,... },
	valueTag INTEGER (0..31) OPTIONAL, -- Cond SIB-TYPE
	areaScope ENUMERATED {true} OPTIONAL -- Need S
	}
	-- Configuration for Msg1 based SI Request
	SI-RequestConfig ::= SEQUENCE {
	rach-OccasionsSI SEQUENCE {
	rach-ConfigSI RACH-ConfigGeneric,
	ssb-perRACH-Occasion ENUMERATED {oneEighth, oneFourth, oneHalf, one, two, four, eight, sixteen}
	}
	OPTIONAL, -- Need R
	si-RequestPeriod ENUMERATED {one, two, four, six, eight, ten, twelve, sixteen} OPTIONAL, -- Need R
	si-RequestResources SEQUENCE (SIZE (1..maxSI-Message)) OF SI-RequestResources
	}
	SI-RequestResources ::= SEQUENCE {
	ra-PreambleStartIndex INTEGER (0..63),
	ra-AssociationPeriodIndex INTEGER (0..15) OPTIONAL, -- Need R
	ra-ssb-OccasionMaskIndex INTEGER (0..15) OPTIONAL -- Need R
	}
	-- TAG-SI-SCHEDULINGINFO-STOP

Claim 1	Accused Products
	-- ASN1STOP
Element e determining which of the changed SIBs is required to be updated for the UE according to the received RMSI;	**TS 38.331 (V15.15.0)** **Section 5.2.2.4.2 Actions upon reception of the *SIB1*** Upon receiving the *SIB1* the UE shall: .... 4> if the UE has not stored a valid version of a SIB, in accordance with sub-clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub-clause 5.2.2.1: 5> for the SI message(s) that, according to the *si-SchedulingInfo*, contain at least one required SIB and for which *si-BroadcastStatus* is set to broadcasting: 6> acquire the SI message(s) as defined in sub-clause 5.2.2.3.2; 5.2.2.2.1 SIB validity The UE shall apply the SI acquisition procedure as defined in clause 5.2.2.3 upon cell selection (e.g. upon power on), cell-reselection, return from out of coverage, after reconfiguration with sync completion, after entering the network from another RAT, upon receiving an indication that the system information has changed, upon receiving a PWS notification; and whenever the UE does not have a valid version of a stored SIB. The UE shall: 1> delete any stored version of a SIB after 3 hours from the moment it was successfully confirmed as valid; 1> for each stored version of a SIB: 2> if the *areaScope* is associated and its value for the stored version of the SIB is the same as the value received in the *si-SchedulingInfo* for that SIB from the serving cell: 3> if the first *PLMN-Identity* included in the *PLMN-IdentityInfoList*, the *systemInformationAreaID* and the *valueTag* that are included in the *si-SchedulingInfo* for the SIB received from the serving cell are identical to

Claim 1	Accused Products

	the *PLMN-Identity*, the *systemInformationAreaID* and the *valueTag* associated
	with the stored version of that SIB:
	4> consider the stored SIB as valid for the cell;
	2> if the *areaScope* is not present for the stored version of the SIB and the *areaScope* value is not included in the *si-SchedulingInfo* for that SIB from the serving cell:
	3> if the first *PLMN-Identity* in the *PLMN-IdentityInfoList,* the *cellIdentity* and
	valueTag that are included in the *si-SchedulingInfo* for the SIB received from the serving cell are identical to the *PLMN-Identity,* the *cellIdentity* and the *valueTag* associated with the stored version of that SIB:
	4> consider the stored SIB as valid for the cell;
	
	SI-SchedulingInfo
	The IE *SI-SchedulingInfo* contains information needed for acquisition of SI messages.
	***SI-SchedulingInfo* information element**
	-- ASN1START
	-- TAG-SI-SCHEDULINGINFO-START
	SI-SchedulingInfo ::= SEQUENCE {
	schedulingInfoList SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo,
	si-WindowLength ENUMERATED {s5, s10, s20, s40, s80, s160, s320, s640, s1280},
	si-RequestConfig SI-RequestConfig OPTIONAL, -- Cond MSG-1
	si-RequestConfigSUL SI-RequestConfig OPTIONAL, -- Cond SUL-MSG-1
	systemInformationAreaID BIT STRING (SIZE (24)) OPTIONAL, -- Need R
	...
	}

Claim 1	Accused Products

	SchedulingInfo ::= SEQUENCE {
	si-BroadcastStatus ENUMERATED {broadcasting, notBroadcasting},
	si-Periodicity ENUMERATED {rf8, rf16, rf32, rf64, rf128, rf256, rf512},
	sib-MappingInfo SIB-Mapping
	}
	SIB-Mapping ::= SEQUENCE (SIZE (1..maxSIB)) OF SIB-TypeInfo
	SIB-TypeInfo ::= SEQUENCE {
	type ENUMERATED {sibType2, sibType3, sibType4, sibType5, sibType6, sibType7, sibType8, sibType9,
	spare8, spare7, spare6, spare5, spare4, spare3, spare2, spare1,... },
	valueTag INTEGER (0..31) OPTIONAL, -- Cond SIB-TYPE
	areaScope ENUMERATED {true} OPTIONAL -- Need S
	}
	-- Configuration for Msg1 based SI Request
	SI-RequestConfig ::= SEQUENCE {
	rach-OccasionsSI SEQUENCE {
	rach-ConfigSI RACH-ConfigGeneric,
	ssb-perRACH-Occasion ENUMERATED {oneEighth, oneFourth, oneHalf, one, two, four, eight, sixteen}
	} OPTIONAL, -- Need R
	si-RequestPeriod ENUMERATED {one, two, four, six, eight, ten, twelve, sixteen} OPTIONAL, -- Need R
	si-RequestResources SEQUENCE (SIZE (1..maxSI-Message)) OF SI-RequestResources
	}
	SI-RequestResources ::= SEQUENCE {

Claim 1	Accused Products
	ra-PreambleStartIndex INTEGER (0..63), ra-AssociationPeriodIndex INTEGER (0..15) OPTIONAL, -- Need R ra-ssb-OccasionMaskIndex INTEGER (0..15) OPTIONAL -- Need R } -- TAG-SI-SCHEDULINGINFO-STOP -- ASN1STOP
Element f and receiving content of the required changed SIBs based on the determination.	**TS 38.331 (V15.15.0)** **Section 5.2.2.4.2 Actions upon reception of the *SIB1*** Upon receiving the *SIB1* the UE shall: ……. 4> if the UE has not stored a valid version of a SIB, in accordance with sub- clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub- clause 5.2.2.1: 5> for the SI message(s) that, according to the *si-SchedulingInfo*, contain at least one required SIB and for which *si-BroadcastStatus* is set to broadcasting: 6> acquire the SI message(s) as defined in sub-clause 5.2.2.3.2;

EXHIBIT 6

U.S. Patent No. 10,791,502 ("'502 Patent")

Defendant's Accused Products, including those which comply with 3GPP Standard TS 38.311 V15.15.0, 3GPP Standard TS 38.331 V16.6.0, 3GPP Standard TS 38.212 V.16.7, 3GPP Standard TS 38.213 V.16.7, and 3GPP Standard TS 38.214 V.16.7, infringe at least claim of the '502 patent as set forth below, which Plaintiff provides without the benefit of information about the Accused Products obtained through discovery.

Claim 1

Claim 1	Accused Products
Element a A method of an on-demand system information (SI) request procedure performed by a user equipment (UE), the method comprising:	**TS 38.331 (v16.6.0)** **Section 5.2.2.3.5** Request for on demand system information **in RRC_CONNECTED** The UE shall: 1> if the UE is in [illegible] with an active BWP not configured with common search space with the field *searchSpaceOtherSystemInformation* and the UE has not stored a valid version of a SIB, in accordance with sub-clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub-clause 5.2.2.1 or if requested by upper layers: 2> for the SI message(s) that, according to the *si-SchedulingInfo* or *posSI-SchedulingInfo* in the stored SIB1, contain at least one required SIB or requested posSIB: 3> if *onDemandSIB-Request* is configured and timer T350 is not running: 4> initiate transmission of the DedicatedSIBRequest message in accordance with 5.2.2.3.6; 4> start timer T350 with the timer value set to the *onDemandSIB-RequestProhibitTimer*; 1> else if the UE is in RRC_CONNECTED with an active BWP configured with common search space with the field *searchSpaceOtherSystemInformation* and the UE has not stored a valid version of a SIB, in accordance with sub-clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub-clause
Element b transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);	

Claim 1	Accused Products
	5.2.2.1 or if requested by upper layers: 2> for the SI message(s) that, according to the *si-SchedulingInfo* in the stored SIB1, contain at least one required SIB and for which *si-BroadcastStatus* is set to *broadcasting*: 3> acquire the SI message(s) as defined in sub-clause 5.2.2.3.2; > for the SI message(s) that, according to the *si-SchedulingInfo* in the stored SIB1, contain at least one required SIB and for which *si-BroadcastStatus* is set to *notBroadcasting*: 3> if *onDemandSIB-Request* is configured and timer T350 is not running: 4> initiate transmission of the *DedicatedSIBRequest* message in accordance with 5.2.2.3.6; 4> start timer T350 with the timer value set to the *onDemandSIB-RequestProhibitTimer*; 3> acquire the requested SI message(s) corresponding to the requested SIB(s) as defined in sub-clause 5.2.2.3.2. **Section 5.2.2.3.6 Actions related to transmission of** DedicatedSIBRequest message The UE shall set the contents of *DedicatedSIBRequest* message as follows: 1> if the procedure is triggered to request the required SIB(s): 2> include *requestedSIB-List* in the *onDemandSIB-RequestList* to indicate the requested SIB(s);

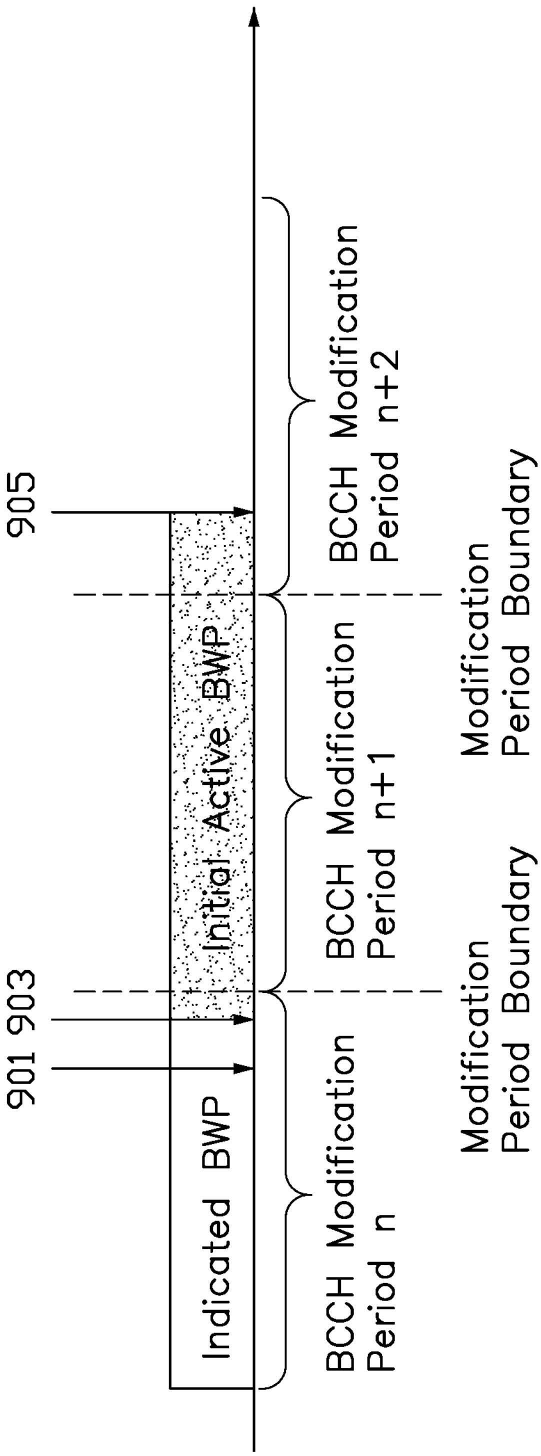
905
901 903
Indicated BWP
Initial Active BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary

FIG. 9

Claim 1	Accused Products

	1> if the procedure is triggered to request the required posSIB(s):
	
	2> include *requestedPosSIB-List* in the *onDemandSIB-RequestList* to indicate the requested posSIB(s).
	
	Section 6.2.2 Message definitions
	– *DedicatedSIBRequest*
	
	The *DedicatedSIBRequest* message is used to request SIB(s) required by the UE in RRC_CONNECTED as specified in clause 5.2.2.3.5.
	Signalling radio bearer: SRB1 RLC-SAP: AM
	
	Logical channel: DCCH
	
	Direction: UE to Network
	
	DedicatedSIBRequest message
	
	`-- ASN1START`
	`-- TAG-DEDICATEDSIBREQUEST-START`
	
	`DedicatedSIBRequest-r16 ::=`
	`SEQUENCE`
	`{ criticalExtensions  CHOICE {`
	`dedicatedSIBRequest-r16  DedicatedSIBRequest-r16-IEs, criticalExtensionsFuture  SEQUENCE {}`
	`}`
	
	`}`
	
	`DedicatedSIBRequest-r16-IEs ::=`
	`SEQUENCE { onDemandSIB-`

Claim 1	Accused Products

	RequestList-r16 SEQUENCE {
	
	requestedSIB-List-r16 SEQUENCE (SIZE (1..maxOnDemandSIB-r16)) OF SIB-ReqInfo-r16 OPTIONAL,
	requestedPosSIB-List-r16 SEQUENCE (SIZE (1..maxOnDemandPosSIB- r16)) OF PosSIB-ReqInfo-r16
	OPTIONAL
	} OPTIONAL,
	lateNonCriticalExtension OCTET STRING OPTIONAL,
	nonCriticalExtension SEQUENCE {} OPTIONAL
	}
	
	SIB-ReqInfo-r16 ::= ENUMERATED { sib12, sib13, sib14, spare6, spare5, spare4, spare3, spare2, spare1 }
	
	PosSIB-ReqInfo-r16 ::= SEQUENCE {
	gnss-id-r16 GNSS-ID-r16 OPTIONAL,
	sbas-id-r16 SBAS-ID-r16 OPTIONAL,
	posSibType-r16 ENUMERATED { posSibType1-1, posSibType1-2, posSibType1-3, posSibType1-4, posSibType1-5, posSibType1-6,
	posSibType1-7, posSibType1-8, posSibType2-1, posSibType2-2, posSibType2-3, posSibType2-4,
	posSibType2-5, posSibType2-6, posSibType2-7, posSibType2-8, posSibType2-9, posSibType2-10,
	posSibType2-11, posSibType2-12, posSibType2-13, posSibType2-14, posSibType2-15,
	posSibType2-16, posSibType2-17, posSibType2-18, posSibType2-19,

Claim 1	Accused Products
	posSibType2-20, posSibType2-21, posSibType2-22, posSibType2-23, posSibType3-1, posSibType6-1, posSibType6-2, posSibType6-3,... } -- TAG-DEDICATEDSIBREQUEST-STOP -- ASN1STOP ***DedicatedSIBRequest* field descriptions** *requestedSIB-List* Contains a list of SIB(s) the UE requests while in RRC_CONNECTED. ***requestedPosSIB-List*** Contains a list of posSIB(s) the UE requests while in RRC_CONNECTED.
Element c activating a prohibit timer; and transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.	**TS 38.331 (v16.6.0)** **Section 5.2.2.3.5 Request for on demand system information in RRC_CONNECTED** The UE shall: 1> if the UE is in RRC_CONNECTED with an active BWP not configured with common search space with the field *searchSpaceOtherSystemInformation* and the UE has not stored a valid version of a SIB, in accordance with sub-clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub-clause 5.2.2.1 or if requested by upper layers: 2> for the SI message(s) that, according to the *si-SchedulingInfo* or *posSI-SchedulingInfo* in the stored SIB1, contain at least one required SIB or requested posSIB: 3> if *onDemandSIB-Request* is configured and timer T350 is not running:

Claim 1	Accused Products
	4> initiate transmission of the DedicatedSIBRequest message in accordance with 5.2.2.3.6; 4> start timer T350 with the timer value set to the *onDemandSIB-RequestProhibitTimer*; 1> else if the UE is in RRC_CONNECTED with an active BWP configured with common search space with the field *searchSpaceOtherSystemInformation* and the UE has not stored a valid version of a SIB, in accordance with sub-clause 5.2.2.2.1, of one or several required SIB(s), in accordance with sub-clause 5.2.2.1 or if requested by upper layers: 2> for the SI message(s) that, according to the *si-SchedulingInfo* in the stored SIB1, contain at least one required SIB and for which *si-BroadcastStatus* is set to *broadcasting*: 3> acquire the SI message(s) as defined in sub-clause 5.2.2.3.2; 2> for the SI message(s) that, according to the *si-SchedulingInfo* in the stored SIB1, contain at least one required SIB and for which *si-BroadcastStatus* is set to *notBroadcasting*: 3> if *onDemandSIB-Request* is configured and timer T350 is not running: 4> initiate transmission of the *DedicatedSIBRequest* message in accordance with 5.2.2.3.6; 4> start timer T350 with the timer value set to the *onDemandSIB-RequestProhibitTimer*; 3> acquire the requested SI message(s) corresponding to the requested SIB(s) as defined in sub-clause 5.2.2.3.2.

Exhibit 7

U.S. Patent No. 10,972,972 ("'972 Patent")

Defendant's Accused Products, including those which comply with 3GPP Standard TS 38.311 V15.15.0, 3GPP Standard TS 38.331 V16.6.0, 3GPP Standard TS 38.212 V.16.7, 3GPP Standard TS 38.213 V.16.7, and 3GPP Standard TS 38.214 V.16.7, infringe at least claim of the '972 patent as set forth below, which Plaintiff provides without the benefit of information about the Accused Products obtained through discovery.

Claim 1

Claim 1	Accused Products
Element a A wireless communication device comprising: a plurality of antenna panels; a processor coupled to the plurality of antenna panels and configured to:	Each of the Accused Products are wireless communication devices comprising a plurality of antenna panels and a processor coupled to the plurality of antenna panels.
Element b maintain a plurality of leading time values, the plurality of leading time values indicating a plurality of leading time durations; receive an indicator for antenna panel status information from a base station (BS);	**TS 38.214 (v16.7)** **Section 5.3.1 Application delay of the minimum scheduling offset restriction** When the UE is scheduled with DCI format 0_1 or 1_1 with a '*Minimum applicable scheduling offset indicator*' field in slot *n*, it shall determine the *K*0min and *K*2min values, if configured respectively, to be applied, while the previously applied *K*0min and/or *K*2min values are applied until the new values take effect. If the DCI in slot *n* also indicates an active DL (UL) BWP change for a serving cell, the indicated *K*0min (*K*2min) value in the new active DL (UL) BWP, if configured, is applied from the slot indicated by the slot offset value of the time domain resource assignment field in the DCI. Otherwise, change of applied minimum scheduling offset restriction indication carried by DCI in slot *n*, shall be applied in slot *n*+*X* of the scheduling cell. The UE does not expect to be scheduled with DCI format 0_1 or 1_1 with '*Minimum applicable scheduling offset indicator*' field indicating another change to *K*0min or *K*2min for the same active BWP of the scheduled cell before slot *n*+*X* of the scheduling cell. When the DCI format 0_1 or 1_1 with '*Minimum applicable scheduling offset indicator*'

Claim 1	Accused Products
	field indicating a change to the applied $K0_{min}$ or $K2_{min}$ is contained within the first three symbols of slot n, the value of application delay X is determined by, $X = \max(\lceil K_{0minOld} \cdot \frac{2^{\mu PDCCH}}{2^{\mu PDSCH}} \rceil, Z_{\mu})$ where $K_{0minOld}$ is the currently applied K_{0min} value of the active DL BWP in the scheduled cell and is zero, if *minimumSchedulingOffsetK0* is not configured for the active DL BWP in the scheduled cell, Z_{μ} is determined by the subcarrier spacing of the active DL BWP in the scheduling cell in slot n, and given in Table 5.3.1-1, and μPDCCH and μPDSCH are the sub-carrier spacing configurations for PDCCH of the active DL BWP in the scheduling cell and PDSCH of the active DL BWP in the scheduled cell, respectively, in slot n.
Element c apply one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the indicator for antenna panel status information; receive a scheduling offset value from the BS, the scheduling offset value comprising at least one of a K0 parameter for a Downlink (DL) channel and a K2 parameter for an Uplink (UL) channel;	**TS 38.312 (v16.7)** **Section 7.3.1.1.2 Format 0_1** Bandwidth part indicator – 0, 1 or 2 bits as determined by the number of UL BWPs $n_{BWP,RRC}$ configured by higher layers, excluding the initial UL bandwidth part. The bitwidth for this field is determined as $\lceil \log_2(n_{BWP}) \rceil$ bits, where - $n_{BWP} = n_{BWP,RRC} + 1$ if $n_{BWP,RRC} \leq 3$, in which case the bandwidth part indicator is equivalent to the ascending order of the higher layer parameter *BWP-Id*; - otherwise $n_{BWP} = n_{BWP,RRC}$, in which case the bandwidth part indicator is defined in Table 7.3.1.1.2-1; Minimum applicable scheduling offset indicator – 0 or 1 bit - 0 bit if higher layer parameter *minimumSchedulingOffsetK2* is not configured;

Claim 1	Accused Products
	1 bit if higher layer parameter *minimumSchedulingOffsetK2* is configured. The 1 bit indication is used to determine the minimum applicable K2 for the active UL BWP and the minimum applicable K0 value for the active DL BWP, if configured respectively, according to Table 7.3.1.1.2-33. If the minimum applicable K0 is indicated, the minimum applicable value of the aperiodic CSI-RS triggering offset for an active DL BWP shall be the same as the minimum applicable K0 value. **TS 38.331 (v16.6)** **PDSCH-Config** The PDSCH-Config IE is used to configure the UE specific PDSCH parameters. minimumSchedulingOffsetK0-r16 SetupRelease { MinSchedulingOffsetK0-Values-r16 } OPTIONAL, --Need M minimumSchedulingOffsetK0 List of minimum K0 values.Minimum K0 parameter denotes minimum applicable value(s) for the TDRA table for PDSCH and for A-CSI RS triggering Offset(s) (see TS 38.214 [19], clause 5.3.1). **PUSCH-Config** The IE PUSCH-Config is used to configure the UE specific PUSCH parameters applicable to a particular BWP. … minimumSchedulingOffsetK2-r16 SetupRelease { MinSchedulingOffsetK2-

Claim 1	Accused Products
	Values-r16 } OPTIONAL, --Need M minimumSchedulingOffsetK2 List of minimum K2 values.Minimum K2 parameter denotes minimum applicable value(s) for the Time domain resource assignment table for PUSCH (see TS 38.214 [19], clause 6.1.2.1).
Element d and determine that the scheduling offset value is invalid, when a time duration indicated by the scheduling offset value is less than a leading time duration indicated by the applied leading time value.	**TS 38.214 (v16.7)** **Section 5.1.2.1 Resource allocation in time domain** When the UE is configured with *minimumSchedulingOffsetK0* in an active DL BWP it applies a minimum scheduling offset restriction indicated by the 'Minimum applicable scheduling offset indicator' field in DCI format 1_1 or DCI format 0_1 if the same field is available. When the UE is configured with *minimumSchedulingOffsetK0* in an active DL BWP and it has not received 'Minimum applicable scheduling offset indicator' field in DCI format 0_1 or 1_1, the UE shall apply a minimum scheduling offset restriction indicated based on 'Minimum applicable scheduling offset indicator' value '0'. When the minimum scheduling offset restriction is applied the UE is not expected to be scheduled with a DCI in slot *n* to receive a PDSCH scheduled with C-RNTI, CS-RNTI or MCS-C-RNTI with $K0$ smaller than $\lceil K0_{min} \cdot \frac{2^{\mu'}}{2^{\mu}} \rceil$, where $K0_{min}$ and μ are the applied minimum scheduling offset restriction and the numerology of the active DL BWP of the scheduled cell when receiving the DCI in slot *n*, respectively, and μ' is the numerology of the new active DL BWP in case of active DL BWP change in the scheduled cell and is equal to μ, otherwise.

Exhibit 8

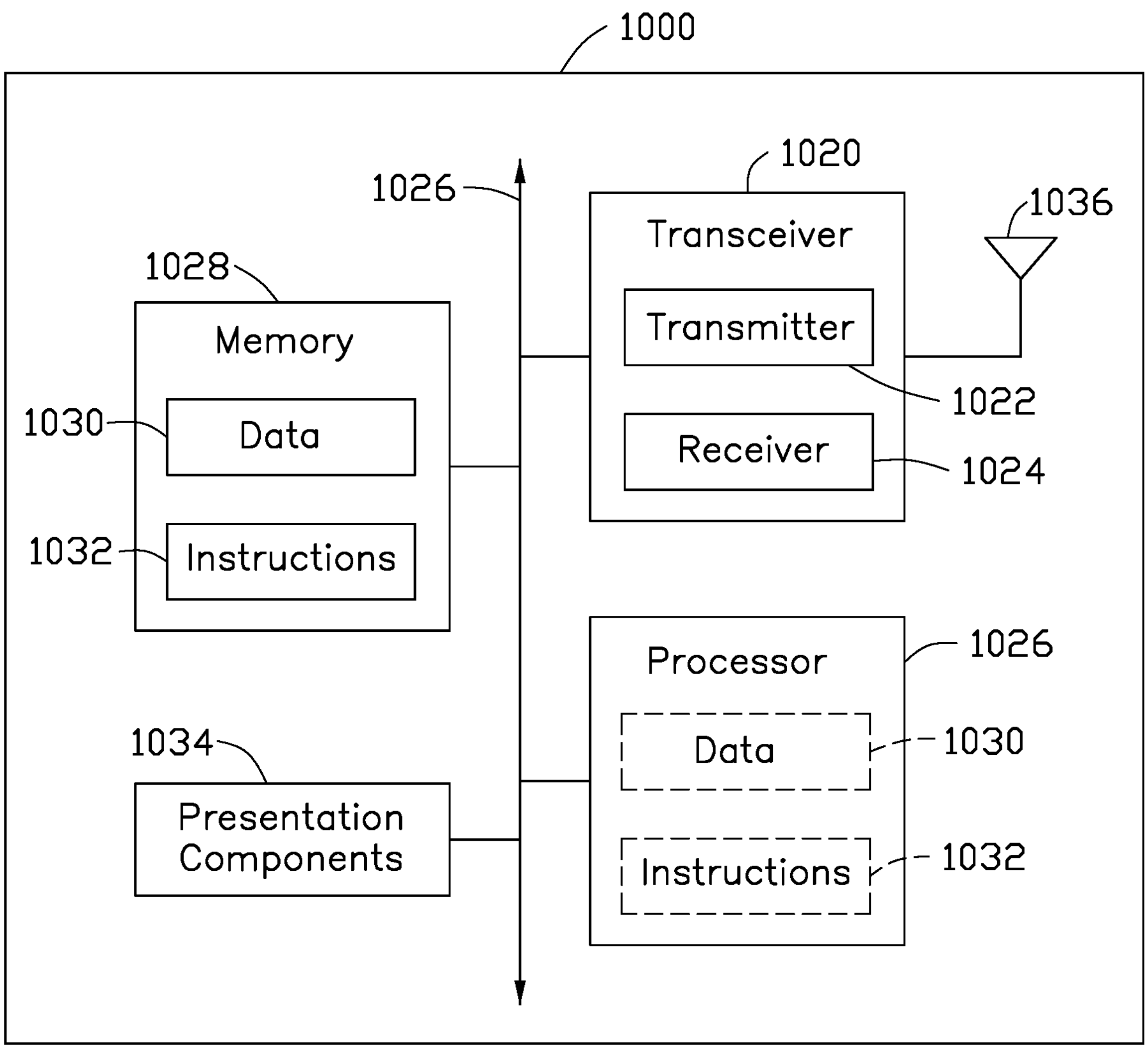
1000
1026
1020
1036
1028
Transceiver
Memory
Transmitter
1030
Data
1022
Receiver
1024
1032
Instructions
Processor
1026
1034
Data
1030
Presentation Components
Instructions
1032

FIG. 10

U.S. Patent No. 11,115,165 ("'165 Patent")

Defendant's Accused Products, including those which comply with 3GPP Standard TS 38.311 V15.15.0, 3GPP Standard TS 38.331 V16.6.0, 3GPP Standard TS 38.212 V.16.7, 3GPP Standard TS 38.213 V.16.7, and 3GPP Standard TS 38.214 V.16.7, infringe at least claim of the '165 patent as set forth below, which Plaintiff provides without the benefit of information about the Accused Products obtained through discovery.

Claim 1

Claim 1	Accused Products
Element a A user equipment (UE) comprising: one or more non- transitory computer-readable media having computer-executable instructions embodied thereon; and at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to:	The Accused Products include a user equipment (UE) comprising one or more non-transitory computer-readable media having computer- executable instructions embodied thereon; and at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions.
Element b receive, in a Physical Download Control Channel (PDCCH), Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups;	**TS 38.212 (v16.7)** **Section 7.3.1.2.2 Format 1_1** DCI format 1_1 is used for the scheduling of PDSCH in one cell. - Antenna port(s) – 4, 5, or 6 bits as defined by Tables 7.3.1.2.2-1/2/3/4 and Tables 7.3.1.2.2- 1A/2A/3A/4A, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports {p0,...,pv−1} shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4 or Tables 7.3.1.2.2-1A/2A/3A/4A. When a UE receives an activation command that maps at least one codepoint of DCI field 'Transmission Configuration Indication' to two TCI states, the UE shall use Table 7.3.1.2.2-1A/2A/3A/4A; otherwise, it

Claim 1	Accused Products
	shall use Tables 7.3.1.2.2- 1/2/3/4. The UE can receive an entry with DMRS ports equals to 1000, 1002, 1003 when two TCI states are indicated in a codepoint of DCI field 'Transmission Configuration Indication'. **TS 38.214 (v16.7)** **Section 5.1.5 Antenna ports quasi co-location** When a UE supports two TCI states in a codepoint of the DCI field 'Transmission Configuration Indication' the UE may receive an activation command, as described in clause 6.1.3.24 of [10, TS 38.321], the activation command is used to map up to 8 combinations of one or two TCI states to the codepoints of the DCI field 'Transmission Configuration Indication'. The UE is not expected to receive more than 8 TCI states in the activation command.
Element c and obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data,	**TS 38.213 (v16.7)** **Section 5 Radio link monitoring** if the active TCI state for PDCCH reception includes two RS, the UE expects that one RS is configured with qcl-Typeset to 'typeD' [6, TS 38.214] and the UE uses the RS configured with qcl-Typeset to 'typeD' for radio link monitoring; the UE does not expect both RS to be configured with qcl-Type set to 'typeD' **TS 38.214 (v16.7)** **Section 5.1.5 Antenna ports quasi co-location** The UE can be configured with a list of up to M TCI-State configurations within the higher layer parameter PDSCHConfig to decode PDSCH according to a detected PDCCH with DCI intended for the UE and the given serving cell, where M depends on the UE capability maxNumberConfiguredTCIstates PerCC. Each TCI-State contains parameters for configuring a quasi co-location relationship

Claim 1	Accused Products
	between one or two downlink reference signals and the DM-RS ports of the PDSCH, the DM-RS port of PDCCH or the CSI-RS port(s) of a CSI-RS resource. The quasi co-location relationship is configured by the higher layer parameter qcl-Type1 for the first DL RS, and qcl-Type2 for the second DL RS (if configured). For the case of two DL RSs, the QCL types shall not be the same, regardless of whether the references are to the same DL RS or different DL RSs. The quasi co-location types corresponding to each DL RS are given by the higher layer parameter qcl-Type in QCL-Info and may take one of the following values: - 'typeA': {Doppler shift, Doppler spread, average delay, delay spread} - 'typeB': {Doppler shift, Doppler spread} - 'typeC':{Doppler shift, average delay} - 'typeD': {Spatial Rx parameter}
Element d wherein: each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups, the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups	**TS 38.214 (v16.7)** **Section 5.1.5 Antenna ports quasi co-location** The UE can be configured with a list of up to M TCI-State configurations within the higher layer parameter PDSCHConfig to decode PDSCH according to a detected PDCCH with DCI intended for the UE and the given serving cell, where M depends on the UE capability maxNumberConfiguredTCIstates PerCC. Each TCI-State contains parameters for configuring a quasi co-location relationship between one or two downlink reference signals and the DM-RS ports of the PDSCH, the DM-RS port of PDCCH or the CSI-RS port(s) of a CSI-RS resource. The quasi co-location relationship is configured by the higher layer parameter qcl-Type1 for the first DL RS, and qcl-Type2 for the second DL RS (if configured). For the case of two DL RSs, the QCL types shall not be the same, regardless of whether the references are to the same DL RS or different DL RSs. The quasi co-location types corresponding to each DL RS are given by the higher layer parameter qcl-Type in QCL-Info and may take one of the following values: - 'typeA': {Doppler shift, Doppler spread, average delay, delay spread} - 'typeB': {Doppler shift, Doppler spread} - 'typeC': {Doppler shift, average delay} - 'typeD': {Spatial Rx parameter}

Claim 1	Accused Products

	TS 38.331 (v16.6)
	
	TCI-State
	
	The IE TCI-State associates one or two DL reference signals with a corresponding quasi- colocation (QCL) type. TCI-State information element
	
	TCI-State ::= SEQUENCE {
	tci-StateId TCI-StateId, qcl-Type1 QCL-Info,
	qcl-Type2 QCL-Info OPTIONAL, -- Need R
	
	...
	
	}
	
	QCL-Info ::= SEQUENCE {
	
	cell ServCellIndex OPTIONAL, -- Need R
	
	bwp-Id BWP-Id OPTIONAL, -- Cond CSI-RS-
	
	Indicated referenceSignal CHOICE {
	
	csi-rs NZP-CSI-RS-ResourceId,
	
	ssb SSB-Index
	
	},
	
	qcl-Type ENUMERATED {typeA, typeB, typeC, typeD},

SYSTEM INFORMATION UPDATES IN BAND WIDTH PART (BWP) SWITCH OPERATION

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of and priority to U.S. Provisional Application No. 62/586,598 filed on Nov. 15, 2017 and entitled "SYSTEM INFORMATION UPDATE IN BWP SWITCH OPERATION," (hereinafter referred to as "US72315 application"). The disclosure of the US72315 application is hereby incorporated fully by reference into the present disclosure.

TECHNICAL FIELD

The present disclosure generally relates to a method for bandwidth part switching operations performed by a user equipment and user equipment performing the same.

BACKGROUND

In a cellular network, a UE-specific serving cell may configure one or more bandwidth parts (BWPs) in downlink and uplink respectively for a UE by dedicated RRC signaling. One the other hand, a UE may be allocated to with at most one active DL BWP and one active UL BWP at a given time by the cell. A single scheduled downlink control information (DCI) may be applied to switching from one active BWP to another for an operating UE.

For a UE, an initial active DL BWP is defined as the frequency location and bandwidth dedicated for broadcasting remaining minimum SI (RMSI). When the NW sends to a Connected_UE a system information (SI) change indication that notifies of system information change, the Connected_UE may have to switch from the currently active BWP to the initial active BWP for accessing the RMSI and updating to the changed SI if there is no SI broadcasting on the currently active BWP. Furthermore, the Connected_UE may not successfully complete SI update if there is no clear UE behavior defined for BWP switching. As a result of BWP switching inability problem, the UE may not be able to update system information.

SUMMARY

The present disclosure is directed to bandwidth part (BWP) switching operations in conjunction with system information updates for a user equipment.

In one aspect of the present disclosure, a method for bandwidth part (BWP) operations performed by a user equipment (UE) of a connected state is provided. The method comprises receiving a system information (SI) change indication broadcasted by a paging via a currently active bandwidth part (BWP) during a modification period; switching from the currently active bandwidth part (BWP) for data transmission to an initial active BWP for an SI update; receiving remaining minimum SI (RMSI) via the initial active BWP during a next modification period that immediately follows the modification period, the RMSI including information associated with changed system information blocks (SIBs); determining which of the changed SIBs is required to be updated for the UE; and receiving content of the required changed SIBs based on the determination.

In one aspect of the present disclosure, a user equipment (UE) of a connected state is configured to receive a system information (SI) change indication broadcasted by a paging via a currently active bandwidth part (BWP) during a modification period; to switch from the currently active bandwidth part (BWP) for data transmission to an initial active BWP for an SI update; to receive remaining minimum SI (RMSI) via the initial active BWP during a next modification period that immediately follows the modification period, the RMSI including information associated with changed system information blocks (SIBs); to determine which of the changed SIBs is required to be updated for the UE; and to receive content of the required changed SIBs based on the determination.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the exemplary disclosure are best understood from the following detailed description when read with the accompanying figures. Various features are not drawn to scale, dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

FIG. **1** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving an SI change indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **2** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving an SI change indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **3** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving an SI change indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **4** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving an SI change indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **5** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving an SI change indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **6** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving an SI change indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **7** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving a public warning system (PWS) notification indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **8** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving a public warning system (PWS) notification indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **9** is a schematic diagram illustrating a BWP switching operation for a Connected_UE due to receiving a public warning system (PWS) notification indication in accordance with one exemplary embodiment of the present disclosure.

FIG. **10** is a block diagram of a device for wireless communication in accordance with various embodiments of the present disclosure.

DETAILED DESCRIPTION

The following description contains specific information pertaining to exemplary implementations in the present disclosure. The drawings in the present disclosure and their accompanying detailed description are directed to merely exemplary implementations. However, the present disclosure is not limited to merely these exemplary implementations. Other variations and implementations of the present disclosure will occur to those skilled in the art. Unless noted otherwise, like or corresponding elements among the figures may be indicated by like or corresponding reference numerals. Moreover, the drawings and illustrations in the present disclosure are generally not to scale, and are not intended to correspond to actual relative dimensions.

The description uses the phrases "in one implementation," or "in some implementations," which may each refer to one or more of the same or different implementations. The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The term "comprising," when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the equivalent.

It is noted that the term "and/or" includes any and all combinations of one or more of the associated listed items. It will also be understood that, although the terms first, second, third etc. may be used herein to describe various elements, components, regions, parts and/or sections, these elements, components, regions, parts and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, part or section from another element, component, region, layer or section. Thus, a first element, component, region, part or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present disclosure.

It should be noted that, in the present disclosure, a UE may include, but is not limited to, a mobile station, a mobile terminal or device, a user communication radio terminal. For example, a UE may be a portable radio equipment, which includes, but is not limited to, a mobile phone, a tablet, a wearable device, a sensor, a personal digital assistant (PDA), or a television display with wireless communication capability. The UE is configured to receive and transmit signals over an air interface to one or more cells in a radio access network.

A base station may include, but is not limited to a node B (NB) as in the UMTS, an evolved node B (eNB) as in the LTE-A, a radio network controller (RNC) as in the UMTS, a base station controller (BSC) as in the GSM/GERAN, an NG-eNB as in an E-UTRA base station in connection with the 5GC, a next generation node B (gNB) as in the 5G Access Network (5G-AN), and any other apparatus capable of controlling radio communication with cellular positioning technology and managing radio resources within a cell. The base station may connect to serve the one or more UEs through a radio interface to the network.

In one embodiment of the present disclosure, a Connected_UE may implicitly switch to an initial active BWP upon receiving a system information (SI) change indication broadcasted by paging from cellular network (NW). The SI change indication indicates a SI change/modification and notifies the UE to update to the changed SI if required by the UE. This results in reduction of redundant L1 signaling for switching from a currently active BWP to the initial active BWP for the UE. In FIG. **1**, a BWP switching operation for a Connected_UE due to receiving an SI change indication is illustrated. In DL, the UE may operate on an indicated BWP as currently active DL BWP for DL data transmission (e.g., based on RRC configuration, DCI control or the behavior for BWP inactivity timer) or operate on an initial active DL BPW able to receive the content of changed SI required for the UE SI update. The UE may also have an uplink (UL) BWP for UL data transmission and an initial active UL BWP. Within n^{th} broadcast control channel modification period (denoted as BCCH modification period n), the UE may operate on the indicated BWP as the currently active BWP for data transmission according to L1 signaling.

The SI change indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE operates on the indicated BWP. Specifically, the UE receives indications about SI modifications and/or PWS notifications using Short Message transmitted with P-RNTI over downlink control information (DCI). At **101**, upon receiving the SI change indication, UE may switch immediately to the initial active BWP from the indicated BWP during BCCH modification period n. The SI change indication is used to inform the UE that there is a system information change(s) or update(s), and may be carried as part of the Short Message. Then, RRC sublayer of the NW may inform the PHY sublayer that the paging has been sent to the UE and the switching of the UE to the initial active BWP has been performed. So, the NW may stop sending to the UE any other L1 signaling (e.g., DCI) for BWP switching operations.

After switching to the initial active BWP, the UE may continue to stay on the initial active BWP until BCCH modification period n+1 ends. The BCCH modification period n+1 immediately follows the BCCH modification period n in time sequence. Although the UE has switched to the initial active BWP at certain timing (e.g., at **101**) within BCCH modification period n, it is in the next BCCH modification period n+1 that the UE performs the system information acquisition to update to changed system information. In modification period n+1, the UE may receive broadcast remaining minimum system information (RMSI) carrying information associated with changed system information blocks (SIBs) via the initial active BWP and perform the SI update(s) according to the information. The RMSI is also known as SIB1 (system information block 1). The UE may receive the RMSI at certain time point in modification period n+1 (e.g., at the start time point of the modification period n+1). After receiving the RMSI, the UE may determine which of the changed SIB(s) is (or are) required for the SI update(s) according to the received information. For example, the UE may identify one or more of the changed SIB(s) that the UE requires for the SI update(s). Then the UE may receive the content(s) of the changed SIBs which are identified as being required for the SI update(s) based on the determination. For another example, the UE may identify none of the changed SIBs is required to update and may not perform any SI update(s). The UE may not update the changed SIB(s) based on the identification within BCCH modification period n+1.

After the UE completes the SI update(s), the NW may re-take control over the BWP switching of the UE on the end of BCCH modification period n+1.

In this case, since the NW may know the UE by default will complete the SI update within modification period n+1, the PHY sublayer may re-take control over the BWP switching after BCCH modification period n+1 ends. Therefore, at **103** on the ending boundary of modification period n+1 the NW re-takes the BWP switching operations by sending L1 signaling to switch the initial active BWP to a BWP for subsequent data transmission.

In one embodiment, the currently active BWP happens to be the initial active BWP. In this case, it is not necessary that a BWP switching operation is involved for updating the SI when receiving the SI change indication. For example, the Connected UE has already been on the initial active BWP as currently active BWP because of certain on-going services in modification period n and will stay on the initial active BWP to perform system information acquisition to conduct the SI update in BCCH modification period n+1. The PHY sublayer of the NW may consider the completeness of the SI update in the next BCCH modification period n+1. Then, the PHY sublayer of the NW may re-take control over the BWP switching operation on the end of BCCH modification period n+1.

In one embodiment, the UE may be only permitted to receive the Short Message of the paging on the initial active BWP. For example, based on the paging frame and paging occasion derived from an associated UE ID and per-configured parameters, the Short Message cannot be broadcasted on other BWPs but the initial active BWP. On occasions, the UE may switch to the initial active BWP automatically to detect whether there is a Short Message and receiving the Short Message. If receiving the SI change indication carried in the Short Message, the UE may stay on the initial active BWP for the subsequent SI update without the need for additional BWP switching. If receiving no Short Message or no SI change indication carried in the Short Message, the UE may switch back to the previous active BWP without involvement of the NW. Alternatively, the UE may not switch back but stay on the initial active BWP after modification period n+1 ends, waiting for next L1 signaling from the NW (e.g., DCI) for BWP switching.

In one embodiment of the present disclosure, the Connected UE may feedback to the NW while the SI update is completed, and the NW may re-take control over the BWP switching immediately upon receiving the feedback. In FIG. **2**, a BWP switching operation for an RRC_connected UE due to receiving an SI change indication is illustrated. The UE may operate on an indicated BWP as currently active BWP for data transmission or operate on an initial active BPW able to receive the content of changed SI required for the UE SI update. Within modification period n, the UE may operate on the indicated BWP for data transmission according to L1 signaling.

The SI change indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE may operate on the indicated BWP. At **201**, upon receiving the SI change indication, UE may switch to the initial active BWP immediately from the indicated BWP in BCCH modification period n. The SI change indication is used to inform the UE that there is SI change(s) or update(s), and may be carried as part of Short Message in the paging. Then, RRC sublayer of the NW may inform the PHY sublayer that the paging has been sent to the UE and the switching of the UE to the initial active BWP has been performed. So, the NW may stop sending to the UE any other L1 signaling for BWP switching operations, and wait for the UE feedback indicating the completeness of the SI update.

After switching to the initial active BWP, the UE may continue to stay on the initial active BWP until the update to SI is completed. At **203**, the UE completed the SI update if required and feedback to the NW that the system information update is completed by sending an SI update complete indication. Upon receiving the SI update complete indication as the UE feedback, the PHY sublayer of the NW may re-take control over the BWP switching operation immediately. Although the UE has to operate on the initial active BWP for the SI update in DL, the NW may be still able to schedule data transmission on the initial active BWP.

The UE feedback of SI update complete may be sent by L1 signaling (via PUCCH) or by MAC-CE transmission on an uplink (UL) BWP paired with the initial active DL BWP. If using L1 signaling, the upper sublayer (e.g., RRC) of the UE may inform PHY sublayer that the SI update is completed, and the UE PHY sublayer may feedback it to the NW. The NW may re-take control over the BWP switching after receiving the feedback in NW PHY sublayer. Alternatively, if using MAC-CE transmission, the upper sublayer of the UE may inform MAC sublayer that the system information update is completed, and the UE MAC sublayer may feedback it to the NW. The NW may re-take control over the BWP switching once receiving the feedback in NW MAC sublayer.

In one embodiment of the present disclosure, upon receiving the SI change indication, the UE may not switch to the initial active BPW until the current BCCH modification period ends. In FIG. **3**, a BWP switching operation for an RRC_connected UE due to receiving an SI change indication is illustrated. The UE may operate on an indicated BWP as currently active BWP for data transmission or operate on an initial active BPW able to receive the content of changed SI required for the UE SI update. Within BCCH modification period n, the UE may operate on the indicated BWP for data transmission according to L1 signaling.

The SI change indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE may operate on the indicated BWP. At **301**, upon receiving the SI change indication, UE may continue to stay on the indicated BWP instead of switching immediately to the initial active BWP. Then, the UE switches to the initial active BWP automatically on the ending boundary of BCCH modification period n. The BWP switching operation(s) for the UE could be still performed for certain required services before the automatic switching to the initial active BWP takes place on the end of BCCH modification period n.

In this case, PHY sublayer of the NW may know that the UE switches to the initial active BWP automatically on the end of BCCH modification period n, and may stop sending to the UE any other L1 signaling for BWP switching operations after modification period n ends. The PHY sublayer of the NW may know the UE by default will complete the SI update within the next modification period n+1, the PHY sublayer may re-take control over the BWP switching after BCCH modification period n+1 ends. Therefore, at **303** on the ending boundary of modification period n+1 the NW re-takes the BWP switching operations by sending L1 signaling to switch the initial active BWP to a BWP for data transmission.

After switching to the initial active BWP on the end of modification period n, the UE may wait to receive, via the initial active BWP, broadcast information required for updating to the changed SI in a next BCCH modification period directly following modification period n. Therefore, within BCCH modification period n+1 (the next BCCH modification period as shown in FIG. **3**), the UE performs the system information acquisition to update the changed system information if required.

In this case, since the NW may know the UE by default will complete the SI update within the next modification period n+1, the PHY sublayer may re-take control over the BWP switching after BCCH modification period n+1 ends. Therefore, at **303** on the ending boundary of modification period n+1 the NW re-takes the BWP switching operations by sending L1 signaling to switch the initial active BWP to a BWP for data transmission.

In one embodiment of the present disclosure, the Connected UE may feedback to the NW while the SI update is completed, and the NW may take control over the BWP switching immediately upon receiving the feedback. In FIG. **4**, a BWP switching operation for an RRC_connected UE due to receiving an SI change indication is illustrated. The UE may operate on an indicated BWP as currently active BWP for data transmission or operate on an initial active BPW able to receive the content of changed SI required for the UE SI update. Within BCCH modification period n, the UE may operate on the indicated BWP for data transmission according to L1 signaling.

The SI change indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE may operate on the indicated BWP. At **401**, upon receiving the SI change indication, UE may continue to stay on the indicated BWP instead of switching immediately to the initial active BWP. Then, the UE switches to the initial active BWP automatically on the ending boundary of BCCH modification period n. The BWP switching operation(s) for the UE could be still performed for certain required services before the automatic switching to the initial active BWP takes place on the end of modification period n. In this case, PHY sublayer of the NW may know that the UE switches to the initial active BWP automatically on the end of BCCH modification period n, and may stop sending to the UE any other L1 signaling for BWP switching operations after period n ends.

After switching to the initial active BWP on the end of modification period n, the UE may continue to stay on the initial active BWP until the update of the required SI change(s) is completed. At **403**, the UE complete the SI update and feedback to the NW that the system information update is completed by sending an SI update complete indication. Upon receiving the SI update complete indication as the UE feedback, the PHY sublayer of the NW may re-take control over the BWP switching operation at **403**. Although the UE has to operate on the initial active BWP for the SI update in DL, the NW may be still able to schedule data transmission on the initial active BWP.

The UE feedback of SI update complete may be sent by L1 signaling (via PUCCH) or by MAC-CE transmission on an uplink (UL) BWP paired with the initial active DL BWP. If using L1 signaling, the upper sublayer (e.g., RRC) of the UE may inform PHY sublayer that the SI update is completed, and the UE PHY sublayer may feedback it to the NW. The NW may re-take control over the BWP switching after receiving the feedback in NW PHY sublayer. Alternatively, if using MAC-CE transmission, the upper sublayer of the UE may inform MAC sublayer that the system information update is completed, and the UE MAC sublayer may feedback it to the NW. The NW may re-take control over the BWP switching once receiving the feedback in NW MAC sublayer.

In one embodiment of the present disclosure, after receiving an SI change indication the UE may not switch to an initial active BWP until an L1 signaling is received from the NW. In FIG. **5**, a BWP switching operation for an RRC_connected UE due to receiving an SI change indication is illustrated. The UE may operate on an indicated BWP as currently active BWP for data transmission or operate on an initial active BPW able to receive the content of changed SI required for the UE SI update. Within BCCH modification period n, the UE may operate on the indicated BWP for data transmission according to L1 signaling.

The SI change indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE may operates on the indicated BWP in BCCH modification period n. At **501**, upon receiving the SI change indication, the UE may not switch to the initial active BWP but continue to stay on the indicated BWP. On the NW side, the RRC sublayer may inform the PHY sublayer that the SI change indication is sent to the UE. The SI change indication may be carried as part of the Short Message in the paging. In response to the UE reception of the SI change indication, the PHY sublayer of the NW may schedule the L1 signaling and decide when to send the L1 signaling to switch the UE to the initial active BWP. After sending the SI change indication, the NW may perform the L1 signaling before BCCH modification period n ends.

At **503**, the UE switches to the initial active BWP in response to receiving the L1 signaling sent from the NW in BCCH modification period n, and the NW may also stop sending to the UE any other L1 signaling for BWP switching operations. In this case, the PHY sublayer of the NW may know the UE by default will complete the SI update within the next modification period (i.e., BCCH modification period n+1 as shown in FIG. **5**), and the PHY sublayer may re-take control over the BWP switching after BCCH modification period n+1 ends.

Thus, at **505** the NW re-takes control over the BWP switching operations on the ending boundary of modification period n+1 by sending L1 signaling to switch the initial active BWP to a BWP for data transmission.

Alternatively, the NW may re-take control over the BWP switching operations upon receiving a feedback from the UE indicating the SI update is complete before BCCH modification period n+1 ends. In FIG. **6**, the UE receives a L1 signaling for switching to the initial active BWP at **603** after receiving the SI change indication at **601** in modification period n, followed by the SI update operations in modification period n+1. Once the UE completes the SI update at **605**, the UE feedback of SI update complete (e.g., an SI update completeness indication) may be sent by another L1 signaling (via PUCCH) or by MAC-CE transmission on an uplink (UL) BWP paired with the initial active DL BWP. If using L1 signaling, the upper sublayer (e.g., RRC) of the UE may inform PHY sublayer that the SI update is completed, and the UE PHY sublayer may feedback it to the NW. The NW may re-take control over the BWP switching after receiving the feedback in NW PHY sublayer. If using MAC-CE transmission, the upper sublayer of the UE may inform MAC sublayer that the system information update is completed, and the UE MAC sublayer may feedback it to the NW. The NW may re-take control over the BWP switching once receiving the feedback in NW MAC sublayer.

In one embodiment of the present disclosure, the UE may receive a public warning system (PWS) notification indication for ETWS indication or CMAS indication carried in Short Message of a paging. The PWS notification indication notifies the UE of immediate reception of a PWS notification. When a Connected UE receives a PWS notification indication broadcasted by paging of the NW, the RRC sublayer of the UE may inform the PHY sublayer that a PWS notification reception is required immediately.

If the UE receives the PWS notification indication(s) of a paging from the NW, the UE has to immediately start receiving the PWS notification(s) according to the scheduling information in RMSI. The PWS notification indication may trigger the UE to perform re-acquisition of the scheduling information in RMSI for checking scheduling changes for the SIBs associated with the PWS notification(s). Once the SIB(s) associated with the corresponding PWS notification(s) is no longer scheduled, the UE could stop receives the SIB(s).

In FIG. **7**, a BWP switching operation for an RRC_connected UE due to receiving a PWS notification indication is illustrated. The UE may operate on an indicated BWP as currently active BWP for data transmission or operate on an initial active BPW able to receive the content of changed SI required for the UE SI update. Within BCCH modification period n, the UE may operate on the indicated BWP as the current active BWP for data transmission according to L1 signaling.

The PWS notification indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE operates on the indicated BWP. At **701**, upon receiving the PWS notification indication, UE may switch automatically to the initial active BWP from the indicated BWP in BCCH modification period n. The PWS notification indication may be carried as part of Short Message in the paging. Then, RRC sublayer of the NW may inform the PHY sublayer that the paging has been sent to the UE. So, the PHY sublayer of the NW knows successful automatic switching to the initial active BWP and may stop sending to the UE any other L1 signaling for BWP switching operations. The PHY sublayer of the NW would wait for the information from upper layer(s) indicating the stop of broadcasting PWS notification(s) at a certain time point, e.g. at **703** in BBCH modification period n+2. Then, the PHY sublayer in the NW could re-start to take control over BWP switching operation(s).

In another embodiment of the present disclosure, the Connected UE may feedback to the NW while the PWS notification is no longer scheduled, and the NW may re-take control over the BWP switching immediately upon receiving the feedback. In FIG. **8**, a BWP switching operation for an RRC_connected UE due to receiving a PWS notification indication is illustrated. The UE may operate on an indicated BWP as currently active BWP for data transmission or operate on an initial active BPW able to receive the content of changed SI required for the UE SI update. Within BCCH modification period n, the UE may operate on the indicated BWP for data transmission according to L1 signaling.

The PWS notification indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE may operates on the indicated BWP. At **801**, upon receiving the PWS notification indication, UE may switch to the initial active BWP automatically from the indicated BWP in BCCH modification period n. The PWS notification indication may be carried as part of Short Message in the paging. Then, RRC sublayer of the NW may inform the PHY sublayer that the paging has been sent to the UE and the switching of the UE to the initial active BWP has been performed. So, the NW may stop sending to the UE any other L1 signaling for BWP switching operations, and wait for the UE feedback indicating the PWS notification is no longer scheduled.

At **803**, the UE may inform the NW of the stopping broadcast of the PWS notification(s) by a feedback that indicates the PWS notification is no longer scheduled.

In one embodiment of the present disclosure, after receiving a PWS notification indication the UE may not switch to an initial active BWP until an L1 signaling is received from the NW. Since the PWS notification is for emergence, the L1 signalling for switching the UE to the initial active BWP shall be transmitted as fast as possible. In FIG. **9**, a BWP switching operation for an RRC_connected UE due to receiving a PWS notification indication is illustrated. The UE may operate on an indicated BWP as currently active BWP for data transmission or operate on an initial active BPW able to receive the content of changed SI required for

the UE SI update. Within BCCH modification period n, the UE may operate on the indicated BWP for data transmission according to L1 signaling.

The PWS notification indication is sent to the UE by paging (e.g., a Short Message) from the NW while the UE may operate on the indicated BWP in BCCH modification period n. At **901**, upon receiving the PWS notification indication, the UE may not switch to the initial active BWP but continue to stay on the indicated BWP until an L1 signaling from the NW is received. At **903**, the UE switches to the initial active BWP in response to receiving the L1 signaling sent from the NW in BCCH modification period n, and the NW may also stop sending to the UE any other L1 signaling for BWP switching operations. At **905**, the PHY sublayer of the NW would wait for the information from upper layer(s) indicating the stop of broadcasting PWS notification(s) at a certain time point, e.g. in BCCH modification period n+2. Then, the PHY sublayer in the NW could re-start to take control over BWP switching operation(s).

Alternatively, the UE may inform the NW of the stopping broadcast of the PWS notification(s) by a feedback that indicates the PWS notification is no longer scheduled in this case.

In some embodiments of the present disclosure, a BWP inactivity timer is introduced to switch an ongoing indicated BWP (or the currently active BWP) to a default BWP after a certain inactive time. The BWP inactivity timer may start to run for an inactive time period immediately after the UE switches off the default BWP. In other words, no matter what BWPs the Connected_UE currently operates on, the UE may switch back to the default BWP immediately after the BWP inactivity timer expires.

If the initial active BWP is the default BWP, the currently running BWP inactivity timer would stop after receiving Short Message on the configured active BWP. The UE may switch to another BWP after SI acquisition in response to receiving an L1 signalling, and the BWP inactivity timer would reset with the configured value and start running.

If the initial active BWP is not the default BWP, the currently running BWP inactivity timer may keep running. In some embodiments, the BWP inactivity timer would restart with the configured value and start running. It is noted that the configured value may be different from the normal one (i.e., the normal one is not used for SI acquisition upon switching to the initial active BWP). For example, gNB(s) may configure the BWP inactivity timer with two values, one is 5 ms, the other is 40 ms (e.g., equal to the duration of one BCCH modification period), and UE will automatically apply the second one when the UE needs to perform SI acquisition after receiving the SI change indication carried in the Short Message.

In one embodiment of the present application, if the BWP inactivity timer expires but the SI update is not complete, the UE may keep staying on the initial active BWP until the next L1 signalling (e.g., DCI) controls the UE to perform another BWP switching. The NW may need the timing of the SI update completeness by an NW control mechanism (e.g., waiting for the whole BCCH modification period for SI updated as introduced in the above embodiments) or an UE control mechanism (e.g., by waiting for the UE feedback as introduced in the above embodiments). The BWP inactivity timer would then reset and restart while the UE is switched to another BWP, which is not the default BWP. On the other hand, if the BWP inactivity timer is expired but the PWS notification receiving is not complete, the UE would keep staying on the initial active BWP until the next L1 signalling (e.g., DCI) controls the UE to perform another BWP switch. The NW would need the timing of the SI complete by an NW control mechanism (e.g., waiting for the whole BCCH modification period for SI updated as introduced in the embodiments) or an UE control mechanism (e.g., by waiting for the UE feedback as introduced in the embodiment). The BWP inactivity timer may then reset and restart while the UE switches to another BWP, which is not the default BWP. If there is no system information change indication or Public Warning System (PWS) notification indication indicating that the following SI update or PWS notification receiving procedure is required, once the BWP inactivity timer expires, the UE would automatically switch to the default BWP without L1 signalling.

FIG. **10** illustrates a block diagram of a device for wireless communication, according to various exemplary implementations of the present disclosure. As shown in FIG. **10**, device **1000** may include transceiver **1020**, processor **1026**, memory **1028**, one or more presentation components **1034**, and at least one antenna **1036**. Device **1000** may also include an RF spectrum band module, a base station communications module, a network communications module, and a system communications management module, input/output (I/O) ports, I/O components, and power supply (not explicitly shown in FIG. **10**). Each of these components may be in communication with each other, directly or indirectly, over one or more buses **1026**.

Transceiver **1020** having transmitter **1022** and receiver **1024** may be configured to transmit and/or receive time and/or frequency resource partitioning information. In some implementations, transceiver **1020** may be configured to transmit in different types of subframes and slots including, but not limited to, usable, non-usable and flexibly usable subframes and slot formats. Transceiver **1020** may be configured to receive data and control channels.

Device **1000** may include a variety of computer-readable media. Computer-readable media can be any available media that can be accessed by device **1000** and include both volatile and non-volatile media, removable and non-removable media. By way of example, and not limitation, computer-readable media may comprise computer storage media and communication media. Computer storage media includes both volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data.

Computer storage media includes RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices. Computer storage media does not comprise a propagated data signal. Communication media typically embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of any of the above should also be included within the scope of computer-readable media.

Memory **1028** may include computer-storage media in the form of volatile and/or non-volatile memory. Memory **1028** may be removable, non-removable, or a combination thereof. Exemplary memory includes solid-state memory, hard drives, optical-disc drives, and etc. As illustrated in FIG. **10**, memory **1028** may store computer-readable, computer-executable instructions **1032** (e.g., software codes) that are configured to, when executed, cause processor **1026** to perform various functions described herein, for example, with reference to FIGS. **1** through **9**. Alternatively, instructions **1032** may not be directly executable by processor **1026** but be configured to cause device **1000** (e.g., when compiled and executed) to perform various functions described herein.

Processor **1026** may include an intelligent hardware device, e.g., a central processing unit (CPU), a microcontroller, an ASIC, and etc. Processor **1026** may include memory. Processor **1026** may process data **1030** and instructions **1032** received from memory **1028**, and information through transceiver **1020**, the base band communications module, and/or the network communications module. Processor **1026** may also process information to be sent to transceiver **1020** for transmission through antenna **1036**, to the network communications module for transmission to a core network.

One or more presentation components **1034** presents data indications to a person or other device. Exemplary one or more presentation components **1034** include a display device, speaker, printing component, vibrating component, and etc.

From the above description it is manifest that various techniques can be used for implementing the concepts described in the present disclosure without departing from the scope of those concepts. Moreover, while the concepts have been described with specific reference to certain implementations, a person of ordinary skill in the art would recognize that changes can be made in form and detail without departing from the scope of those concepts. As such, the described implementations are to be considered in all respects as illustrative and not restrictive. It should also be understood that the present disclosure is not limited to the particular implementations described above, but many rearrangements, modifications, and substitutions are possible without departing from the scope of the present disclosure.

What is claimed is:

1. A method for a user equipment (UE) of a connected state, the method comprising:

receiving a system information (SI) change indication broadcasted by a paging via a currently active bandwidth part (BWP) during a modification period;

in response to receiving the SI change indication, switching from the currently active BWP to an initial active BWP for an SI update;

receiving remaining minimum SI (RMSI) via the initial active BWP during a next modification period that immediately follows the modification period, wherein the RMSI includes information associated with changed system information blocks (SIBs);

determining which of the changed SIBs is required to be updated for the UE according to the received RMSI; and

receiving content of the required changed SIBs based on the determination.

2. The method of claim **1**, wherein the currently active BWP is switched to the initial active BWP automatically on the end of the modification period.

3. The method of claim **1**, wherein the currently active BWP is switched to the initial active BWP immediately upon receiving the SI change indication.

Exhibit 1

4. The method of claim 1, wherein the currently active BWP is switched to the initial active BWP in response to receiving downlink control information (DCI).

5. The method of claim 1, further comprising:

completing the SI update of the required changed SIBs within the next modification period in response to receiving the content of the required changed SIBs.

6. The method of claim 1, further comprising:

sending an SI update complete indication as a feedback indicating completeness of the SI update via an uplink BWP.

7. The method of claim 1, wherein the UE is pre-configured with a default BWP and a BWP inactivity timer for the connected state, and wherein the UE starts the BWP inactivity timer after switching off the default BWP and switches back to the default BWP after the BWP inactivity timer expires.

8. The method of claim 7, wherein the BWP inactivity timer stops after the currently active BWP for data transmission is switched to an initial active BWP in response to receiving the SI change indication.

9. The method of claim 7, wherein the BWP inactivity timer is further configured to have a short period and a long period, and wherein the UE selects the long period for the BWP inactivity timer upon receiving the SI change indication.

10. The method of claim 7, wherein the UE stays on the initial active BWP in order to complete the SI update after the BWP inactivity timer expires.

11. A user equipment (UE) for wireless communication, comprising:

a non-transitory machine-readable medium storing computer-executable instructions;

a processor coupled to the non-transitory computer-readable medium, and configured to execute the computer-executable instructions to cause the UE of a connected state to perform operations comprising:

receiving a system information (SI) change indication broadcasted by a paging via a currently active bandwidth part (BWP) during a modification period;

in response to receiving the SI change indication, switching from currently active BWP to an initial active BWP for an SI update; and

receiving remaining minimum SI (RMSI) via the initial active BWP during a next modification period that immediately follows the modification period, wherein the RMSI includes information associated with changed system information block (SIB);

determining which of the changed SIBs is required to be updated for the UE according to the received RMSI; and

receiving content of the required changed SIBs based on the determination.

12. The UE of claim 11, wherein the currently active BWP is switched to the initial active BWP automatically on the end of the modification period.

13. The UE of claim 11, wherein the currently active BWP is switched to the initial active BWP immediately upon receiving the SI change indication.

14. The UE of claim 11, wherein the currently active BWP is switched to the initial active BWP in response to receiving downlink control information (DCI).

15. The UE of claim 11, wherein the processor is further configured to execute the computer-executable instructions to cause the UE of a connected state to perform operations comprising:

completing the SI update of the required changed SIBs within the next modification period in response to receiving the content of the required changed SIBs.

16. The UE of claim 15, wherein the processor is further configured to execute the computer-executable instructions to cause the UE of a connected state to perform operations comprising:

sending an SI update complete indication as a feedback indicating completeness of the SI update via an uplink BWP.

17. The UE of claim 11, wherein the UE is pre-configured with a default BWP and a BWP inactivity timer for the connected state, and wherein the UE starts the BWP inactivity timer after switching off the default BWP and switches back to the default after the BWP inactivity timer expires.

18. The UE of claim 17, wherein the BWP inactivity timer stops after the currently active BWP for data transmission is switched to an initial active BWP in response to receiving the SI change indication.

19. The UE of claim 17, wherein the BWP inactivity timer is further configured to have a short period and a long period, and wherein the UE selects the long period for the BWP inactivity timer upon receiving the SI change indication.

20. The UE of claim 17, wherein the UE stays on the initial active BWP in order to complete the SI update after the BWP inactivity timer expires.

* * * * *

Exhibit 2

US010791502B2

(12) United States Patent
Chen et al.

(10) **Patent No.: US 10,791,502 B2**
(45) **Date of Patent: Sep. 29, 2020**

(54) **ON-DEMAND SYSTEM INFORMATION REQUEST PROCEDURE AND ERROR HANDLING**

(71) Applicant: **FG Innovation Company Limited**, Tuen Mun (HK)

(72) Inventors: **Hung-Chen Chen**, Hsinchu (TW); **Chie-Ming Chou**, Hsinchu (TW); **Yung-Lan Tseng**, Hsinchu (TW)

(73) Assignee: **FG Innovation Company Limited**, Tuen Mun (HK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/372,389**

(22) Filed: **Apr. 1, 2019**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 62/651,312, filed on Apr. 2, 2018.

(51) **Int. Cl.**

H04W 4/00	(2018.01)
H04W 48/14	(2009.01)
H04W 48/16	(2009.01)
H04W 76/18	(2018.01)
H04W 36/30	(2009.01)
H04W 76/15	(2018.01)
H04W 36/08	(2009.01)
H04W 74/08	(2009.01)
H04W 76/28	(2018.01)

(52) **U.S. Cl.**

CPC ***H04W 48/14*** (2013.01); ***H04W 36/08*** (2013.01); ***H04W 36/305*** (2018.08); ***H04W 48/16*** (2013.01); ***H04W 76/15*** (2018.02); ***H04W 76/18*** (2018.02); *H04W 74/0833* (2013.01); *H04W 76/28* (2018.02)

(58) **Field of Classification Search**

CPC H04W 48/14; H04W 48/16; H04W 76/18; H04W 36/305; H04W 76/15; H04W 36/08; H04W 74/0833; H04W 76/28

USPC 455/434; 370/338

See application file for complete search history.

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Primary Examiner — Marcos Batista

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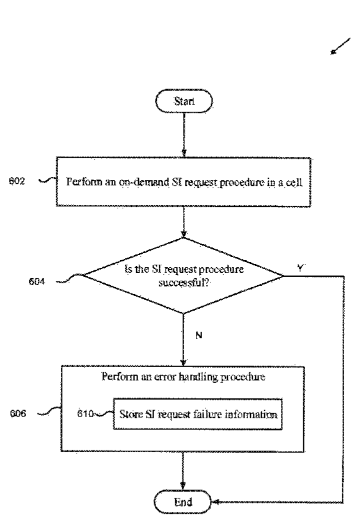
(57) **ABSTRACT**

A method of wireless communications performed by a user equipment (UE) is provided. The method includes performing an on-demand system information (SI) request procedure in a cell; and performing an error handling procedure if the on-demand SI request procedure in the cell is unsuccessful. The error handling procedure includes storing SI request failure information.

20 Claims, 7 Drawing Sheets



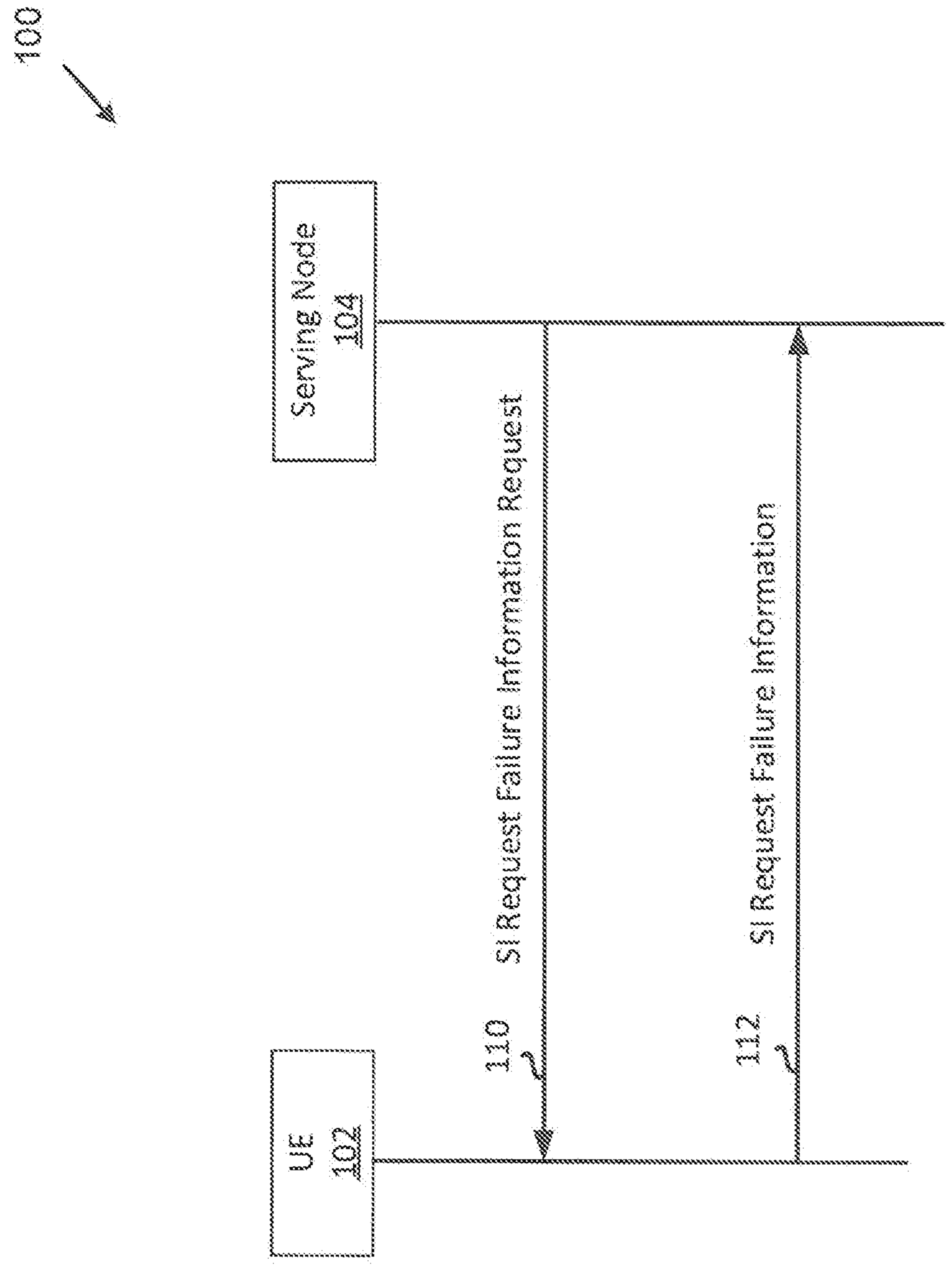

100
Serving Node
104
UE
102
110
SI Request Failure Information Request
112
SI Request Failure Information

FIG. 1

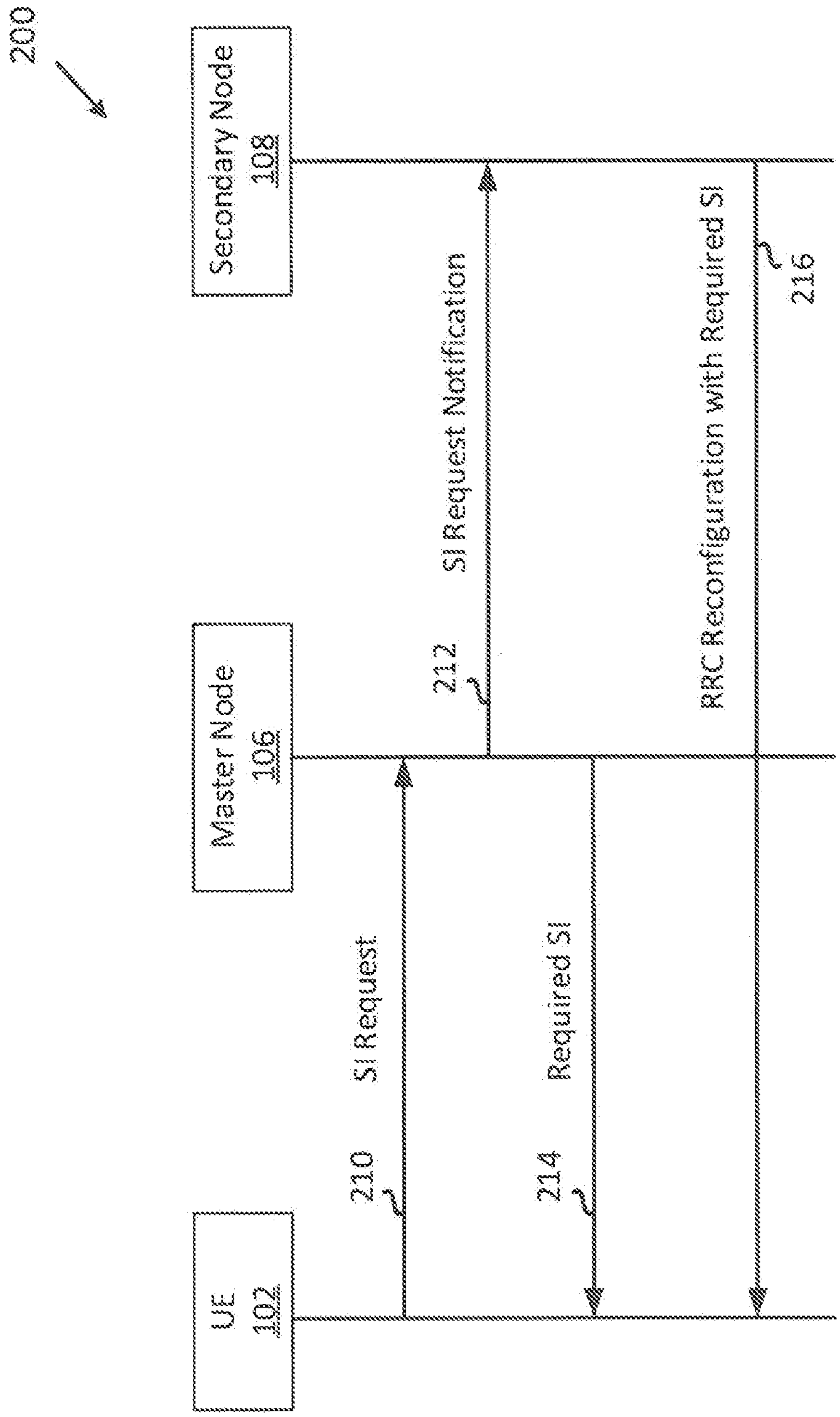

200
Secondary Node 108
Master Node 106
UE 102
SI Request
210
SI Request Notification
212
Required SI
214
RRC Reconfiguration with Required SI
216

FIG. 2

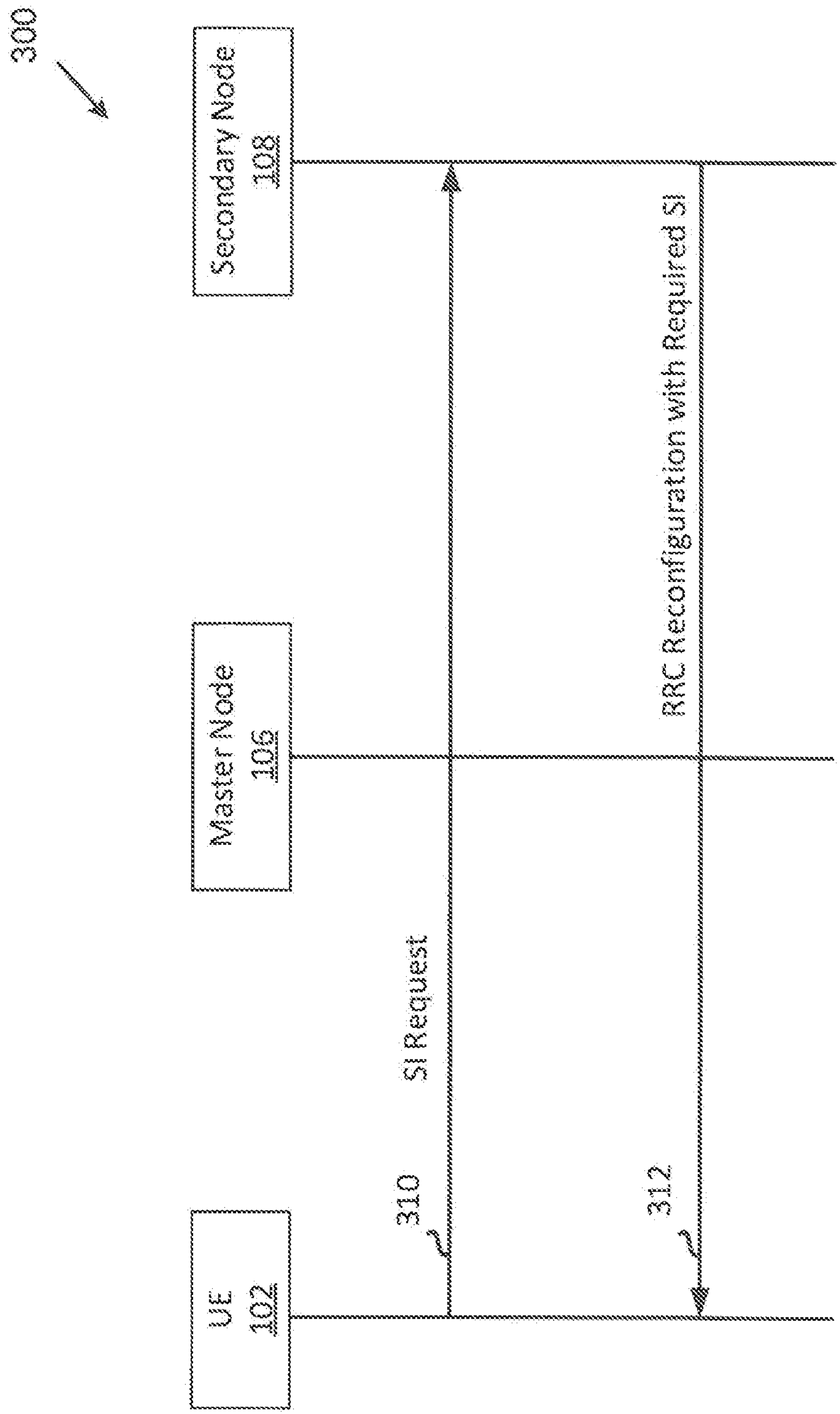

300
Secondary Node
108
Master Node
106
UE
102
310
SI Request
312
RRC Reconfiguration with Required SI

FIG. 3

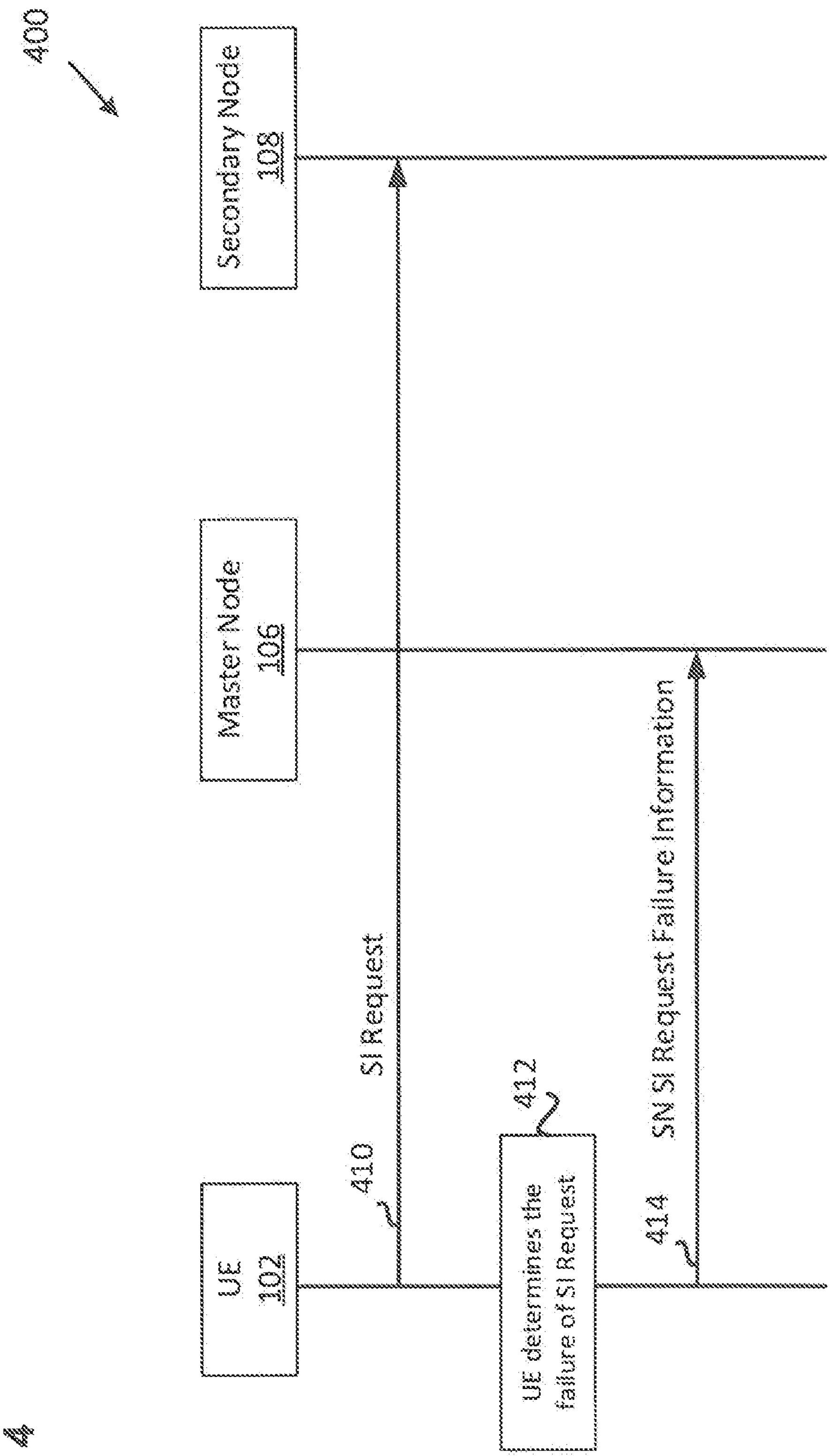

400
Secondary Node
108
Master Node
106
UE
102
410
SI Request
412
UE determines the failure of SI Request
414
SN SI Request Failure Information

FIG. 4

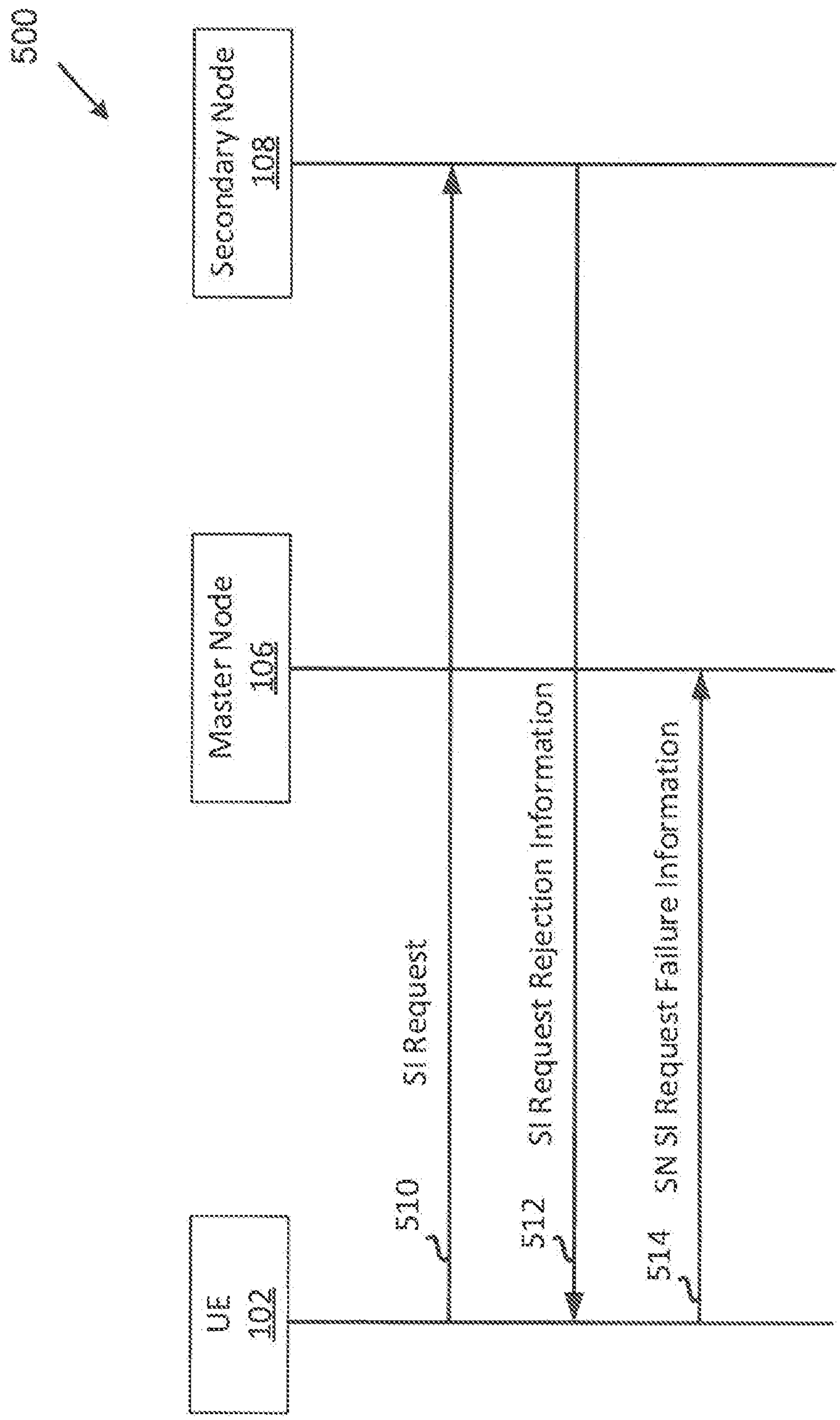
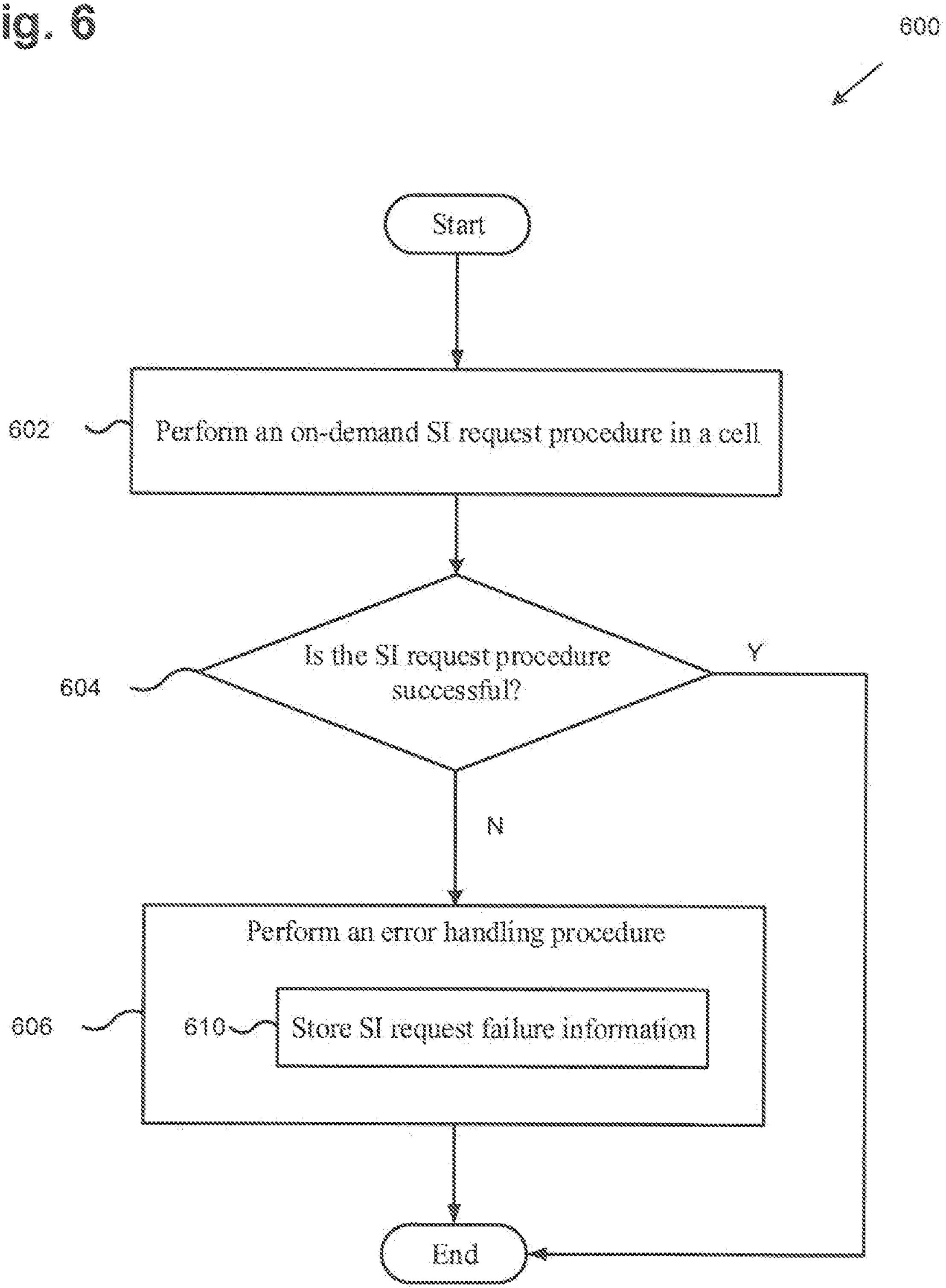

500
Secondary Node
108
Master Node
106
UE
102
510
SI Request
512
SI Request Rejection Information
514
SN SI Request Failure Information

FIG. 5

Fig. 6


600
Start
602
Perform an on-demand SI request procedure in a cell
604
Is the SI request procedure successful?
Y
N
Perform an error handling procedure
606
610
Store SI request failure information
End

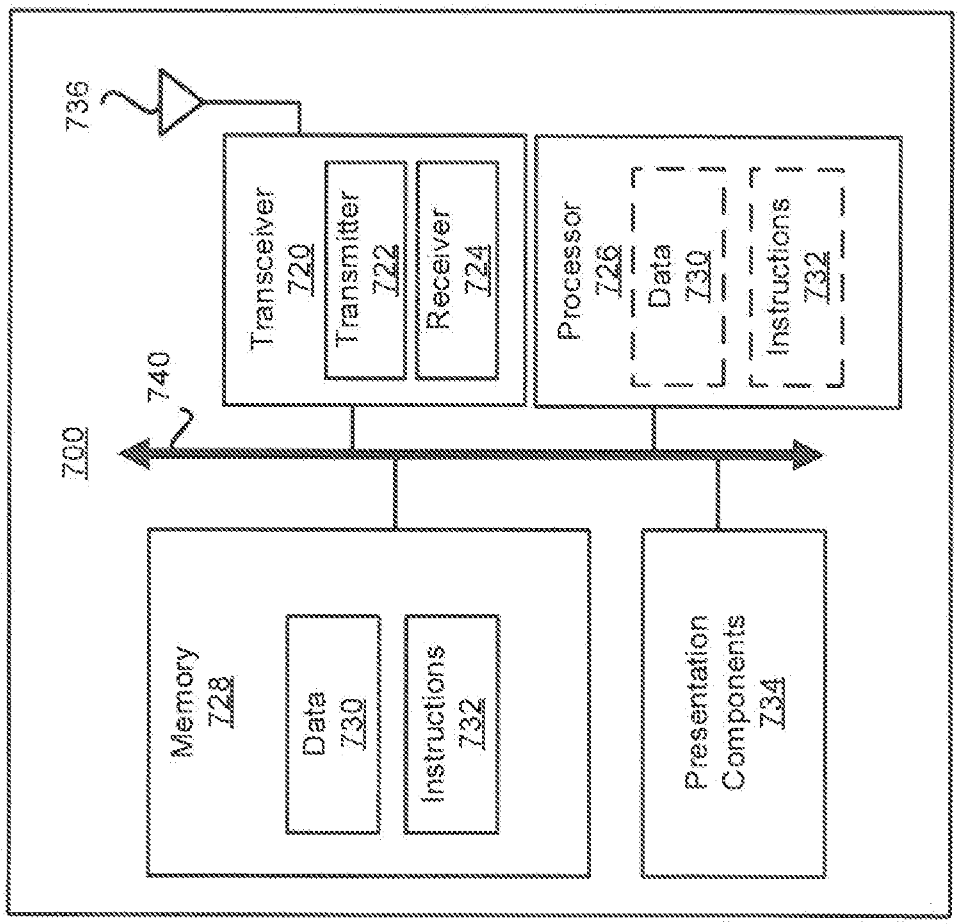

736
700
740
Transceiver
720
Transmitter
722
Receiver
724
Processor
726
Data
730
Instructions
732
Memory
728
Data
730
Instructions
732
Presentation
Components
734

FIG. 7

US010743238B2

(12) **United States Patent**
Chen et al.

(10) **Patent No.: US 10,743,238 B2**

(45) **Date of Patent: Aug. 11, 2020**

(54) **SYSTEM INFORMATION UPDATES IN BAND WIDTH PART (BWP) SWITCH OPERATION**

(71) Applicant: **FG Innovation Company Limited**, Tuen Mun (HK)

(72) Inventors: **Hung-Chen Chen**, Hsinchu (TW); **Chie-Ming Chou**, Hsinchu (TW)

(73) Assignee: **FG Innovation Company Limited**, Tuen Mun (HK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/191,465**

(22) Filed: **Nov. 15, 2018**

(65) **Prior Publication Data**

US 2019/0150064 A1 May 16, 2019

Related U.S. Application Data

(60) Provisional application No. 62/586,598, filed on Nov. 15, 2017.

(51) **Int. Cl.**

H04W 4/00	(2018.01)
H04W 48/10	(2009.01)
H04W 48/12	(2009.01)

(52) **U.S. Cl.**

CPC ***H04W 48/10*** (2013.01); *H04W 48/12* (2013.01)

(58) **Field of Classification Search**

CPC H04W 48/10; H04W 48/12

USPC 370/328, 329, 330

See application file for complete search history.

(56) **References Cited**

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2019/0132109 A1*	5/2019	Zhou	....	H04L 5/0098

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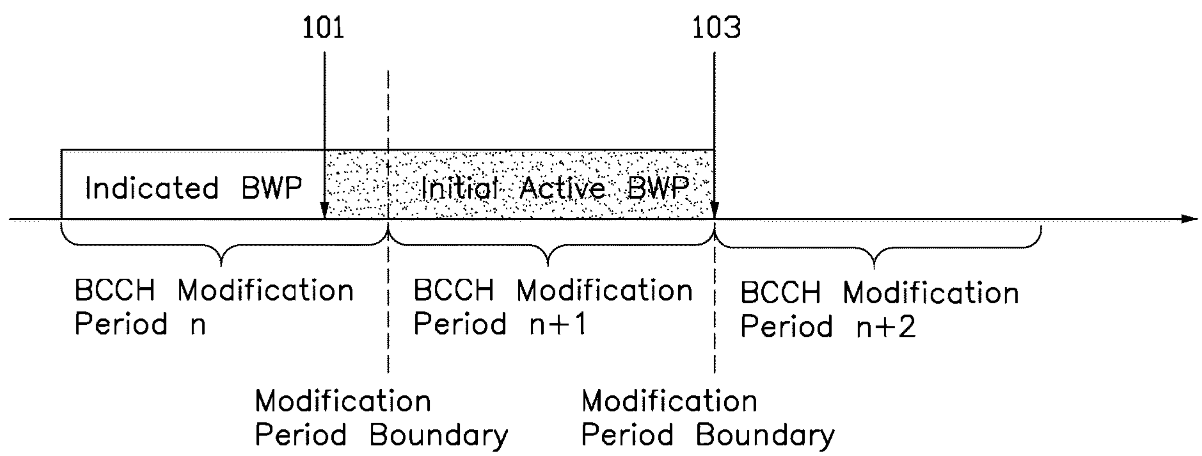
Primary Examiner — Chuong T Ho

(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

A user equipment (UE) for wireless communication is configured to perform bandwidth part (BWP) switching operation in response to receiving a system information change indication. The UE receives the system information change indication via a currently active BWP in a BCCH modification period. The system information change indication notifies the UE that contents of system information have been changed. The UE switches from the currently active BWP to an initial active BWP to receive the changed contents of system information which are required for the UE. The UE receives the changed contents of system information via the initial active BWP in a next BCCH modification period that immediately follows the BCCH modification period. The UE updates the system information according to the changed contents.

20 Claims, 10 Drawing Sheets



ON-DEMAND SYSTEM INFORMATION REQUEST PROCEDURE AND ERROR HANDLING

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present application claims the benefit of and priority to a provisional U.S. Patent Application Ser. No. 62/651,312, filed on Apr. 2, 2018, entitled "On-Demand System Information Request Procedure and Error Handling," (hereinafter referred to as "US73481 application"). The disclosure of the US73481 application is hereby incorporated fully by reference into the present application.

FIELD

The present disclosure generally relates to wireless communication, and more particularly, to the on-demand system information (SI) request procedure for the next generation wireless communication networks.

BACKGROUND

The concept of on-demand System Information (SI) request has been introduced in the next generation wireless network (e.g., a 5th generation (5G) new radio (NR) network). When a UE finds that a required SI message(s) is not broadcasted, based on information in the System Information Block Type 1 (SIB1) (e.g., a one-bit indicator that shows whether the corresponding SI message is currently broadcasted or not) and the mapping of the SIBs to SI messages, the UE may perform an on-demand SI request procedure to ask the network (also referred to as NW) to broadcast the required SIB(s) and/or SI message(s). However, the next generation wireless network lacks an efficient mechanism for error handling associated with the on-demand SI request procedure.

SUMMARY

The present disclosure is directed to on-demand system information request procedure and the corresponding error handling procedure for the next generation wireless communication networks.

According to an aspect of the present disclosure, a method of wireless communications performed by a user equipment (UE) is provided. The method includes performing an on-demand system information (SI) request procedure in a first cell; and performing an error handling procedure if the on-demand SI request procedure in the first cell is unsuccessful. The error handling procedure includes storing SI request failure information.

According to another aspect of the present disclosure, a UE is provided. The UE includes one or more non-transitory computer-readable media having computer-executable instructions embodied thereon and at least one processor coupled to the one or more non-transitory computer-readable media. The at least one processor is configured to execute the computer-executable instructions to perform an on-demand system information (SI) request procedure in a first cell, and perform an error handling procedure if the on-demand SI request procedure in the first cell is unsuccessful. The error handling procedure includes storing SI request failure information.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the exemplary disclosure are best understood from the following detailed description when read with the

accompanying figures. Various features are not drawn to scale, dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

FIG. **1** is a sequence diagram illustrating the transmission of SI request failure information, according to an exemplary implementation of the present application.

FIG. **2** is a sequence diagram illustrating an example of an on-demand SI request being transmitted to an MN in the DC mode, according to an exemplary implementation of the present application.

FIG. **3** is a sequence diagram illustrating an example of an on-demand SI request being transmitted to an SN in the DC mode, according to an exemplary implementation of the present application.

FIG. **4** is a sequence diagram illustrating an example of a UE determining the failure of an SI request in the DC mode, according to an exemplary implementation of the present application.

FIG. **5** is a sequence diagram illustrating an example of a UE receiving SI request rejection information in the DC mode, according to an exemplary implementation of the present application.

FIG. **6** is a flowchart for a method of wireless communications performed by a UE, according to an example implementation of the present application.

FIG. **7** illustrates a block diagram of a node for wireless communication, in accordance with various aspects of the present application.

DETAILED DESCRIPTION

The following description contains specific information pertaining to exemplary implementations in the present disclosure. The drawings in the present disclosure and their accompanying detailed description are directed to merely exemplary implementations. However, the present disclosure is not limited to merely these exemplary implementations. Other variations and implementations of the present disclosure will occur to those skilled in the art. Unless noted otherwise, like or corresponding elements among the figures may be indicated by like or corresponding reference numerals. Moreover, the drawings and illustrations in the present disclosure are generally not to scale, and are not intended to correspond to actual relative dimensions.

For the purpose of consistency and ease of understanding, like features are identified (although, in some examples, not shown) by numerals in the exemplary figures. However, the features in different implementations may be differed in other respects, and thus shall not be narrowly confined to what is shown in the figures.

The description uses the phrases "in one implementation," or "in some implementations," which may each refer to one or more of the same or different implementations. The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The term "comprising," when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the equivalent. The expression "at least one of A, B and C" or "at least one of the following: A, B and C" means "only A, or only B, or only C, or any combination of A, B and C."

Additionally, for the purposes of explanation and non-limitation, specific details, such as functional entities, techniques, protocols, standard, and the like are set forth for providing an understanding of the described technology. In other examples, detailed description of well-known methods, technologies, system, architectures, and the like are omitted so as not to obscure the description with unnecessary details.

Persons skilled in the art will immediately recognize that any network function(s) or algorithm(s) described in the present disclosure may be implemented by hardware, software or a combination of software and hardware. Described functions may correspond to modules may be software, hardware, firmware, or any combination thereof. The software implementation may comprise computer executable instructions stored on computer readable medium such as memory or other type of storage devices. For example, one or more microprocessors or general purpose computers with communication processing capability may be programmed with corresponding executable instructions and carry out the described network function(s) or algorithm(s). The microprocessors or general purpose computers may be formed of applications specific integrated circuitry (ASIC), programmable logic arrays, and/or using one or more digital signal processor (DSPs). Although some of the exemplary implementations described in this specification are oriented to software installed and executing on computer hardware, nevertheless, alternative exemplary implementations implemented as firmware or as hardware or combination of hardware and software are well within the scope of the present disclosure.

The computer readable medium includes but is not limited to random access memory (RAM), read only memory (ROM), erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), flash memory, compact disc read-only memory (CD-ROM), magnetic cassettes, magnetic tape, magnetic disk storage, or any other equivalent medium capable of storing computer-readable instructions.

A radio communication network architecture (e.g., a long term evolution (LTE) system, a LTE-Advanced (LTE-A) system, a LTE-Advanced Pro system, or a 5G New Radio (NR) Radio Access Network) typically includes at least one base station, at least one user equipment (UE), and one or more optional network elements that provide connection towards a network. The UE communicates with the network (e.g., a core network (CN), an evolved packet core (EPC) network, an Evolved Universal Terrestrial Radio Access network (E-UTRAN), a 5G Core (5GC), or an internet), through a radio access network (RAN) established by one or more base stations.

It should be noted that, in the present application, a UE may include, but is not limited to, a mobile station, a mobile terminal or device, a user communication radio terminal. For example, a UE may be a portable radio equipment, which includes, but is not limited to, a mobile phone, a tablet, a wearable device, a sensor, or a personal digital assistant (PDA) with wireless communication capability. The UE is configured to receive and transmit signals over an air interface to one or more cells in a radio access network.

A base station may include, but is not limited to, a node B (NB) as in the UMTS, an evolved node B (eNB) as in the LTE-A, a radio network controller (RNC) as in the UMTS, a base station controller (BSC) as in the GSM/GERAN, a ng-eNB as in an E-UTRA base station in connection with the 5GC, a next generation node B (gNB) as in the 5G-RAN, and any other apparatus capable of controlling radio communication and managing radio resources within a cell. The base station may connect to serve the one or more UEs through a radio interface to the network.

A base station may be configured to provide communication services according to at least one of the following radio access technologies (RATs): Worldwide Interoperability for Microwave Access (WiMAX), Global System for Mobile communications (GSM, often referred to as 2G), GSM EDGE radio access Network (GERAN), General Packet Radio Service (GRPS), Universal Mobile Telecommunication System (UMTS, often referred to as 3G) based on basic wideband-code division multiple access (W-CDMA), high-speed packet access (HSPA), LTE, LTE-A, eLTE (evolved LTE), New Radio (NR, often referred to as 5G), and/or LTE-A Pro. However, the scope of the present application should not be limited to the above mentioned protocols.

The base station is operable to provide radio coverage to a specific geographical area using a plurality of cells forming the radio access network. The base station supports the operations of the cells. Each cell is operable to provide services to at least one UE within its radio coverage. More specifically, each cell (often referred to as a serving cell) provides services to serve one or more UEs within its radio coverage, (e.g., each cell schedules the downlink and optionally uplink resources to at least one UE within its radio coverage for downlink and optionally uplink packet transmissions). The base station can communicate with one or more UEs in the radio communication system through the plurality of cells. A cell may allocate sidelink (SL) resources for supporting proximity service (ProSe) or Vehicle to Everything (V2X) service. Each cell may have overlapped coverage areas with other cells.

As discussed above, the frame structure for NR is to support flexible configurations for accommodating various next generation (e.g., 5G) communication requirements, such as enhanced mobile broadband (eMBB), massive machine type communication (mMTC), ultra reliable communication and low latency communication (URLLC), while fulfilling high reliability, high data rate and low latency requirements. The orthogonal frequency-division multiplexing (OFDM) technology as agreed in 3GPP may serve as a baseline for NR waveform. The scalable OFDM numerology, such as the adaptive sub-carrier spacing, the channel bandwidth, and the Cyclic Prefix (CP) may also be used. Additionally, two coding schemes are considered for NR: (1) low-density parity-check (LDPC) code and (2) Polar Code. The coding scheme adaption may be configured based on the channel conditions and/or the service applications.

Moreover, it is also considered that in a transmission time interval TX of a single NR frame, a downlink (DL) transmission data, a guard period, and an uplink (UL) transmission data should at least be included, where the respective portions of the DL transmission data, the guard period, the UL transmission data should also be configurable, for example, based on the network dynamics of NR. In addition, sidelink resource may also be provided in a NR frame to support ProSe services or V2X services.

The 3rd Generation Partnership Project (3GPP) has introduced a new radio resource control (RRC) state (i.e., the RRC_INACTIVE state) for the next generation (e.g., 5th generation (5G)) wireless communication networks. The RRC_INACTIVE state (also referred to as inactive state in the following description) aims to achieve power saving with acceptable access latency, and is suitable especially for small data transmission, such as in machine type communications (MTC) scenarios. When a UE is in an inactive state, the 5G radio access network (5G-RAN) (e.g., the next generation radio access network (NG-RAN), other 3GPP/non-3GPP access network connected to a 5G core network) and the UE store the "UE context" (which may include Access Stratum (AS) context and Non-Access Stratum (NAS) context of the UE) separately. In addition, when the UE is in the inactive state, the UE may not have an RRC connection with the 5G-RAN, although the 5G-RAN may keep a connection with the next generation core network (e.g., 5G Core Network (5GC)).

The on-demand SI request procedure may be implemented differently for the UEs that are in different Radio Resource Control (RRC) states. For example, in one implementation, for a UE that is in a connected state, the NW may deliver on-demand SI messages or SIB(s) via dedicated signaling to the UE after receiving an SI request from the UE. In some implementations, for a UE that is in an idle state or an inactive state, the NW may deliver on-demand SI messages or SIB(s) via broadcasting. In some implementations, the NW may control the message type for the on-demand SI request procedure. For example, the message type for the on-demand SI request procedure may include a Message 1 (MSG1) based approach and a Message 3 (MSG3) based approach.

In some of the present embodiments, if a Random Access (RA) preamble and/or a Physical Random Access Channel (PRACH) resource specific to each SIB or set of SIBs (which the UE needs to acquire) is included in the minimum SI (e.g., in the Master Information Block and the SIB1), the SI request may be indicated using an MSG 1-based approach.

In an MSG1-based SI request, in some implementations, the minimum granularity for a requested SI may be one SI message (for a set of SIBs, as in an LTE scenario). In some of such implementations, one RA preamble may be used to request for multiple SI messages. In some implementations, a Random Access Preamble Index (RAPID) may be included in a Message 2 (MSG2). Other fields, such as Timing Advance (TA), UL grant and Temporary Cell Radio Network Temporary Identifier (C-RNTI), may not be included in the MSG2 in some implementations.

In some of the present embodiments, an RA procedure for SI request may be considered successful when the UE receives an MSG2 that includes a RAPID corresponding to the transmitted preamble. The MSG2 reception may use an RA-RNTI that corresponds to the MSG1 transmitted by the UE.

In some of the present embodiments, the UE may retransmit the RA preamble according to an NR RA power ramping when the SI request is considered to be unsuccessful. The MSG1 for SI request re-transmission may be continued until reaching maximum preamble transmissions in some of the present embodiments. Thereafter, an RA problem may be indicated to the upper layer (e.g., RRC layer). In some of the present embodiments, a Back off mechanism may be applicable to the MSG1-based SI requests. In some of such embodiments, however, no special back off sub-header/procedure may be required.

In some of the present embodiments, if the RA preamble and/or the PRACH resource (or PRACH occasions) specific to each SIB or set of SIBs (which the UE needs to acquire) is not included in the minimum SI, the SI request may be included in an MSG3. The UE may determine whether the MSG3-based approach is successful or not based on a reception of the MSG4. The preamble(s) and/or the PRACH occasions for the SI request using the MSG3-based approach may not be reserved in some aspects of the present embodiments. RRC signaling may be used for the SI request in an MSG3-based approach. In some embodiments, the UE's ID may not be included in the MSG3.

In some of the present embodiments, a temporary C-RNTI received in the MSG2 may be used for an MSG4 reception. The UE may check the contention resolution Medium Access Control (MAC) Control Element (CE) against the transmitted request.

Specifically, based on the MSG1-based SI request procedure, a UE which transmits a preamble on a dedicated PRACH resource (or PRACH occasions) for the SI request may need to wait for a corresponding Random Access Response (RAR) within a configured RAR window. If no RAR that contains a RAPID corresponding to the transmitted preamble is received, the UE may retransmit the RA preamble until the corresponding RAR is received. The MSG1 for SI request re-transmission, in some of the present embodiments, may be continued until a maximum preamble transmission is reached. In some of such embodiments, an RA problem may be indicated to the upper layers. However, during the whole MSG1-based SI request procedure, the requested SIB(s) or SI message(s) may be broadcasted based on the NW decision or other UE's SI request(s). There may be a power consumption issue if the UE does not stop the ongoing MSG1-based SI request procedure when the required SIB(s) has been broadcasted.

As described above, based on the MSG1-based SI request procedure, a UE which transmits a preamble on a dedicated PRACH resource for the SI request may need to wait for the corresponding RAR within a configured RAR window. If no RAR that contains a RAPID corresponding to the transmitted preamble is received, the UE may retransmit the RA preamble until reaching a maximum preamble transmission, and then an RA problem may be indicated to upper layers. If the corresponding RAR is received, the UE may send an MSG3 to indicate the required SIB(s) and/or SI message(s). After sending the MSG3, the UE may need to wait for a period e.g., defined by a contention resolution timer) for receiving the MSG4 for contention resolution. If the contention resolution timer expires and no MSG4 is received, the UE may retransmit a preamble again. In some of the present embodiments, the MSG1 for the SI request re-transmission may be continued until a maximum preamble transmission is reached. In some aspects of the present embodiments, an RA problem may be indicated to the upper layers. Similarly, since contention resolution is also adopted for the MSG3-based SI request procedure, an RA problem may be indicated to the upper layers if the maximum preamble transmission is reached.

CASE 1: A UE's Behaviour when an On-Demand SI Request is Unsuccessful for the UE in an Idle State or an Inactive State:

When an MSG1-based SI request or an MSG3-based SI request procedure in a cell is failed, the UE may consider the cell as barred, or may consider that the required SIB(s) and/or SI message(s) are not available. In one implementation, the UE may consider the on-demand SI request procedure as unsuccessful when the number of times the UE transmits a random access preamble reaches a threshold (e.g., maximum allowable preamble transmissions), and/or the UE receives SI request rejection information (e.g., in a RAR) in some of the present embodiments.

If the UE considers that a cell is barred due to an SI request failure, the UE may consider the cell as barred for a configurable time period or a fixed time period (e.g., for 300 s). The UE may perform a cell reselection procedure to find another cell to camp on. The barring time period may be broadcasted to the UE in system information, carried in an MSG2 or MSG4, or may be predefined as a fixed value in some of the present embodiments.

If the UE considers that the required SIB(s) and/or SI message(s) are not available, the UE may not perform the SI request for the unavailable SIB(s) and/or SI message(s) again on the cell. In some of the present embodiments, when the UE considers that the required SIB(s) and/or SI message(s) are not available (e.g., when an RA procedure problem is reported, or when SI request rejection information is received), the UE may activate a prohibit timer. In some of such embodiments, the UE may avoid initiating another on-demand SI request procedure until the prohibit timer expires. In one implementation, the UE is forbidden to perform another on-demand SI request procedure until the prohibit timer expires. For example, the prohibit timer may start when an upper layer (e.g., the RRC layer) receives the SI request rejection information, or receives the RA problem due to an SI request failure from a lower layer (e.g., the MAC layer). After the prohibit timer expires, the UE may initiate another SI request procedure. The prohibit timer may be preconfigured or may be a fixed value in some of the present embodiments. The value of the prohibit timer may be broadcasted in system information, carried in an MSG2 or MSG4, or may be predefined as a fixed value in some embodiments.

In one implementation, if the prohibit timer is not present in the signaling from the NW, it is up to UE's implementation on when to start the SI request procedure again.

In one implementation, the UE may determine whether to perform a cell reselection procedure due to a failure of the MSG1-based SI request or the MSG3-bsed SI request. The UE may make such a determination based on whether the required SIB(s) and/or SI message(s) are essential for the UE (e.g. essential for the UE's targeting services) or based on some other predefined rules. For example, the UE may determine to perform a cell reselection procedure as a result of an unsuccessful SI request if the required SIB(s) and/or SI message(s) are essential.

The UE may perform a cell reselection procedure due to a failure of the MSG1-based SI request or the MSG3-based SI request. Specifically, when the UE performs a cell reselection procedure, the UE may consider the cell, for which the UE fails to request the required SIB(s) and/or SI messages(s), as barred or having a lower priority (e.g., by setting the priority of the frequency on which the barred cell is to a default value). In one implementation, the requested SIB(s) and/or SI messages(s) may be defined/considered as the essential SI for different UE categories or UE types. If the requested SIB(s) and/or SI messages(s) are not defined/considered as the essential SI for the category or type of the UE, the UE may decide whether to re-request the requested SIB(s) or SI messages(s) on the camped cell. In one implementation, if the requested SIB(s) or SI messages(s) are not defined/considered as the essential SI for the category or type of the UE, a prohibit timer may start when the upper layer (e.g., the RRC layer) receives the RA problem due to an SI request failure from the lower layer (e.g., the MAC layer). After the prohibit timer expires, the UE may perform the SI request procedure again. The prohibit timer may be preconfigured or be a fixed value. The value of the prohibit timer may be broadcasted in the system information, carried in an MSG2 or MSG4, or may be predefined as a fixed value.

CASE 2: A UE's Behaviour when the On-Demand SI Request is Unsuccessful for the UE in a Connected State:

A UE may also request the required SIB(s) or SI message(s) while the UE is in a connected state. Normally, the UE may receive the required SIB(s) or SI message(s) via dedicated signaling. If the UE does not receive the required SIB(s) or SI message(s) via dedicated signaling, (e.g., no response from the NW side to deliver the required SIB(s) or SI message(s), or receiving SI request rejection information), the UE may consider that there is an NW error and perform reestablishment to another qualified cell if there is another qualified cell with a valid UE context. If there is no such a qualified cell or if the reestablishment is rejected/failed, the UE may switch to an idle state and perform a cell reselection procedure by considering the cell as barred. In another implementation, the UE may directly switch to the idle state and then perform a cell reselection procedure by considering the cell as barred.

In one implementation, the NW may respond an SI request rejection message/information to the UE. After receiving the SI request rejection message/information, the UE may consider that the required SIB(s) or SI message(s) are not available and may not perform the SI request for those SIB(s) or SI message(s) again on the cell. In another implementation, a prohibit timer may be initiated when the UE receives the SI request rejection message/information. After the prohibit timer expires, the UE may perform an SI request procedure again. The prohibit timer may be preconfigured or may be a fixed value.

In one implementation, when the SI request procedure is unsuccessful, the UE may perform, at least, a reestablishment procedure, switch to an idle state for a cell reselection procedure, mark that the requested SIB(s) or SI message(s) are not available, etc.

In one implementation, the requested SIB(s) or SI messages(s) may be defined/considered as the essential SI for different UE categories or UE types. The UE may switch to the idle state and perform a cell reselection procedure when the SI request for essential SI is failed. The UE may consider the cell in which the SI request is failed as barred, or having a lower priority when performing a cell reselection procedure (e.g., by setting the priority of the frequency on which the barred cell is to a default value). The UE, in some of the present embodiments, may only mark that the requested SIB(s) or SI message(s) are not available when the SI request for non-essential SI is failed.

In the connected state, the NW may perform a handover (HO) procedure (e.g., from a source gNB to a target gNB) when receiving the SI request for required SIB(s) or SI message(s) that are not provided by the NW. The target gNB may provide the required SIB(s) or SI message(s) in the HO command (e.g., based on the SI request information provided in the HO Request message from the source gNB).

In the Dual Connectivity (DC) mode, the UE may inform the cause of a Secondary Node (SN) SI request failure, or the information related to the SI request failure to a Master Node (MN) when the on-demand SI request for the SIB(s) of the SN is rejected or failed. After the MN receives the cause of an SI request failure or the information related to the SI request failure, in some of the present embodiments, the MN may try to resolve the SN SI request rejection/failure problem. For example, in one aspect of the present embodiments, the MN may release the SN or change the SN to a new SN for the UE.

CASE 3: Store and Report the Information Related to the SI Request Failure:

An MSG1-based SI request or an MSG3-bsed SI request procedure may be failed when a lower layer (e.g., the MAC layer) informs an upper layer (e.g., the RRC layer) of an RA problem. Since the RRC layer knows the RA procedure is triggered for the SI request, the UE may store the SI request failure information. The SI request failure information may include one or more parameters used in the on-demand SI request procedure. The SI request failure information may include at least one of the following: the on-demand SIB(s) requested by the UE, the on-demand SI message(s) requested by the UE, the cell ID (of the cell in which the UE has performed the SI procedure but has failed), SSB Index(s) (Synchronization Signal Block Index(s)) to perform the SI request procedure, the message type of the failed SI request procedure (e.g., MSG1-based or MSG3-based), the time-stamp (e.g., when to perform the SI request procedure), etc. The SSB Index may indicate which SSB with RA resource (or RA occasions) is used for a preamble transmission. For example, for an MSG1-based approach, the dedicated RA resource (or RA occasions) for transmitting a preamble may be associated with an SSB. For an MSG3-based approach, the common RA resource (or RA occasions) for transmitting a preamble may be associated with an SSB. The UE may report such failure information to the NW when switching to a connected state later. The UE may mandatorily report the information of the SI request failure, according to the configuration, or upon an NW request. The content of the SI request failure information may be predefined, may be based on the required information indicated in the received SI request failure information message, or may be based on the configuration.

FIG. **1** is a sequence diagram illustrating the transmission of SI request failure information, according to an exemplary implementation of the present application. As shown in diagram **100**, in action **110**, serving node **104** (e.g., a gNB) may send a request to UE **102** to provide the information related to SI request failure. For example, serving node **104** may send an SI Request Failure Information Request message to UE **102** if UE **102** informs serving node **104** that such information is stored. In one implementation, UE **102** may set one bit in an RRC message (e.g., in the RRC Connection Setup Complete message or in the RRC Connection Resume message) to true (or '1') to inform serving node **104** that UE **102** supports storage of the SI request failure information and it has the SI request failure information stored. Serving node **104** may determine to request the SI request failure information after receiving such information from UE **102**. In action **112**, UE **102** may send a message including the SI request failure information to serving node **104**.

By utilizing the SI request failure information, serving node **104** may know how to adjust the SI request mechanism between the MSG1-based approach and the MSG3-based approach. For example, if UE **102** reports failure of an MSG3-based SI request procedure in a cell or a certain area, serving node **104** may consider adopting the MSG1-based SI request for the UEs in idle/inactive state to avoid an RA collision by using the dedicated RA resource(s) for SI request. Alternatively, serving node **104** may continue to adopt the MSG3-based SI request procedure when UE **102** reports the failure of the MSG3-based SI request procedure.

In one implementation, UE **102** may store the information related to the SI request failure when UE **102** considers the cell as barred and performs a cell reselection procedure. UE **102** may not store the information related to the SI request failure when UE **102** considers that the required SIB(s) or SI message(s) are not available.

When the SI request procedure for a UE that is in a connected state is failed (e.g., UE **102** does not receive the required SIB(s) or SI message(s) via dedicated signaling, or UE **102** receives the SI request rejection information), UE **102** may store the information of the SI request failure. In one implementation, when the SI request procedure is unsuccessful, UE **102** may perform re-establishment to another qualified cell, or UE **102** may switch to an idle state and then perform a cell reselection procedure by considering the cell as barred. The information of the SI request failure may include at least one of the following: the required SIB(s), the required SI message(s), the cell ID (of the cell in which the UE preforms SI procedure but failed), and the timestamp of the SI request procedure. UE **102** may report such failure information to the NW when switching to a connected state later. UE **102** may mandatorily report the information of the SI request failure, according to the configuration, or upon receiving an NW request. The content of the SI request failure information may be predefined, may be based on the required information indicated in the received SI request failure information message, or may be based on the configuration.

Similarly, UE **102** may store the SI request failure information when UE **102** is in a connected state if the SI request is unsuccessful (where SI request procedure may be an MSG1-based SI approach or an MSG3-based SI approach). The SI request failure information may include at least one of the following: the on-demand SIB(s) requested by UE **102**, the on-demand SI message(s) requested by UE **102**, the cell ID (of the cell which UE **102** preforms SI procedure but failed), SSB Index(s) (Synchronization Signal Block Index(s)) to perform the on-demand SI request procedure, the message type of the unsuccessful SI request procedure (e.g., MSG1-based or MSG3-based), and the timestamp (e.g., when to perform the SI request procedure). The UE may mandatorily report the SI request failure information, according to the configuration, or by an NW request (e.g., requested by serving node **104**). The content in the SI request failure information may be predefined, may be based on the required information indicated in the received SI Request Failure Information message, or may be based on the configuration.

It may be beneficial for the NW to know the information related to SI request failure. For example, the NW may determine which cell, SIB(s)/SI message(s), or the related dedicated preamble may have problems. As a result, the NW is likely to overcome the problem afterwards, or the NW may consider adopting another mechanism for serving the SI request.

In the DC mode, a UE may inform the cause of a Secondary Node (SN) SI request failure, or the information related to the SI request failure, to a Master Node (MN) when the on-demand SI request for the SIB(s) of the SN is rejected or failed. After MN receives the cause of the SI request failure or the information related to the SI request failure, the MN may try to resolve the SN's SI request rejection/failure problem. For example, the MN may release the SN or change the SN to a new SN for the UE.

CASE 4: Harmonization of the SI Request Messages in Idle, Inactive, and Connected States:

For an MSG3-bsed SI request procedure, the MSG3 may include an SI request message (which may be an RRC message) containing no UE ID. In an idle state, there may be no security key and/or security algorithm configured to the UE yet. Therefore, the SI request message transmitted in an idle state may be transmitted on Signaling Radio Bearer 0 (SRB0). Neither integrity protection, nor ciphering, apply to the SRB0 in some embodiments. In one implementation, the SI request message (which is an RRC message) may be the same for idle, inactive, and connected states, resulting in an RRC message harmonization. The SI request message may be transmitted on the SRB0 without integrity protection and ciphering, even if the UE is in a connected state, or in an inactive state, where integrity protection and ciphering may have been already applied.

In one implementation, the SI request message (which is an RRC message) that includes no UE ID may be the same for idle, inactive, and connected states. The UE may transmit the SI request message on the SRB0 when the UE is in an idle or an inactive state. The UE may transmit the SI request message on Signaling Radio Bearer 1 (SRB1) when the UE is in a connected state. Both integrity protection and ciphering may apply to the SRB1.

In one implementation, the SI Request message (which is an RRC message) may be the same for idle, inactive, and connected states. The UE may transmit the SI request message on the SRB0 when the UE is in an idle state. The UE may transmit the SI request message on the SRB1 when the UE is in an inactive or a connected state. Both integrity protection and ciphering may apply to the SRB1. In an inactive State, the UE may still have the UE context and the NW's configuration for integrity protection and ciphering.

In one implementation, whether the SI request message is transmitted on the SRB0 or the SRB1 for a UE in an inactive state may be determined based on the UE's implementation, the NW's preconfiguration, and/or whether the UE context for integrity protection and ciphering is stored/valid or not.

It may be beneficial to keep the commonality of the SI Request message with respect to the UEs in different states, which may lead to simplification of the overall system design in some of the present embodiments.

CASE 5: The Structure of an SI Request Message:

In one implementation, the SI request message in the MSG3 (e.g., in an MSG3-based SI request procedure) may be the same for idle, inactive, and connected states. Different minimum granularity of the requested SI (e.g., SIB-based or SI message-based) may be considered in connection with the SI request message. For example, it may be beneficial for the SI request message to use SI message-based granularity (e.g., the UE indicates which SI message(s) is requested) in the MSG3-based SI request procedure, since there is a one-bit indicator in the NR SIB1 to show whether the corresponding SI message is currently broadcasted or not, and the number of SI messages may be much less than the number of SIBs. However, the SI message-based granularity may not provide sufficient information to the NW in regards to which SIB(s) needs to be broadcasted and/or whether the mapping of the SIB(s) and the SI message(s), and the associated periodicity may need to be re-arranged based on the UE's requirements. The UE in connected state may receive the required SI via dedicated signaling. Therefore, in one implementation, the SIB-based granularity may be used, e.g., by the UE indicating which SIB(s) is requested.

Different implementations regarding the different SIB-based granularities will be discussed next:

CASE 5-1:

In the SI Request message, there may be a choice structure in which the UE may choose to use the SI message-based granularity or the SIB-based granularity. The UE may consider the signaling overhead to select which granularity to use. In one implementation, the UE may use a first bitmap to indicate which SI message(s) is requested and a second bitmap to indicate which SIB(s) is requested. In one implementation, there may be a common bitmap for the UE to indicate which SI message(s) is requested or which SIB ID(s) is requested.

CASE 5-2:

In the SI Request message, there may be a choice structure in which the UE may choose to use the SI message-based granularity or the SIB-based granularity. The UE may select one of the two types of granularity based on the NW configuration. The NW configuration may be delivered to the UE via dedicated signaling or via broadcasting. In one implementation, the UE may use a first bitmap to indicate which SI message(s) is requested and a second bitmap to indicate which SIB(s) is requested. In one implementation, there may be a common bitmap for the UE to indicate which SI message(s) is requested or which SIB ID(s) is requested.

CASE 5-3:

In the SI Request message, in some of the present embodiments, the UE may request one or more SI messages together with one or more SIBs. For example, both SI message-based granularity and SIB-based granularity may be potentially used in the SI Request message. Specifically, a UE may send an SI Request message that only uses the SI message-based granularity, only uses the SIB-based granularity, or uses both SI message-based granularity and SIB-based granularity. The UE may use a first bitmap to indicate which SI message(s) is requested and a second bitmap to indicate which SIB(s) is requested. In one implementation, there may be a common bitmap for the UE to indicate which SI message(s) is requested or which SIB ID(s) is requested.

CASE 5-4:

In some of the present embodiments, the UE may use a two-level bitmap for the SI request messages. In some of such embodiments, the first level bitmap may be used for the SI-based granularity, which may be mandatorily appended in the SI request message. The second level bitmap may be used for the SIB-based granularity, which may be optionally appended in the SI request message if the corresponding SI bit is set to "1" in the first level bitmap. As an example, in which there are 5 SI messages, and the SI message#3 includes SIB#7, SIB#8, SIB#9 and SIB#10, when the UE wants to request SIB#9, the first level bitmap of the UE's SI request message may be "0100" (which indicates SI message#3), and the UE may further optionally append the second level bitmap "0100" (which indicates the third SIB in the SI message#3). Consequently, a gNB may provide SIB#9 specifically in response to such an SI request message. In one implementation, if the second bitmap does not appear, the gNB may provide the complete SI message#3.

CASE 6: On-Demand SI Request Procedure in an NR-NR DC Scenario:

A UE in an NR-NR Dual Connectivity (DC) mode may request one or more required SIBs or one or more SI messages for certain purpose(s) or certain service(s). Several implementations are described below regarding how the UE may request and receive the required SIB(s) from a secondary node (SN) or the serving cells in a secondary cell group (SCG).

CASE 6-1:

When a UE is in an NR-NR DC mode and one or more SIBs or one or more SI messages are required, the UE may be only allowed to send the SI request message to the master node (MN) in some of the present embodiments.

FIG. **2** is a sequence diagram illustrating an example of an on-demand SI request being transmitted to an MN in the DC mode, according to an exemplary implementation of the present application. As shown in diagram **200**, in action **210**, UE **102** may transmit an SI request message to MN **106** when UE **102** requires on-demand system information of a cell belonging to MN **106** or a cell belonging to SN **108**. In action **212**, MN **106** may inform SN **108** to provide the required SIB(s) or SI message(s) to UE **102** based on the SI request message. For example, MN **106** may use a signaling message between two base stations (e.g., X2-AP message or Xn-AP message) with fields indicating the requested SIB(s) or SI message(s). When SN **108** receives the SI request from MN **106**, SN **108** may transmit the required SIB(s) or SI message(s) to UE **102** by initiating serving cell release and addition action in the same RRC reconfiguration message to update the SIB(s) or SI message(s) for certain, or all, serving cell(s). As shown in diagram **200**, this RRC reconfiguration may be transmitted via MN **106** or transmitted via Signaling Radio Bearer 3 (SRB3), if configured.

When the UE requires on-demand system information of a cell belonging to MN **106**, if the requested SI message or SIB is not broadcasted, in action **214**, MN **106** may transmit the required SI to UE **102**. When the UE requires on-demand system information of a cell belonging to SN **108**, if the requested SI message or SIB is not provided before, in action **216**, SN **108** may transmit RRC Reconfiguration with the required SI to UE **102** (e.g., via the SRB3). In one implementation, SN **108** may transmit RRC Reconfiguration with required SI (e.g., action **216**) only when SN **108** receives the SI Request Notification from MN **106** (e.g., action **212**).

In one implementation, SN **108** may directly transmit the modified SIB(s) or SI messages(s) to UE **102** without taking cell release and addition action, when MN **106** sends the SI Request Notification to SN **108**. SN **108** may transmit the modified SIB(s) or SI messages(s) directly to UE **102** only when receiving the SI Request Notification from MN **106**.

In one implementation, UE **102** is only allowed to send the SI request message to MN **106**. The UE may indicate in the SI request message that the SI Request is for the SIB(s) or the SI message(s) on MN **106** or SN **108**. If the SI Request message is marked for MN **106**, MN **106** may be responsible for this SI Request message. On the other hand, if the SI Request message is marked for SN **108**, MN **106** may forward this message to SN **108** and SN **108** may be responsible for this SI Request message. It should be noted that UE **102** may follow the minimum SI's indication (e.g., SI transmission period) of MN **106** or SN **108** to receive the SI while the SI request message is marked to MN **106** or SN **108**, respectively. In another implementation, UE **102** may not mark the SI request toward MN **106** or SN **108**, and MN **106** may provide all (MN **106** and SN **108**) relative SI to UE **102** in a unicast approach.

If some or all of the serving cells in the SCG do not provide the requested SIB(s) or SI message(s), SN **108** may inform MN **106** that the SCG, or some serving cells in the SCG, does not provide the requested SIB(s) or SI message(s). MN **106** may decide whether to perform the SCG change action or release SN **108** for UE **102**.

CASE 6-2:

When a UE in the NR-NR DC mode and one or more SIBs or SI messages are required, the UE may send the SI request message to the MN and/or the SN when required.

FIG. **3** is a sequence diagram illustrating an example of the on-demand SI request being transmitted to an SN in the DC mode, according to an exemplary implementation of the present application. As shown in diagram **300**, in action **310**, UE **102** may transmit the SI request message to SN **108** (e.g., via SRB3, if configured). In action **312**, SN **108** may transmit RRC Reconfiguration with the required SI to UE **102** via SRB3. If SRB3 is not configured, UE **102** may transmit the SI request message to MN **106** and let MN **106** forward the SI request message to SN **108**.

When some or all of the serving cells in the SCG cannot provide the required SIB(s) or SI message(s), SN **108** may inform MN **106** that the SCG, or some serving cells in the SCG, does not provide the requested SIB(s) or SI message(s). MN **106** may decide whether to perform the SCG change action or release SN **108** for UE **102**.

FIG. **4** is a sequence diagram illustrating an example of the UE determining the failure of an SI request in the DC mode, according to an exemplary implementation of the present application. As shown in diagram **400**, in action **410**, UE **102** sends an SI request message to SN **108**. In action **412**, UE **102** determines the failure of the SI request, e.g., when the number of times UE **102** transmits the random access preamble reaches a threshold. After determining the on-demand SI request procedure is unsuccessful, UE **102** may store the SI request failure information related to SN **108**. In action **414**, UE **102** may transmit the SN SI request failure information to MN **106**.

FIG. **5** is a sequence diagram illustrating an example of the UE receiving SI request rejection information in the DC mode, according to an exemplary implementation of the present application. As shown in diagram **500**, in action **510**, UE **102** sends an SI request message to SN **108**. In action **512**, UE **102** receives the SI request rejection information from SN **108**. After determining the on-demand SI request procedure is unsuccessful, UE **102** may store the SI request failure information related to SN **108**. In action **514**, UE **102** may send the SN SI request failure information to MN **106**.

If UE **102** determines that the SI request procedure on SN **108** has failed (e.g., action **412** in diagram **400** or action **512** in diagram **500**), UE **102** may inform MN **106** of the cause of SN SI request failure or the information related to SN SI request failure (e.g., by sending an SN SI Request Failure Information when the on-demand SI request for the SIB(s) of SN **108** is rejected or failed, e.g., in action **414** of diagram **400**, or action **514** of diagram **500**). The information of the SI request failure may include at least one of the following: the required SIB(s), the required SI message(s), the cell ID (of the cell which the UE preforms SI procedure but failed), SSB Index(s) (Synchronization Signal Block Index(s)) to perform SI request, the failed SI request procedure type (e.g., MSG1-based or MSG3-based), or the timestamp (e.g., when to perform the SI request procedure). After MN **106** receives the cause of the SI request failure or the information related to the SI request failure, MN **106** may resolve the SN SI request rejection/failure problem. For example, MN **106** may release SN **108** or change SN **108** to a new SN for UE **102**.

CASE 7: An RA Problem Caused by the MSG1-Based/MSG3-Based SI Request Procedure:

A UE in connected state may be allowed to apply an MSG1-based SI request procedure and/or an MSG3-based SI request procedure. In one implementation, if the RA problem is caused by the MSG1-based or the MSG3-bsed SI request procedures, the UE's operation in connected state is not affected if the requested SI message(s) or SIB(s) is not essential for the UE to perform the targeting services.

In one implementation, the UE may still be fine even if the requested SIB(s) or SI message(s) is not received from the serving node (e.g., in a single connectivity mode) or the MN (e.g., in dual connectivity mode) (e.g., the requested SIB or SI message may not be essential). In this scenario, the UE may not consider the RA problem as a normal radio link failure, and the UE may not perform a re-establishment procedure, or enter into an idle state.

In one implementation, the UE may still be fine even if the requested SIB(s) or SI message(s) is not received from the SN (e.g., in a dual connectivity mode). In this scenario, the UE may not consider the RA problem as a normal radio link failure, and the UE may report the SI failure information to the MN. For example, when the RA problem is reported and the upper layer (e.g., the RRC layer) knows that the problem is caused by an SI request, the UE may initiate a transmission of the SI failure information report to the MN. In this implementation, the UE may not suspend all of the SCG data radio bearers (DRBs) or SCG transmission for the split DRBs or the duplication DRBs. Also, the UE may not reset the MAC entity associated with the SCG (or SN).

In one implementation, the UE may still be fine even if the requested SIB(s) or SI message(s) is not received from the SN (e.g., in a dual connectivity mode). In this scenario, the UE may not consider the RA problem as a normal radio link failure, and the UE may not report the SI failure information to the MN. For example, when the RA problem is reported and the upper layer (e.g., RRC layer) knows that the problem is caused by an SI request, the UE may not initiate a transmission of the SI failure Information report to the MN. In this implementation, the UE may not suspend all of the SCG DRBs or SCG transmission for the split DRBs or the duplication DRBs. Also, the UE may not reset the MAC entity associated with the SCG (or SN). When the upper layer (e.g., the RRC layer) receives the RA problem caused by the SI request from the lower layer (e.g., the MAC layer), it may also inform the NAS layer (or the application layer) so that the NAS layer (or the application layer) does not trigger the SI request procedure for one or more required SIBS on the same cell, or not trigger the SI request procedure for a while (which may follow the NW configuration or a predefined period). How to handle the SI request failure condition may depend on the UE's implementation, if the NAS layer (or the application layer) is informed about the SI request failure.

In one implementation, whether the SN initiates the transmission of the SI failure information report to the MN may depend on the NW configuration.

FIG. **6** is a flowchart for a method of wireless communications performed by a UE, according to an example implementation of the present application. In FIG. **6**, the process/method **600** includes actions **602**, **604**, **606**, and **610**.

In action **602**, the UE may perform an on-demand system information request procedure in a cell. The UE may be in idle, inactive, or connected state. In addition, the UE may be in a single connectivity mode or a dual connectivity mode.

In action **604**, the UE may determine whether the on-demand SI request procedure is successful. In one implementation, the on-demand SI request procedure is considered unsuccessful when the number of times the UE transmits a random access preamble reaches a threshold, and/or the UE receives the SI request rejection information. If the process **600** determines, in action **604**, that the SI request procedure is unsuccessful, the UE may proceed to action **606**. On the other hand, if the request procedure is successful, the process **600** may end.

In action **606**, the UE may perform an error handling procedure corresponding to the on-demand SI request procedure. There may be several implementations regarding the error handling procedure in different implementations. In one implementation, the error handling procedure may include action **610**, in which the UE may store the SI request failure information. For example, the SI request failure information may include one or more parameters used in the on-demand SI request procedure. In one implementation, the error handling procedure may further include at least one of following: a prohibit timer activation, a cell re-selection procedure, and a re-establishment procedure.

FIG. **7** illustrates a block diagram of a node for wireless communication, in accordance with various aspects of the present application. As shown in FIG. **7**, node **700** may include transceiver **720**, processor **726**, memory **728**, one or more presentation components **734**, and at least one antenna

736. Node **700** may also include a Radio Frequency (RF) spectrum band module, a base station communications module, a network communications module, and a system communications management module, input/output (I/O) ports, I/O components, and power supply (not explicitly shown in FIG. **7**). Each of these components may be in communication with each other, directly or indirectly, over one or more buses **740**.

Transceiver **720** having transmitter **722** and receiver **724** may be configured to transmit and/or receive time and/or frequency resource partitioning information. In some implementations, transceiver **720** may be configured to transmit in different types of subframes and slots including, but not limited to, usable, non-usable and flexibly usable subframes and slot formats. Transceiver **720** may be configured to receive data and control channels.

Node **700** may include a variety of computer-readable media. Computer-readable media can be any available media that can be accessed by node **700** and include both volatile and non-volatile media, removable and non-removable media. By way of example, and not limitation, computer-readable media may comprise computer storage media and communication media. Computer storage media includes both volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data.

Computer storage media includes RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices. Computer storage media does not comprise a propagated data signal. Communication media typically embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of any of the above should also be included within the scope of computer-readable media.

Memory **728** may include computer-storage media in the form of volatile and/or non-volatile memory. Memory **728** may be removable, non-removable, or a combination thereof Exemplary memory includes solid-state memory, hard drives, optical-disc drives, and etc. As illustrated in FIG. **7**, memory **728** may store computer-readable, computer-executable instructions **732** (e.g., software codes) that are configured to, when executed, cause processor **726** to perform various functions described herein, for example, with reference to FIGS. **1** through **6**. Alternatively, instructions **732** may not be directly executable by processor **726** but be configured to cause node **700** (e.g., when compiled and executed) to perform various functions described herein.

Processor **726** may include an intelligent hardware device, e.g., a central processing unit (CPU), a microcontroller, an ASIC, and etc. Processor **726** may include memory. Processor **726** may process data **730** and instructions **732** received from memory **728**, and information through transceiver **720**, the base band communications module, and/or the network communications module. Processor **726** may also process information to be sent to transceiver **720** for transmission through antenna **736**, to the network communications module for transmission to a core network.

One or more presentation components **734** presents data indications to a person or other device. Exemplary one or more presentation components **734** include a display device, speaker, printing component, vibrating component, and etc.

From the above description, it is manifest that various techniques can be used for implementing the concepts described in the present application without departing from the scope of those concepts. Moreover, while the concepts have been described with specific reference to certain implementations, a person of ordinary skill in the art may recognize that changes can be made in form and detail without departing from the scope of those concepts. As such, the described implementations are to be considered in all respects as illustrative and not restrictive. It should also be understood that the present application is not limited to the particular implementations described above, but many rearrangements, modifications, and substitutions are possible without departing from the scope of the present disclosure.

What is claimed is:

1. A method of an on-demand system information (SI) request procedure performed by a user equipment (UE), the method comprising:

transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);

activating a prohibit timer; and

transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.

2. The method of claim **1**, wherein the on-demand SI request procedure is unsuccessful when one of the following conditions is met:

a number of times the UE transmits a random access preamble reaches a threshold; and

the UE receives SI request rejection information.

3. The method of claim **1**, wherein when the UE is in a dual connectivity mode, the method further comprises:

transmitting a third SI request message to a master node when the UE requires on-demand system information of a cell belonging to a secondary node.

4. The method of claim **1**, wherein the first SI request message is transmitted on signaling radio bearer **1** (SRB1).

5. The method of claim **1**, further comprising:

receiving, from the BS, the at least one requested SIB via dedicated signaling that is transmitted in response to the first SI request message.

6. The method of claim **1**, further comprising:

transmitting a fourth SI request message to the BS after determining that the UE is not in the connected state, the fourth SI request message including at least one requested SI message.

7. The method of claim **6**, wherein the fourth SI request message is transmitted on signaling radio bearer 0 (SRB0).

8. The method of claim **1**, further comprising:

storing SI request failure information after determining that the on-demand SI request procedure is unsuccessful.

9. The method of claim **8**, wherein the SI request failure information comprises at least one of the following:

the at least one requested SIB;

the at least one requested SI message;

a cell identifier (ID) associated with the BS;

a synchronization signal block (SSB) index for performing the on-demand SI request procedure;

a message type of the on-demand SI request procedure; and

a timestamp for performing the on-demand SI request procedure.

10. The method of claim **8**, further comprising:

transmitting the SI request failure information;

wherein the SI request failure information is transmitted to a master node when the UE is in a dual connectivity mode.

11. A user equipment (UE), comprising:

one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to perform operations for an on-demand system information (SI) request procedure, the operations comprising:

transmitting a first SI request message to a base station (BS) after determining that the UE is in a connected state, the first SI request message including at least one requested system information block (SIB);

activating a prohibit timer; and

transmitting a second SI request message to the BS only when the at least one requested SIB is not received and the prohibit timer expires.

12. The UE of claim **11**, wherein the on-demand SI request procedure is unsuccessful when one of the following conditions is met:

a number of times the UE transmits a random access preamble reaches a threshold; and

the UE receives SI request rejection information.

13. The UE of claim **11**, wherein when the UE is in a dual connectivity mode, the operations further comprise:

transmitting a third SI request message to a master node when the UE requires on-demand system information of a cell belonging to a secondary node.

14. The UE of claim **11**, wherein the first SI request message is transmitted on signaling radio bearer 1 (SRB1).

15. The UE of claim **11**, wherein the operations further comprise:

receiving, from the BS, the at least one requested SIB via dedicated signaling that is transmitted in response to the first SI request message.

16. The UE of claim **11**, wherein the operations further comprise:

transmitting a fourth SI request message to the BS after determining that the UE is not in the connected state, the fourth SI request message including at least one requested SI message.

17. The UE of claim **16**, wherein the fourth SI request message is transmitted on signaling radio bearer 0 (SRB0).

18. The UE of claim **11**, wherein the operations further comprise:

storing SI request failure information after determining that the on-demand SI request procedure is unsuccessful.

19. The UE of claim **18**, wherein the SI request failure information comprises at least one of the following:

the at least one requested SIB;

the at least one requested SI message;

a cell identifier (ID) associated with the BS;

a synchronization signal block (SSB) index for performing the on-demand SI request procedure;

a message type of the on-demand SI request procedure; and

a timestamp for performing the on-demand SI request procedure.

20. The UE of claim **18**, wherein the operations further comprise:

transmitting the SI request failure information;

wherein the SI request failure information is transmitted to a master node when the UE is in a dual connectivity mode.

* * * * *

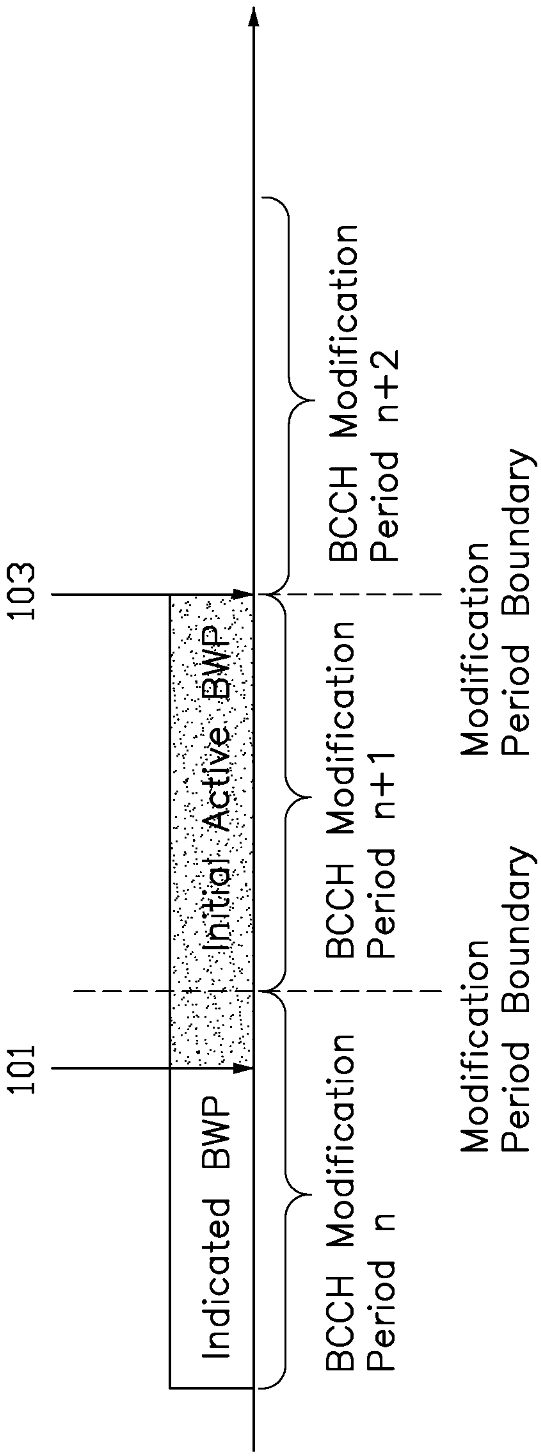

103
101
Indicated BWP
Initial Active BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary
Modification Period Boundary

FIG. 1

Exhibit 3

US010972972B2

(12) **United States Patent**
Cheng et al.

(10) **Patent No.: US 10,972,972 B2**
(45) **Date of Patent: Apr. 6, 2021**

(54) **METHODS AND APPARATUSES FOR OPERATING MULTIPLE ANTENNA PANELS**

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(73) Assignee: **FG Innovation Company Limited**, Tuen Mun (HK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/511,170**

(22) Filed: **Jul. 15, 2019**

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Related U.S. Application Data

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(51) **Int. Cl.**

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H04W 76/28	(2018.01)
H04W 52/02	(2009.01)
H04B 17/309	(2015.01)
H04W 24/10	(2009.01)
H04W 72/04	(2009.01)

(52) **U.S. Cl.**

CPC ***H04W 48/20*** (2013.01); ***H04B 17/309*** (2015.01); ***H04W 24/10*** (2013.01); ***H04W 52/0216*** (2013.01); ***H04W 72/042*** (2013.01); ***H04W 76/28*** (2018.02)

(58) **Field of Classification Search**

CPC H04W 48/20; H04W 76/28; H04W 24/10; H04W 52/0216; H04W 72/042; H04B 17/309

See application file for complete search history.

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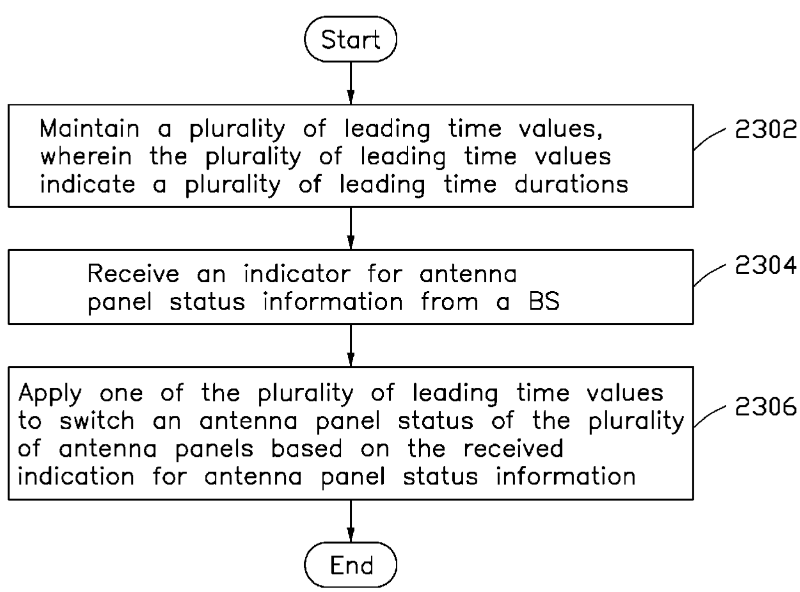
Primary Examiner — Chi H Pham
Assistant Examiner — Ji-Hae Yea
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

Methods and apparatuses for operating multiple antenna panels are provided. The wireless communication device includes a plurality of antenna panels and a processor coupled to the antenna panels. The processor is configured to maintain a plurality of leading time values. The plurality of leading time values may indicate a plurality of leading time durations. The processor is further configured to receive an indicator for antenna panel status information from a base station, and apply one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the indicator for antenna panel status information.

28 Claims, 27 Drawing Sheets



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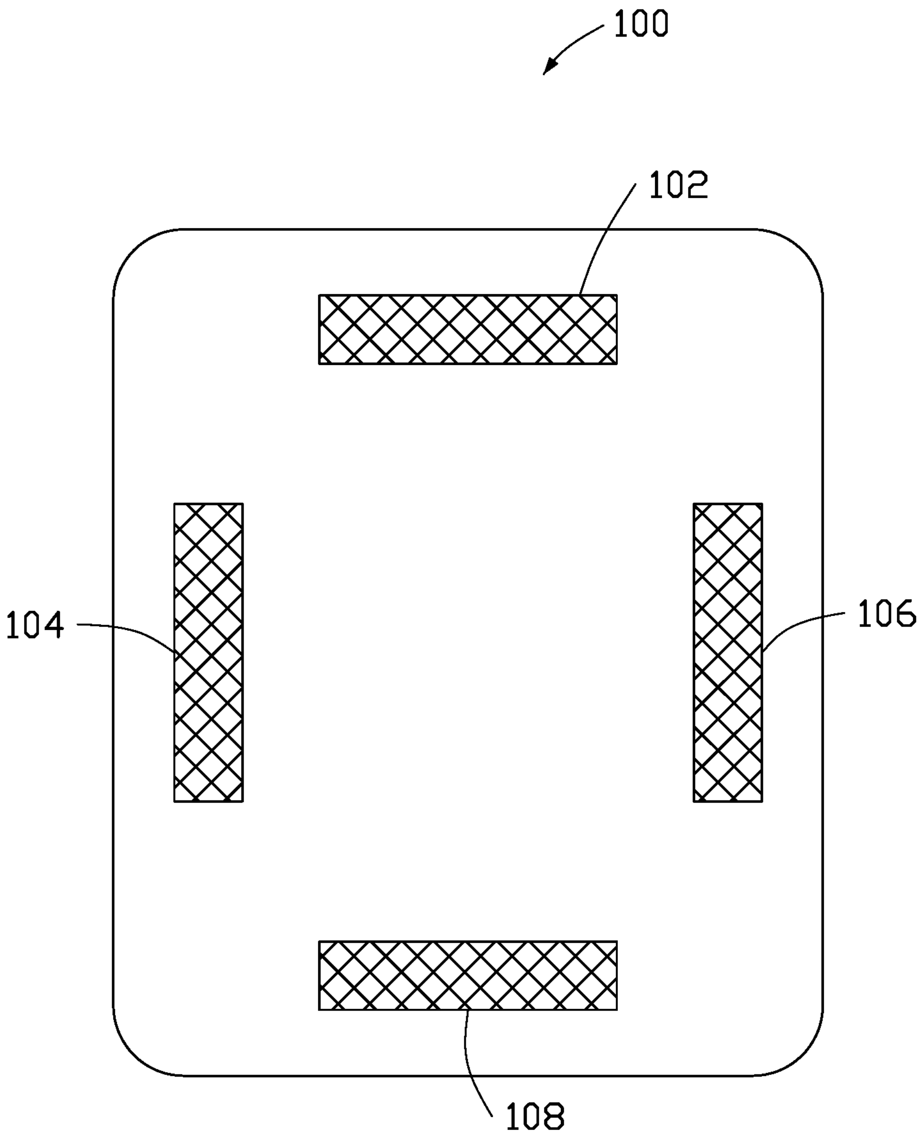


FIG. 1

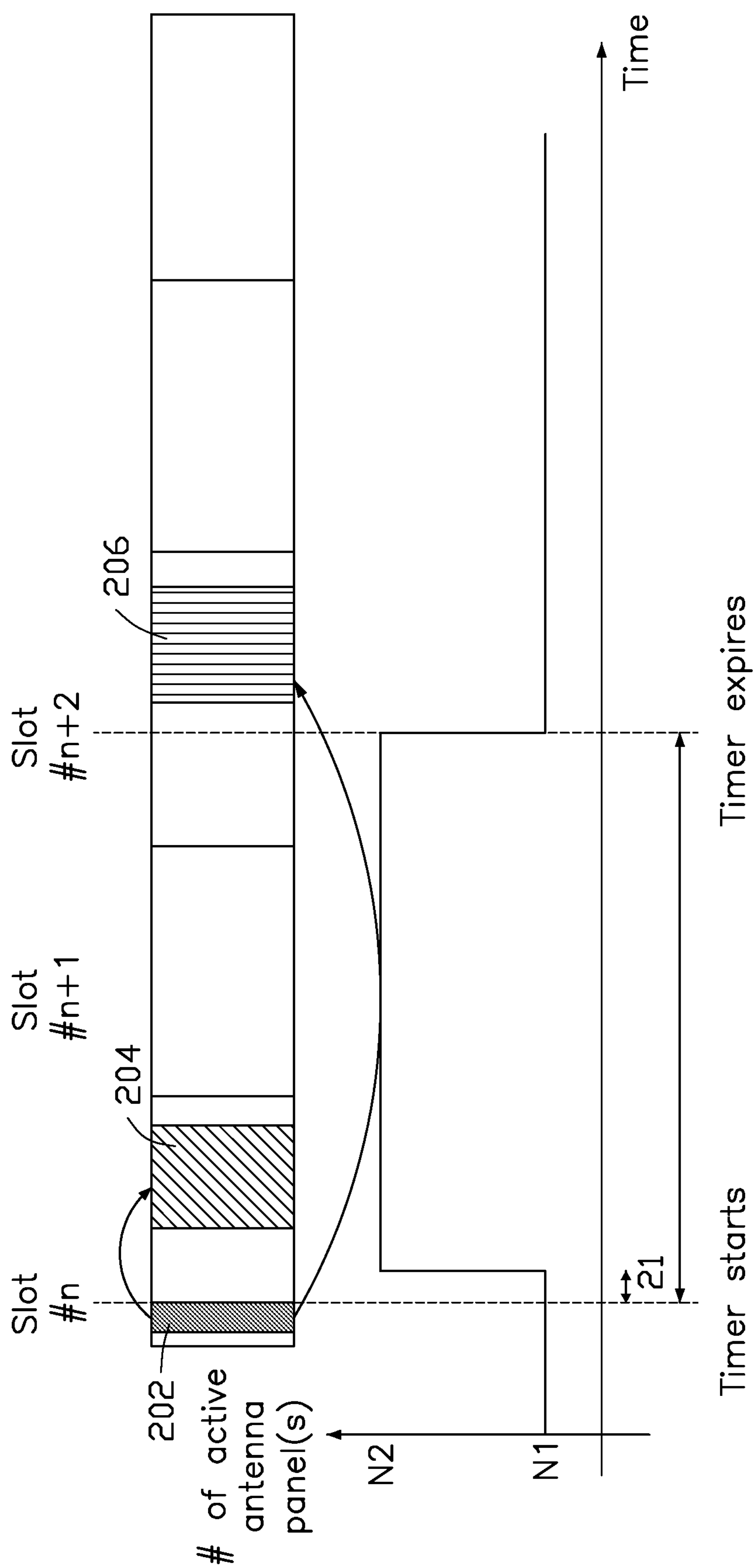
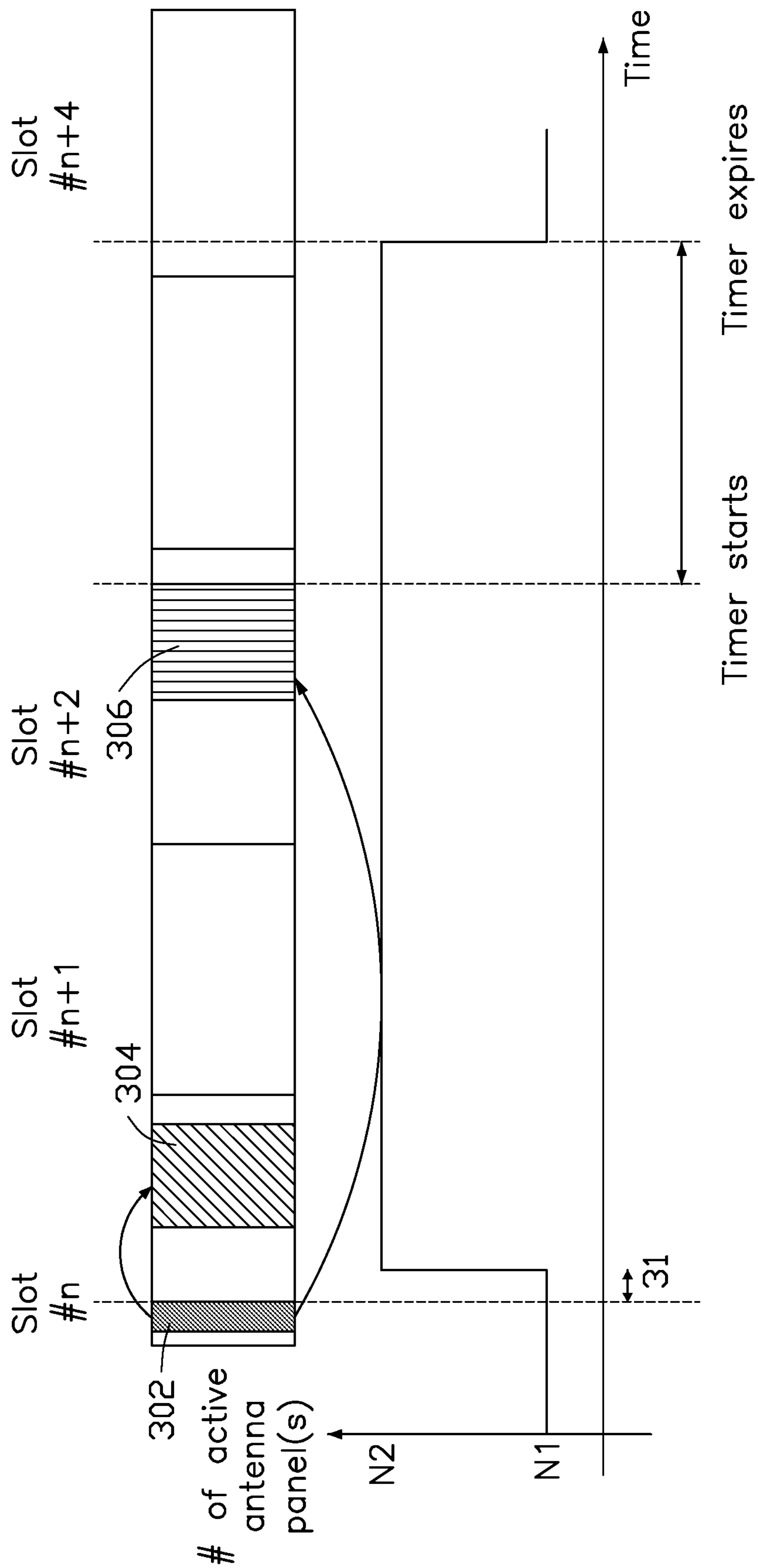

Time
206
Slot #n+2
Slot #n+1
204
Slot #n
202
Timer expires
Timer starts
21
# of active antenna panel(s)
N2
N1

FIG. 2



Slot #n
Slot #n+1
Slot #n+2
Slot #n+4
302
304
306
# of active antenna panel(s)
N2
N1
31
Timer starts
Timer expires
Time

FIG. 3

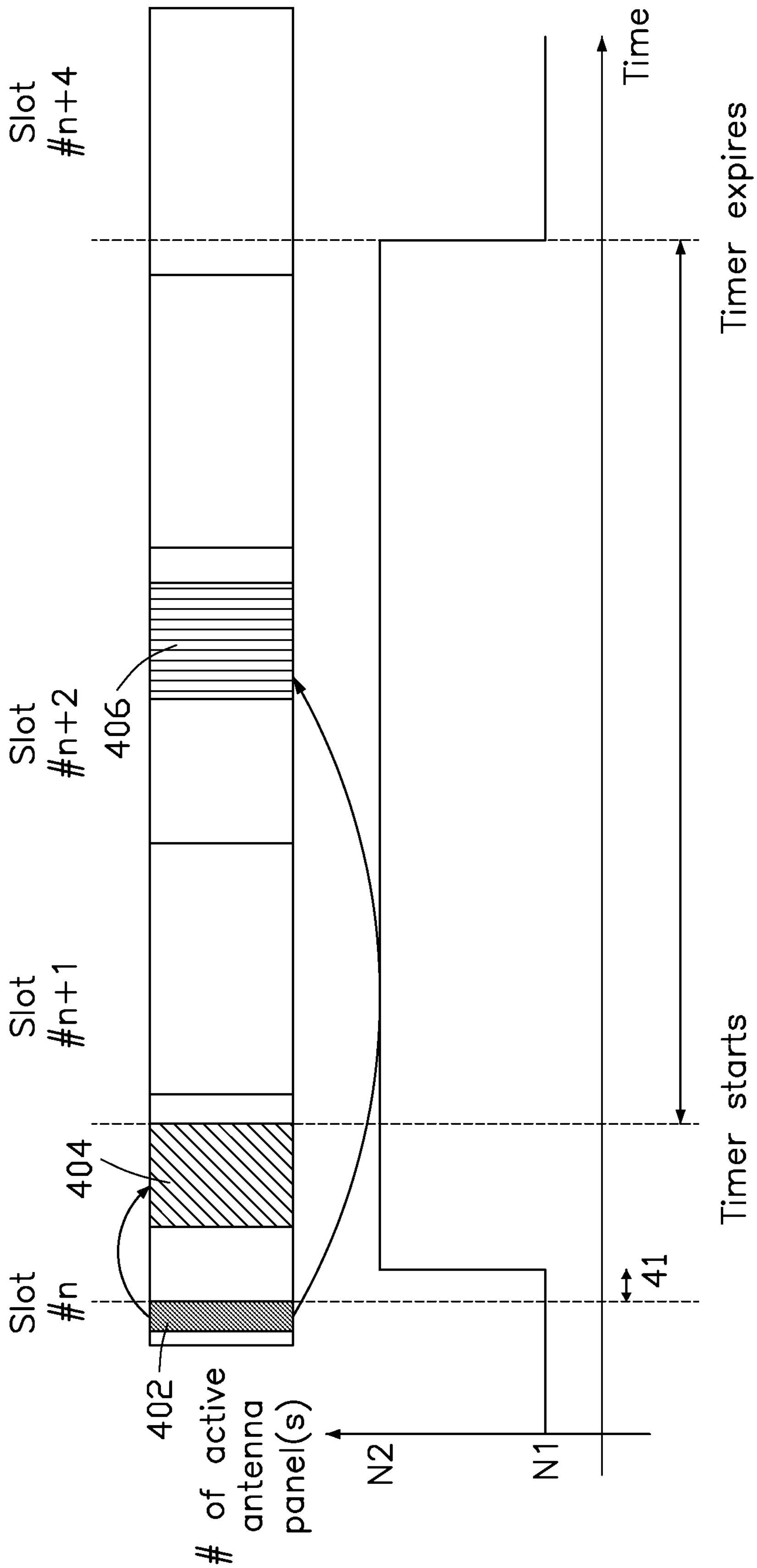

Slot #n
Slot #n+1
Slot #n+2
Slot #n+4
402
404
406
41
# of active antenna panel(s)
N2
N1
Time
Timer starts
Timer expires

FIG. 4

502

- UE capability
  - power saving indicator
    - {True/Support, False/Not support}
  - timer for antenna panel status
    - {True/Support, False/Not support}
  - maximum number of support antenna panels
    - {one, two, four or eight}
  - support indication method
    - {True/Support, False/Not support}
  - require time for antenna panel status switch
    - {1ms, 2ms, 3ms, 4ms}
  - UE assistance
    - {True/Support, False/Not support}

FIG. 5

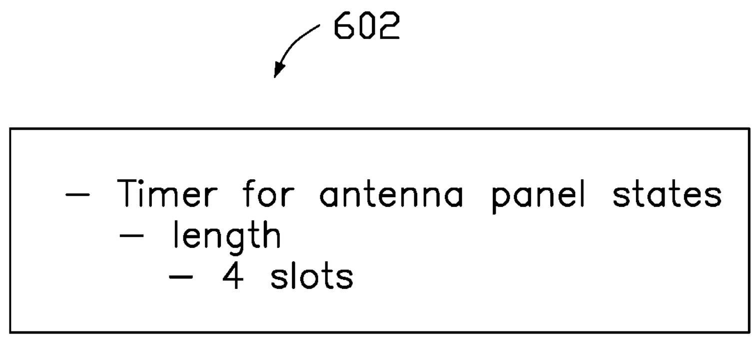


FIG. 6

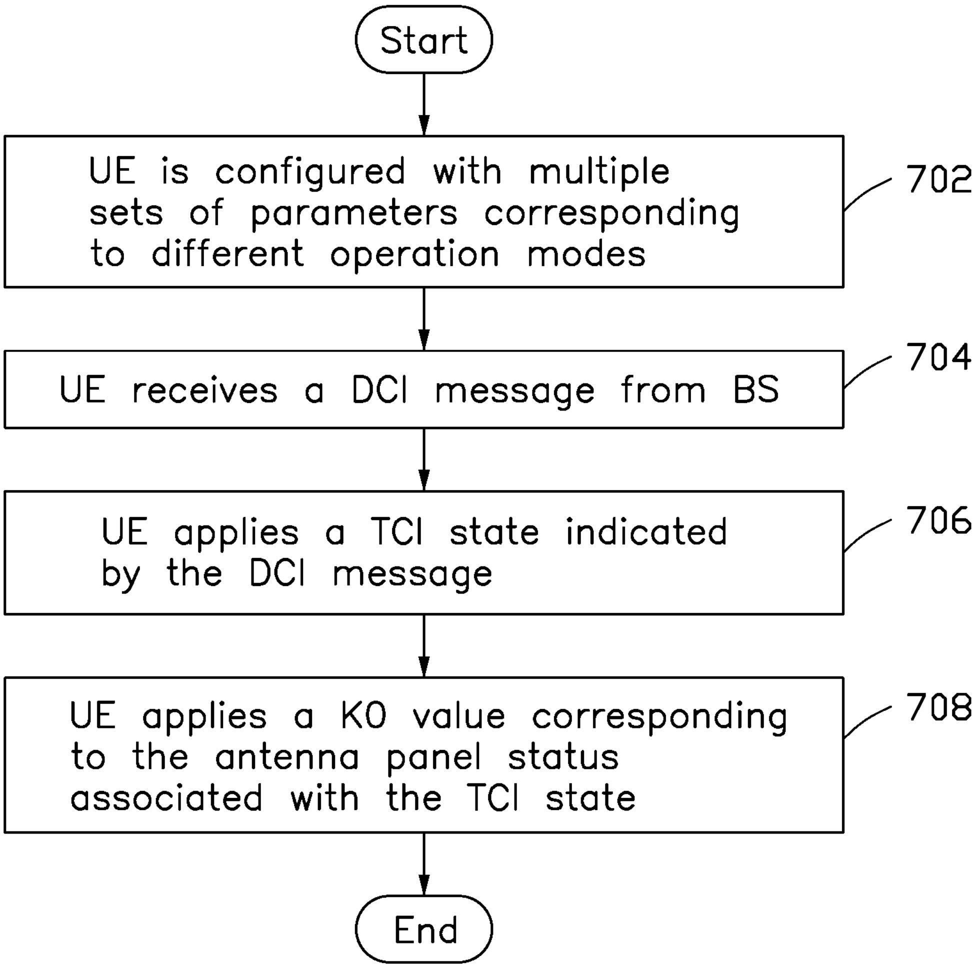

Start
UE is configured with multiple sets of parameters corresponding to different operation modes
702
UE receives a DCI message from BS
704
UE applies a TCI state indicated by the DCI message
706
UE applies a K0 value corresponding to the antenna panel status associated with the TCI state
708
End

FIG. 7

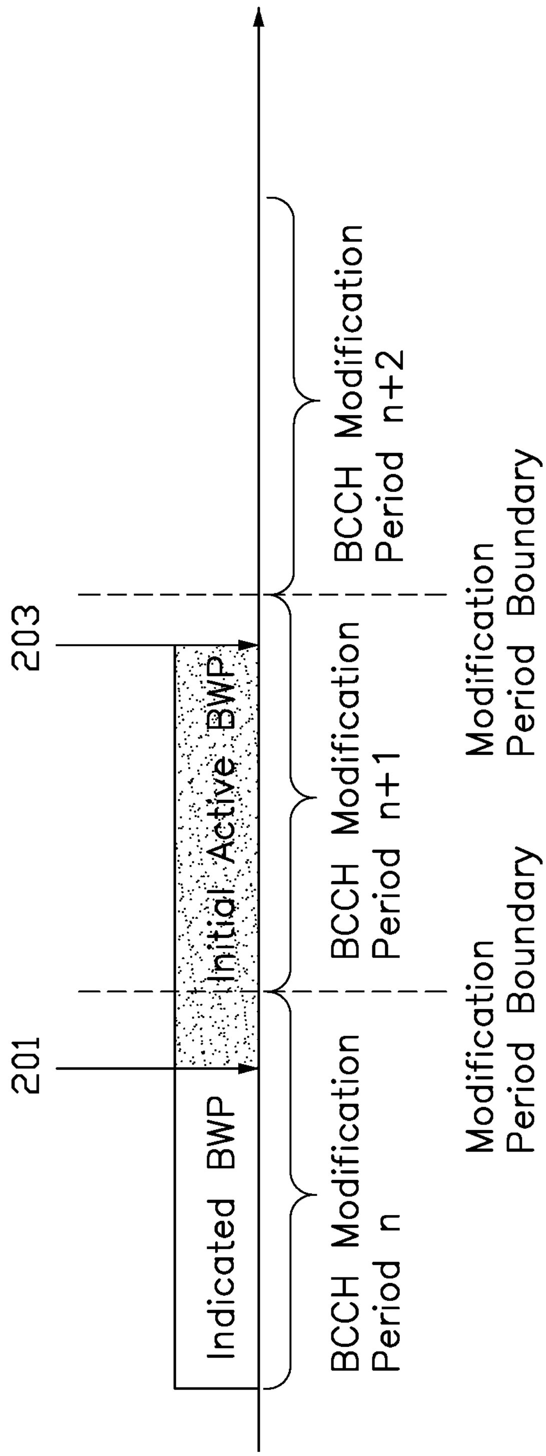

201
203
Indicated BWP
Initial Active BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary
Modification Period Boundary

FIG. 2

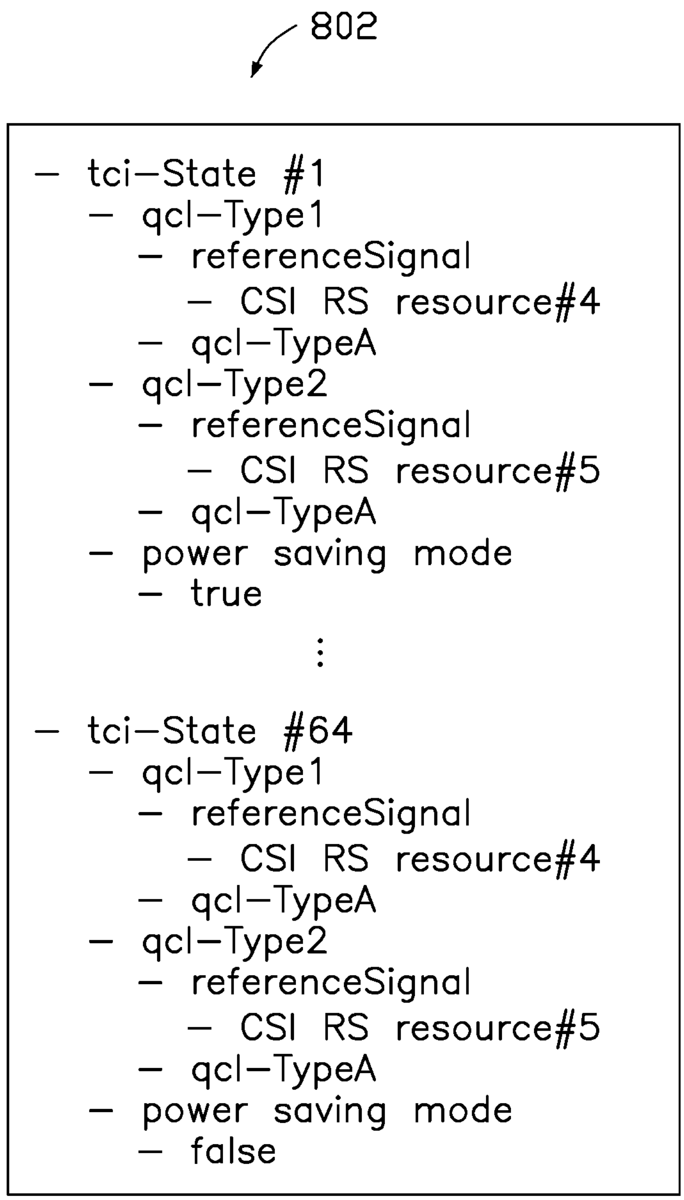

802
– tci–State #1
– qcl–Type1
– referenceSignal
– CSI RS resource#4
– qcl–TypeA
– qcl–Type2
– referenceSignal
– CSI RS resource#5
– qcl–TypeA
– power saving mode
– true
⋮
– tci–State #64
– qcl–Type1
– referenceSignal
– CSI RS resource#4
– qcl–TypeA
– qcl–Type2
– referenceSignal
– CSI RS resource#5
– qcl–TypeA
– power saving mode
– false

FIG. 8

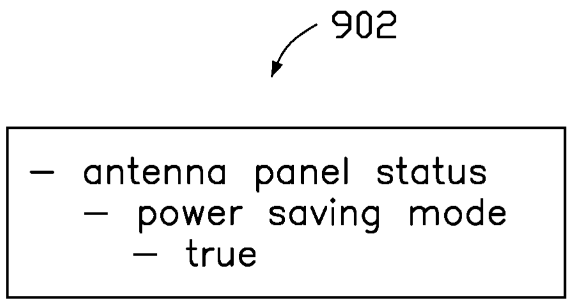


FIG. 9

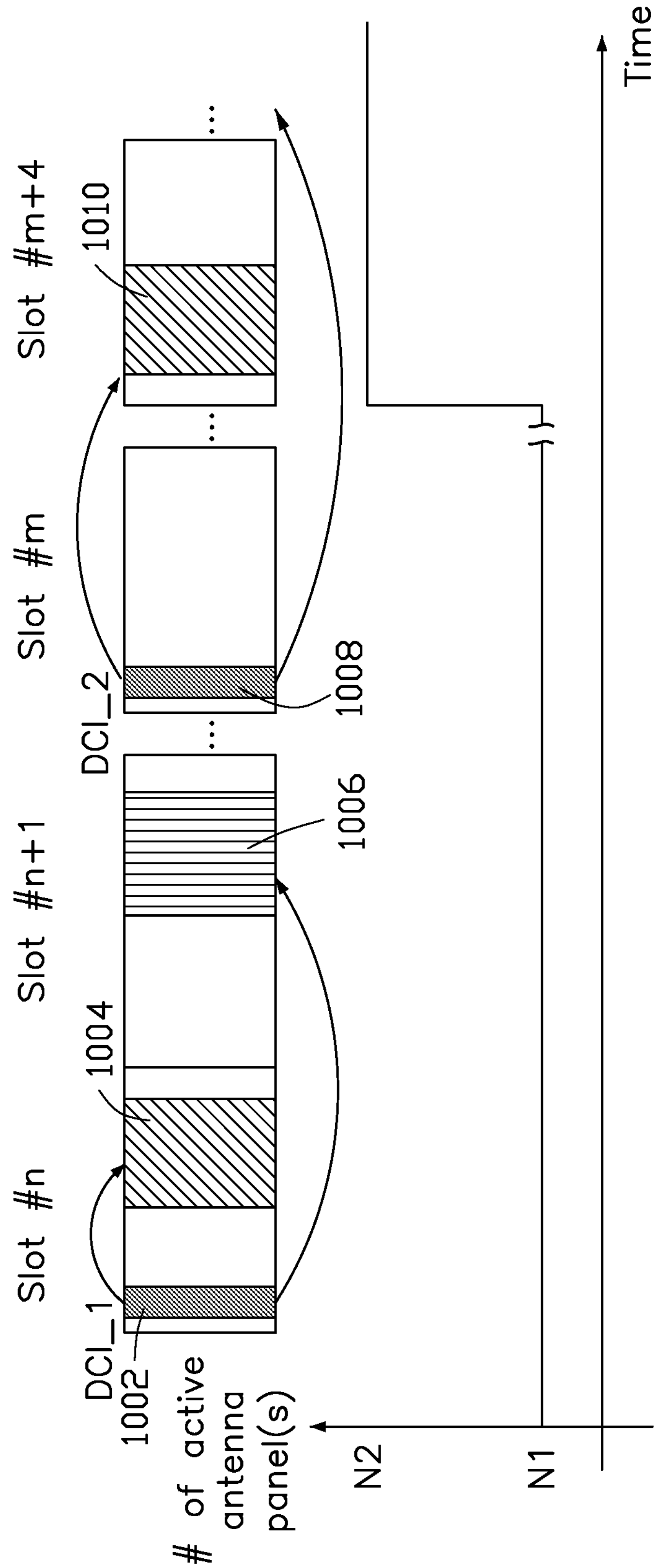

Slot #n
Slot #n+1
Slot #m
Slot #m+4
DCI_1
DCI_2
1002
1004
1006
1008
1010
# of active antenna panel(s)
N2
N1
Time

FIG. 10A

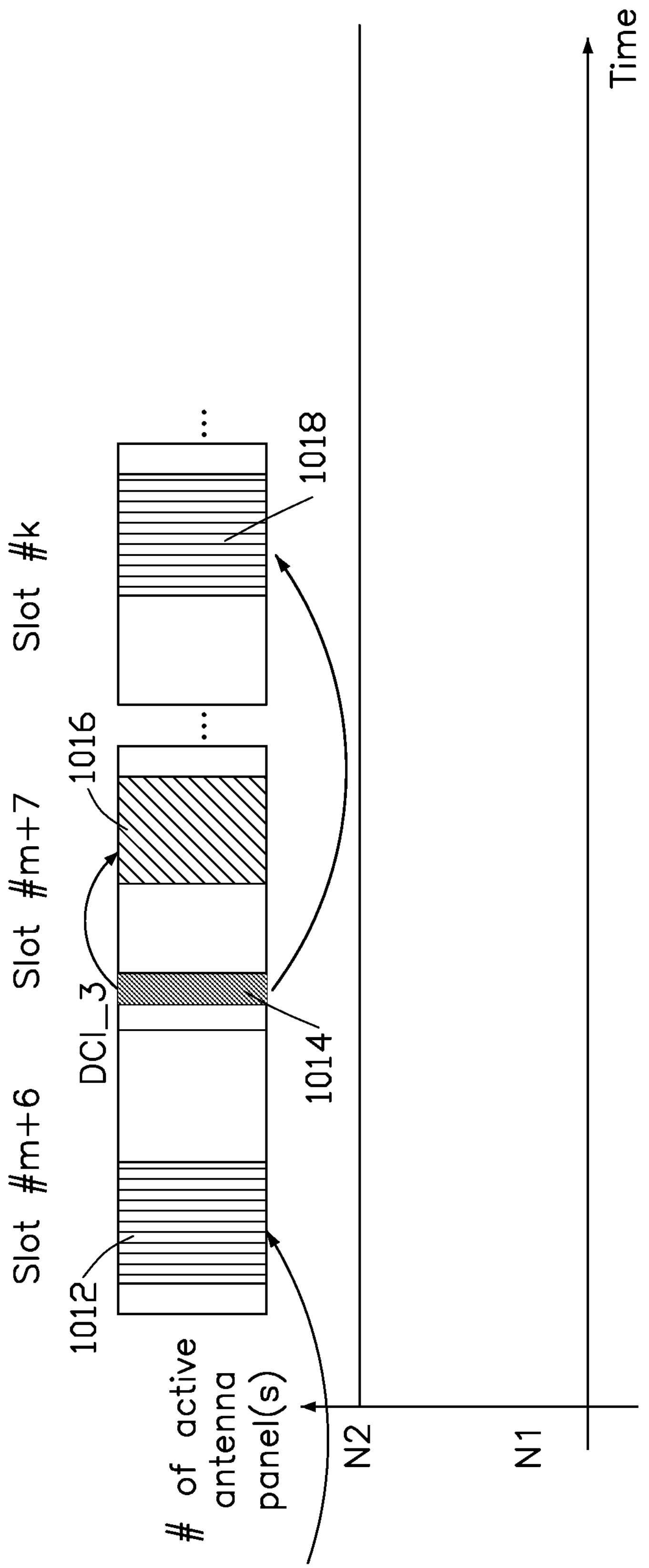

Time
Slot #m+6
Slot #m+7
Slot #k
DCI_3
1012
1014
1016
1018
# of active antenna panel(s)
N2
N1

FIG. 10B

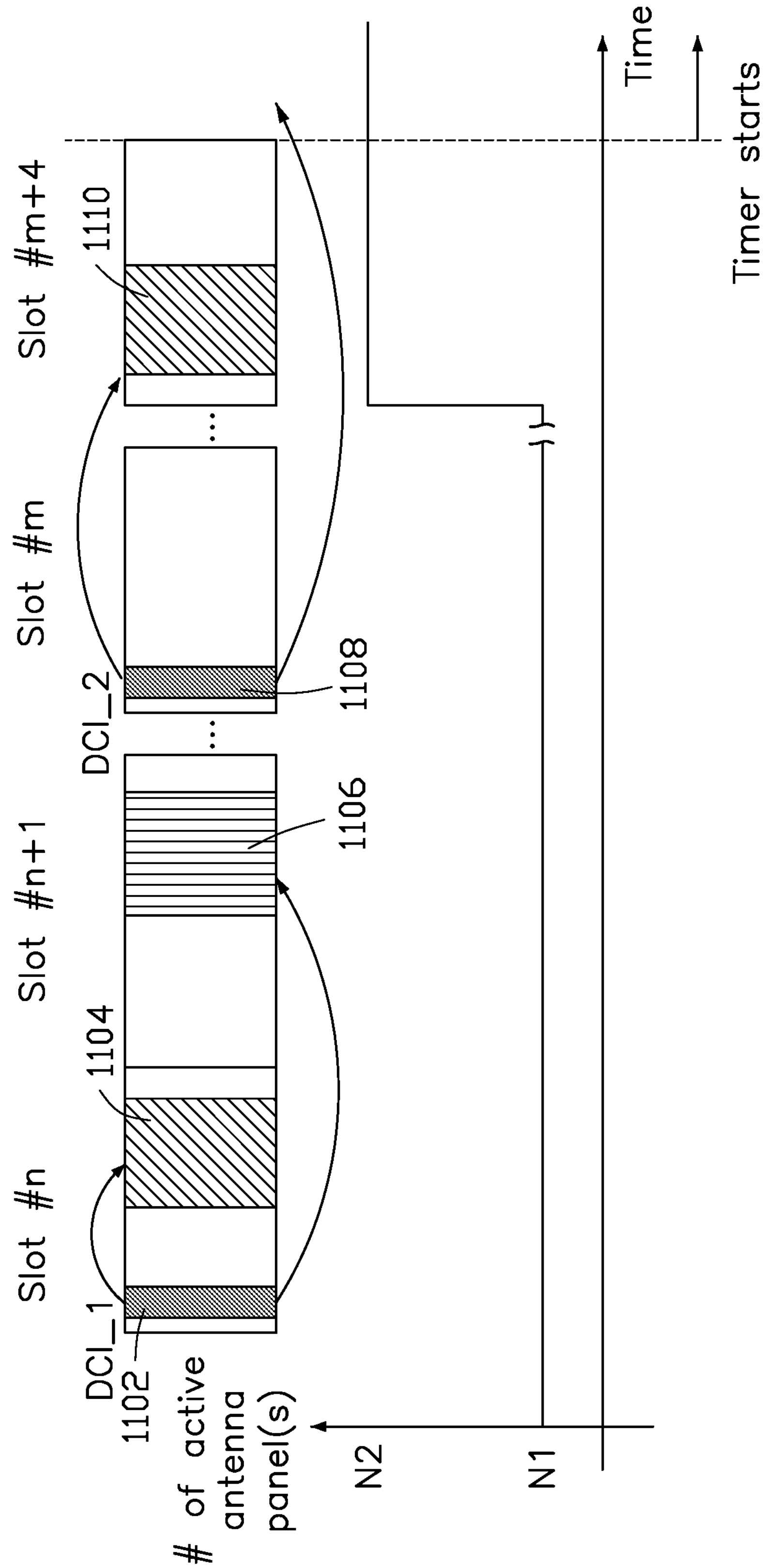
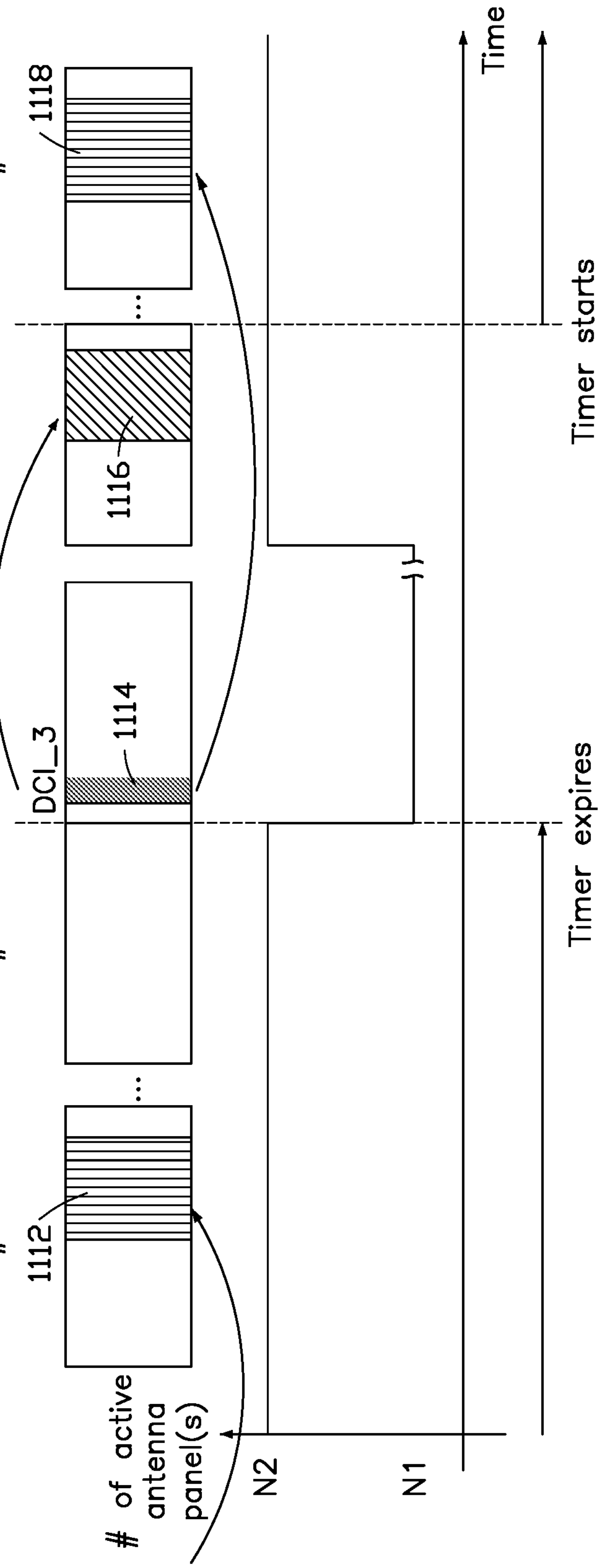

Slot #n
Slot #n+1
Slot #m
Slot #m+4
DCI_1
DCI_2
1102
1104
1106
1108
1110
# of active antenna panel(s)
N2
N1
Time
Timer starts

FIG. 11A



Slot #m+6
Slot #m+8
Slot #m+9
Slot #m+13
Slot #k
1112
1114
1116
1118
DCI_3
# of active antenna panel(s)
N2
N1
Time
Timer expires
Timer starts

FIG. 11B

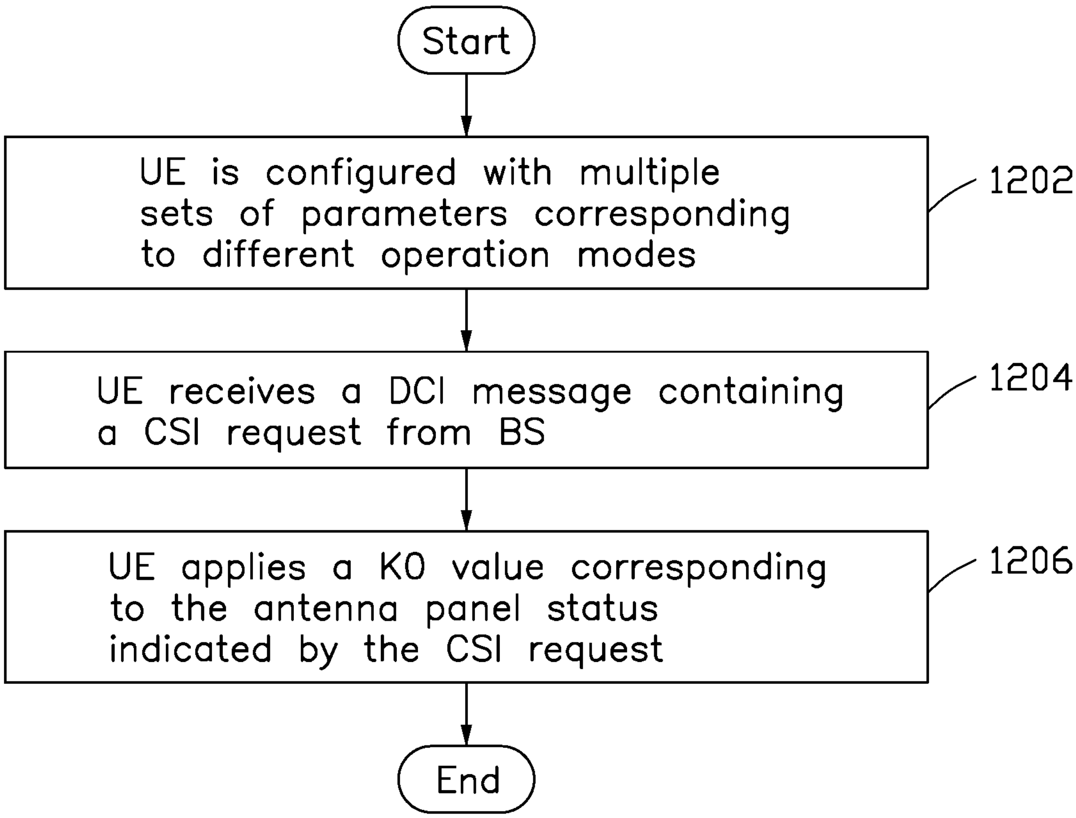

Start
UE is configured with multiple sets of parameters corresponding to different operation modes
1202
UE receives a DCI message containing a CSI request from BS
1204
UE applies a K0 value corresponding to the antenna panel status indicated by the CSI request
1206
End

FIG. 12

1302

- NZP-CSI-RS-ResourceSet
  - aperiodicTriggeringOffset
    - index:10

1304

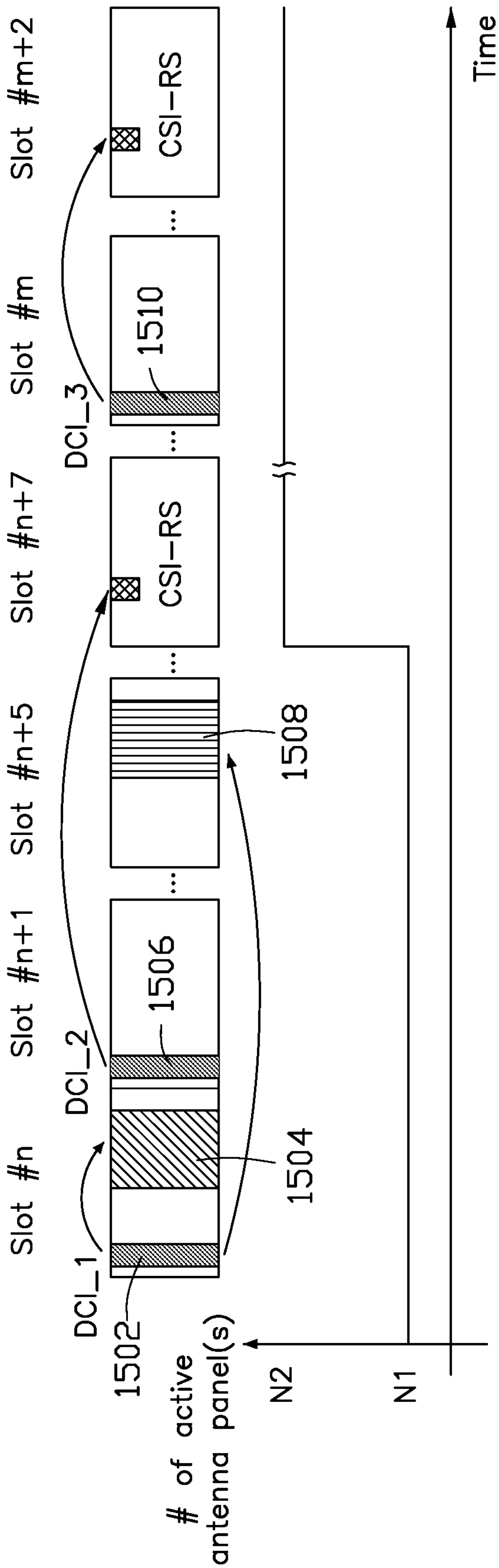
Row index	K0(normal,long)
00	(0 slot, 4 slots)
01	(1 slot, 4 slots)
10	(2 slot, 6 slots)
11	(3 slot, 7 slots)

FIG. 13

1402

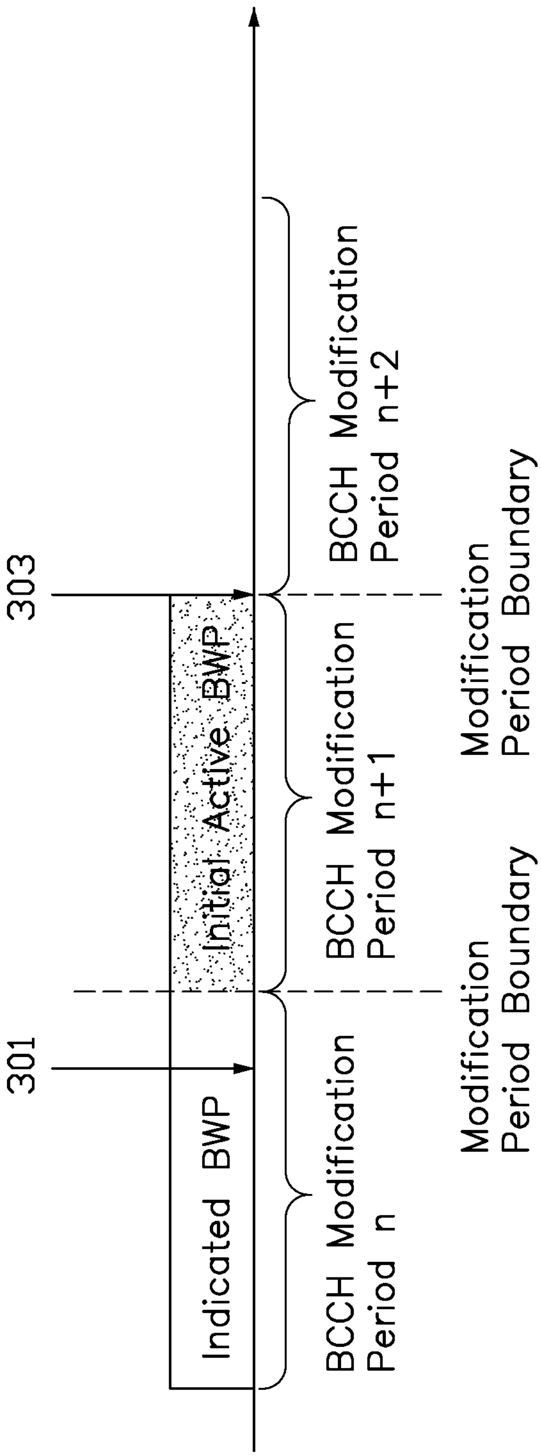
R	R	Cell ID	C	
R	R	00000	0	OCT 1

FIG. 14



Slot #n
Slot #n+1
Slot #n+5
Slot #n+7
Slot #m
Slot #m+2
DCI_1
DCI_2
DCI_3
CSI-RS
CSI-RS
1502
1504
1506
1508
1510
# of active antenna panel(s)
N2
N1
Time

FIG. 15



303
301
Initial Active BWP
Indicated BWP
BCCH Modification Period n+2
BCCH Modification Period n+1
BCCH Modification Period n
Modification Period Boundary
Modification Period Boundary

FIG. 3

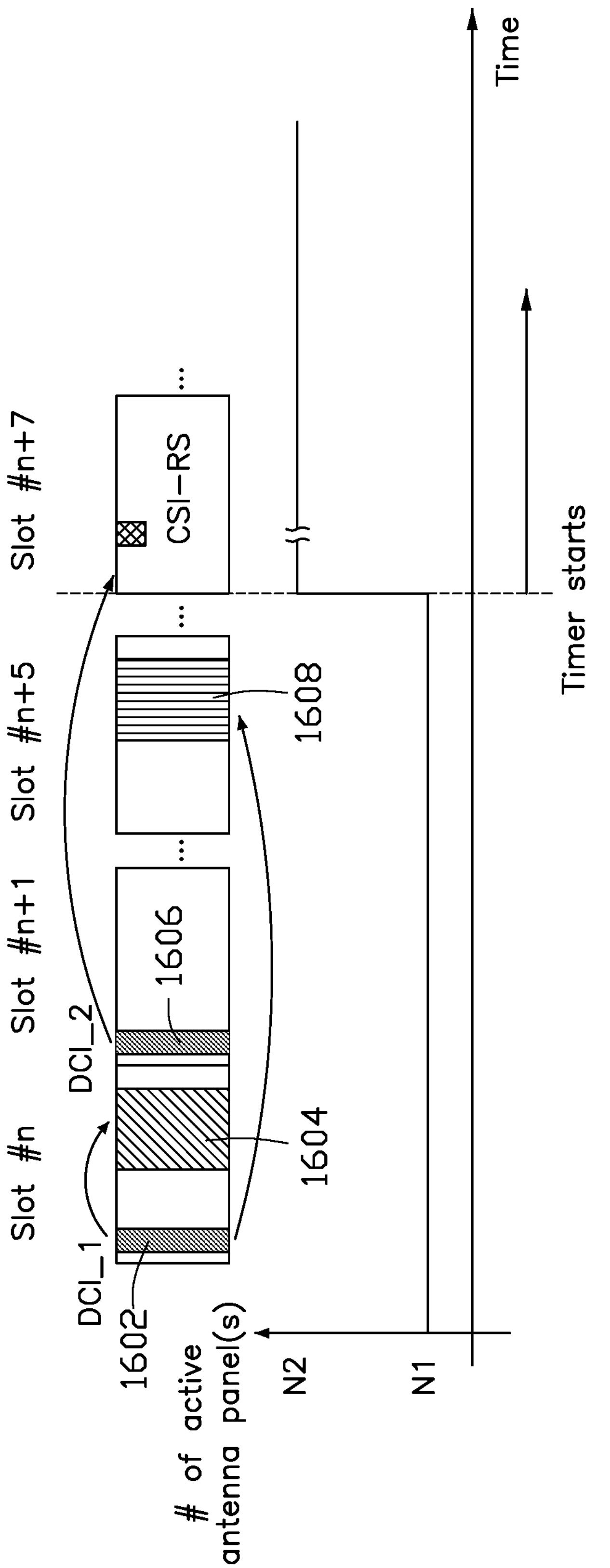

Slot #n
Slot #n+1
Slot #n+5
Slot #n+7
DCI_1
DCI_2
1602
1604
1606
1608
CSI-RS
Time
Timer starts
# of active antenna panel(s)
N2
N1

FIG. 16A

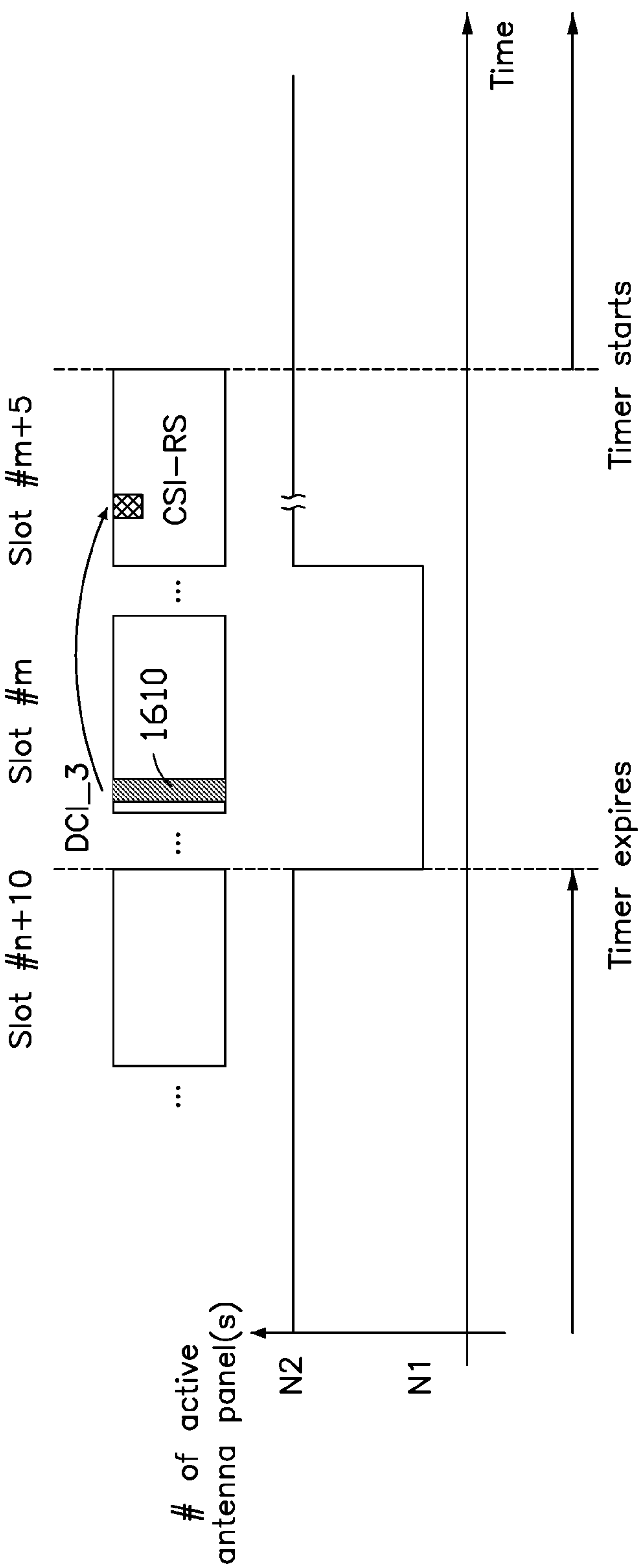
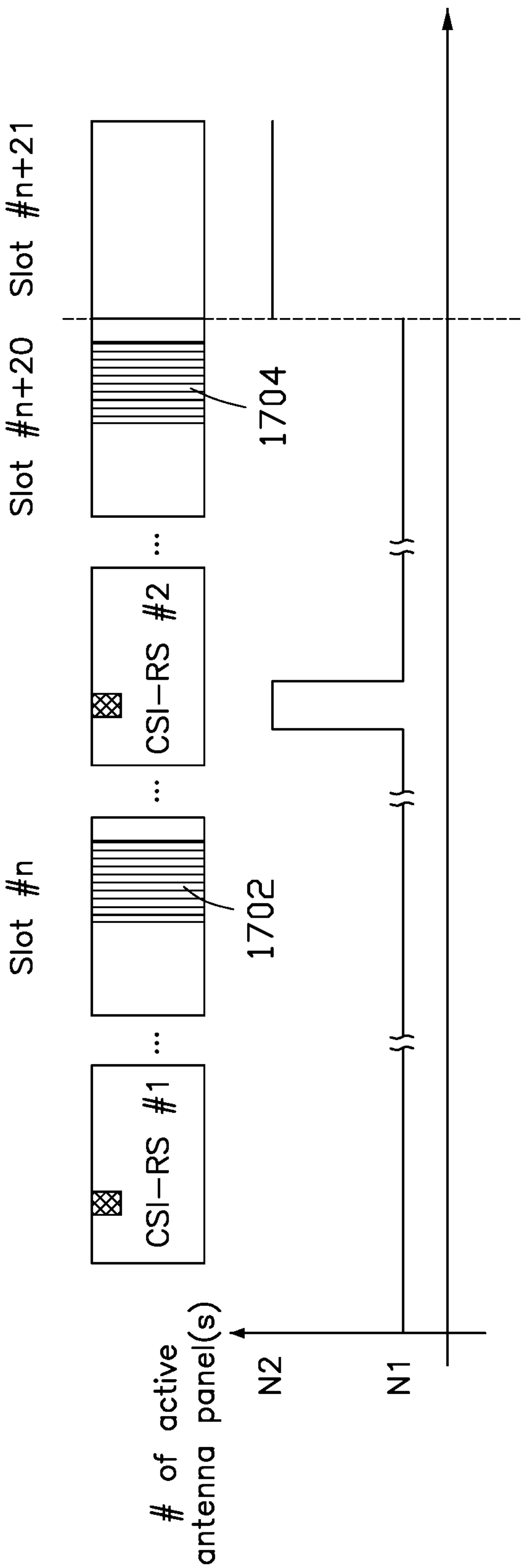

Time
Timer starts
Timer expires
Slot #m+5
Slot #m
Slot #n+10
CSI-RS
DCI_3
1610
# of active antenna panel(s)
N2
N1

FIG. 16B



Slot #n+21
Slot #n+20
Slot #n
1704
1702
CSI-RS #2
CSI-RS #1
# of active antenna panel(s)
N2
N1

FIG. 17

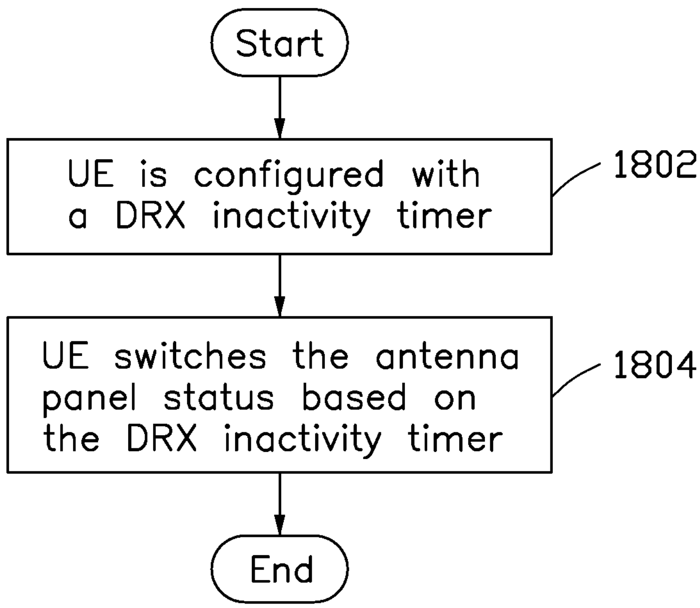

Start
UE is configured with a DRX inactivity timer
1802
UE switches the antenna panel status based on the DRX inactivity timer
1804
End

FIG. 18

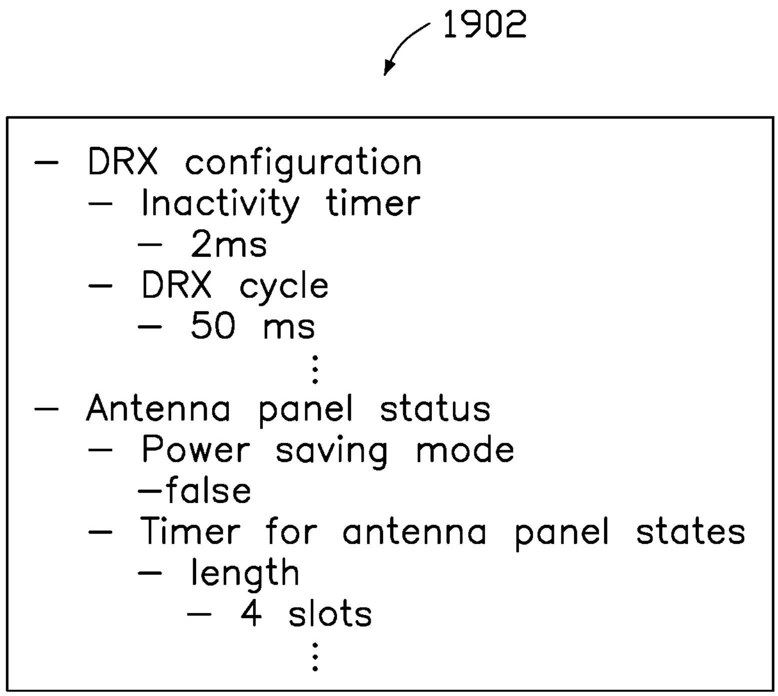

1902
– DRX configuration
– Inactivity timer
– 2ms
– DRX cycle
– 50 ms
⋮
– Antenna panel status
– Power saving mode
–false
– Timer for antenna panel states
– length
– 4 slots
⋮

FIG. 19

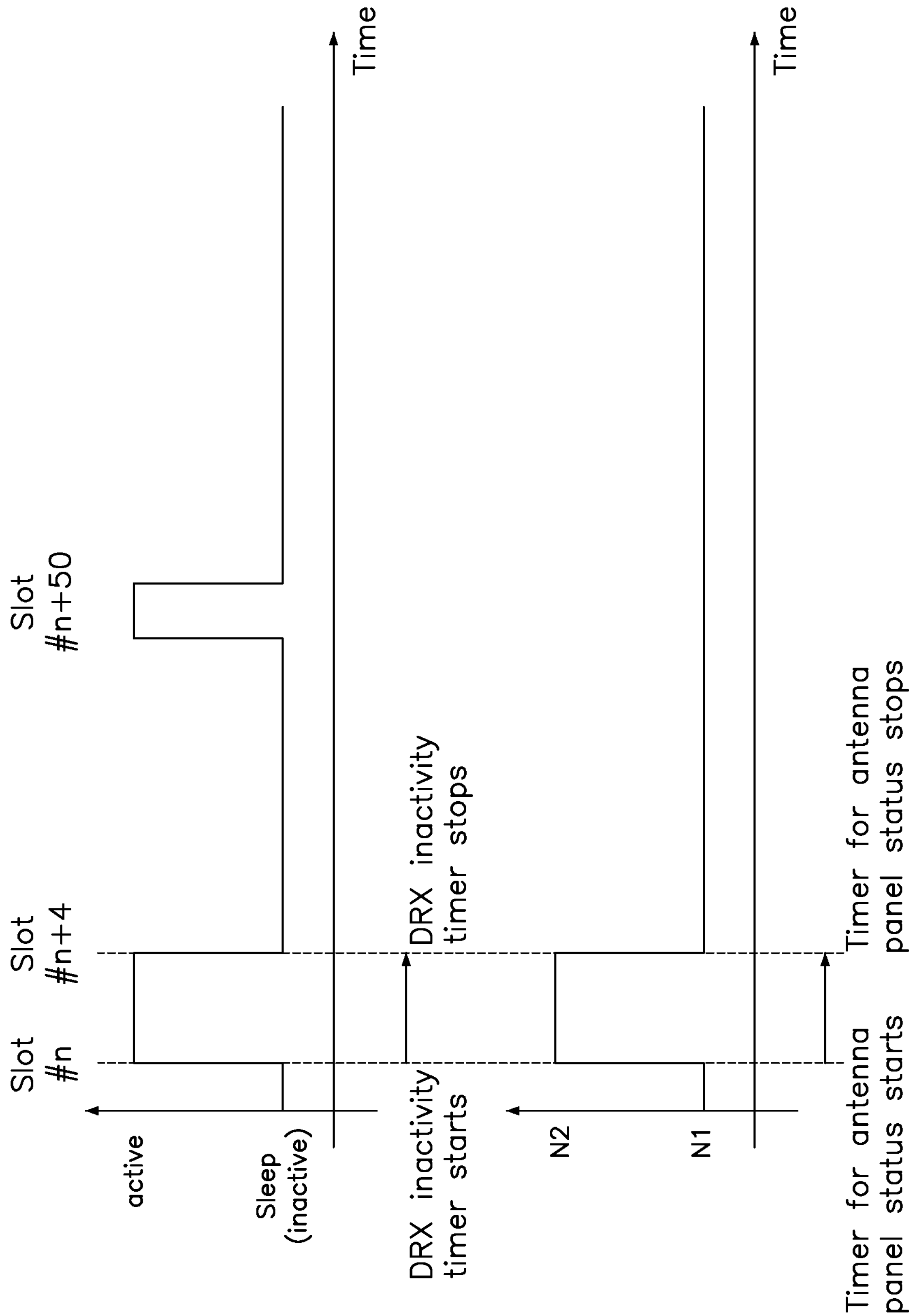

Slot
#n
Slot
#n+4
Slot
#n+50
active
Sleep
(inactive)
Time
DRX inactivity
timer starts
DRX inactivity
timer stops
N2
N1
Time
Timer for antenna
panel status starts
Timer for antenna
panel status stops

FIG. 20

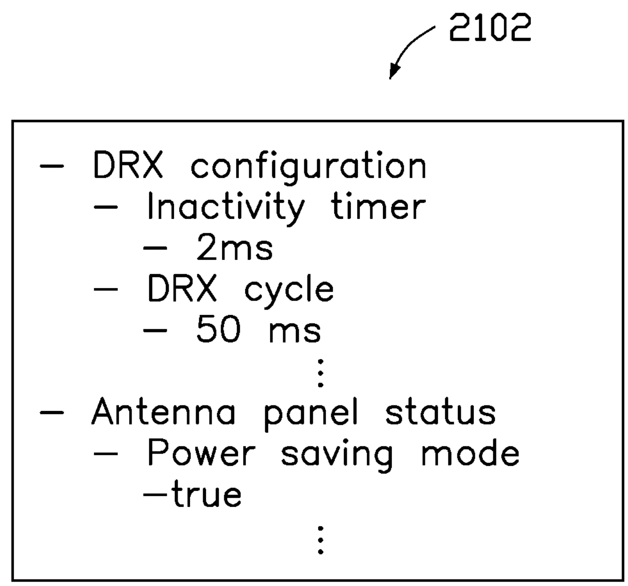

2102
– DRX configuration
– Inactivity timer
– 2ms
– DRX cycle
– 50 ms
– Antenna panel status
– Power saving mode
–true

FIG. 21

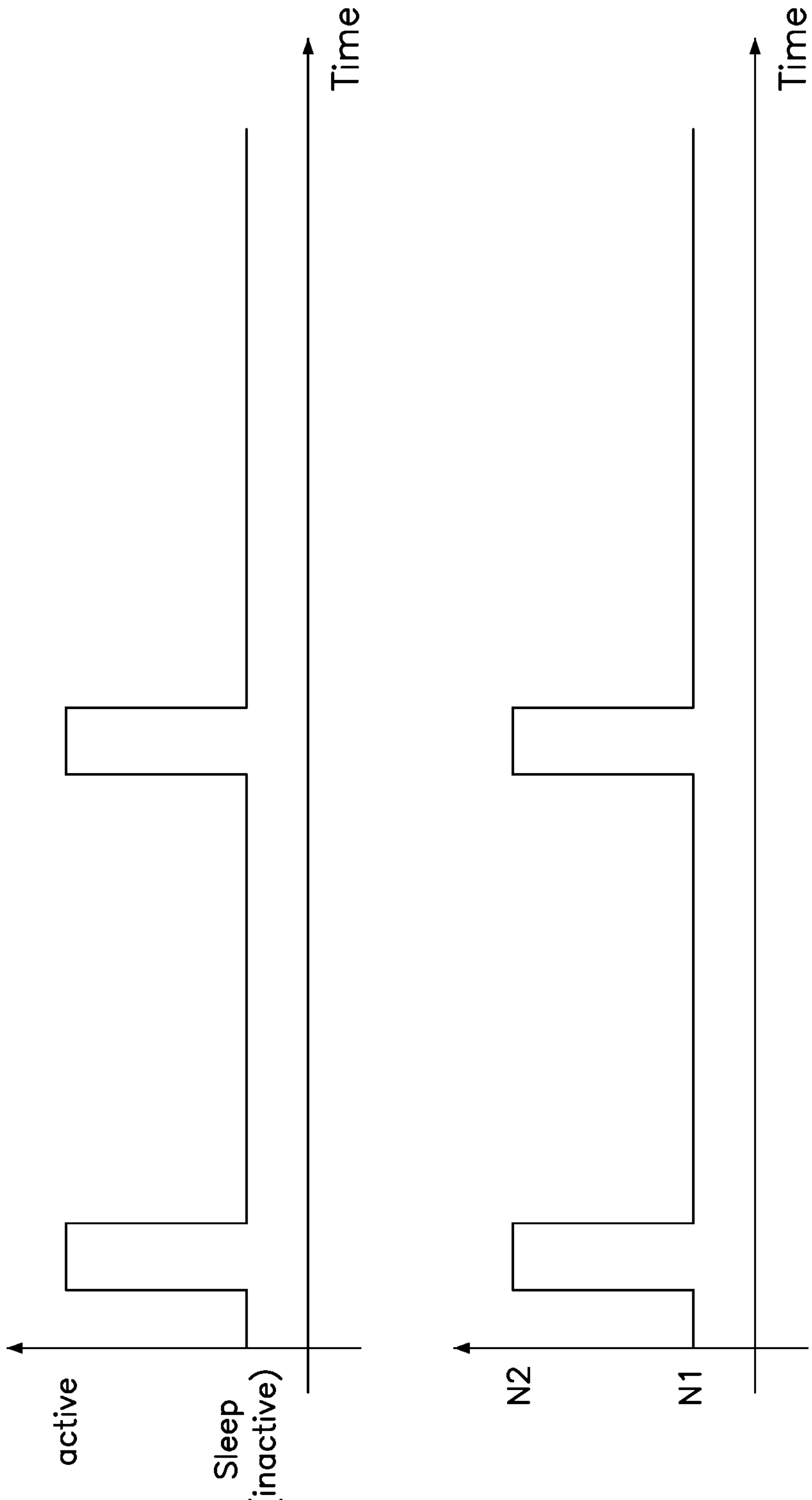


FIG. 22

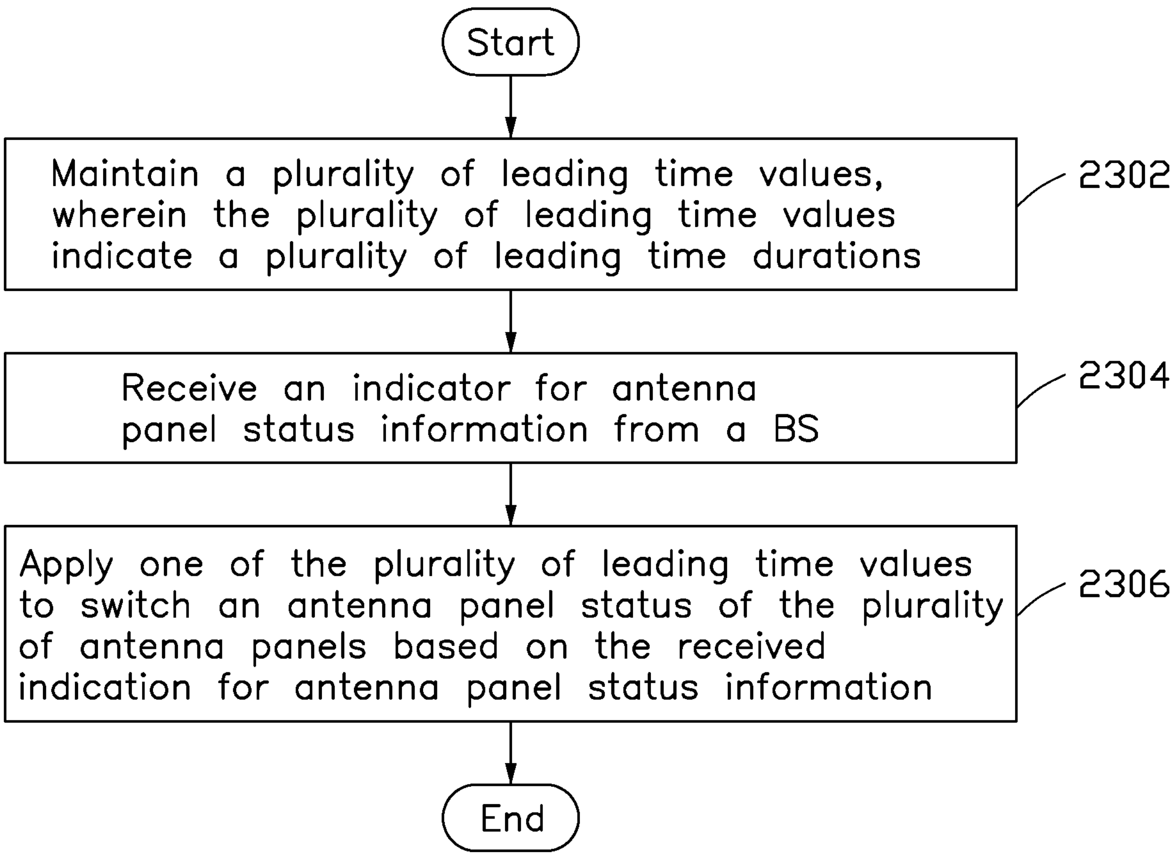

Start
Maintain a plurality of leading time values, wherein the plurality of leading time values indicate a plurality of leading time durations
2302
Receive an indicator for antenna panel status information from a BS
2304
Apply one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the received indication for antenna panel status information
2306
End

FIG. 23

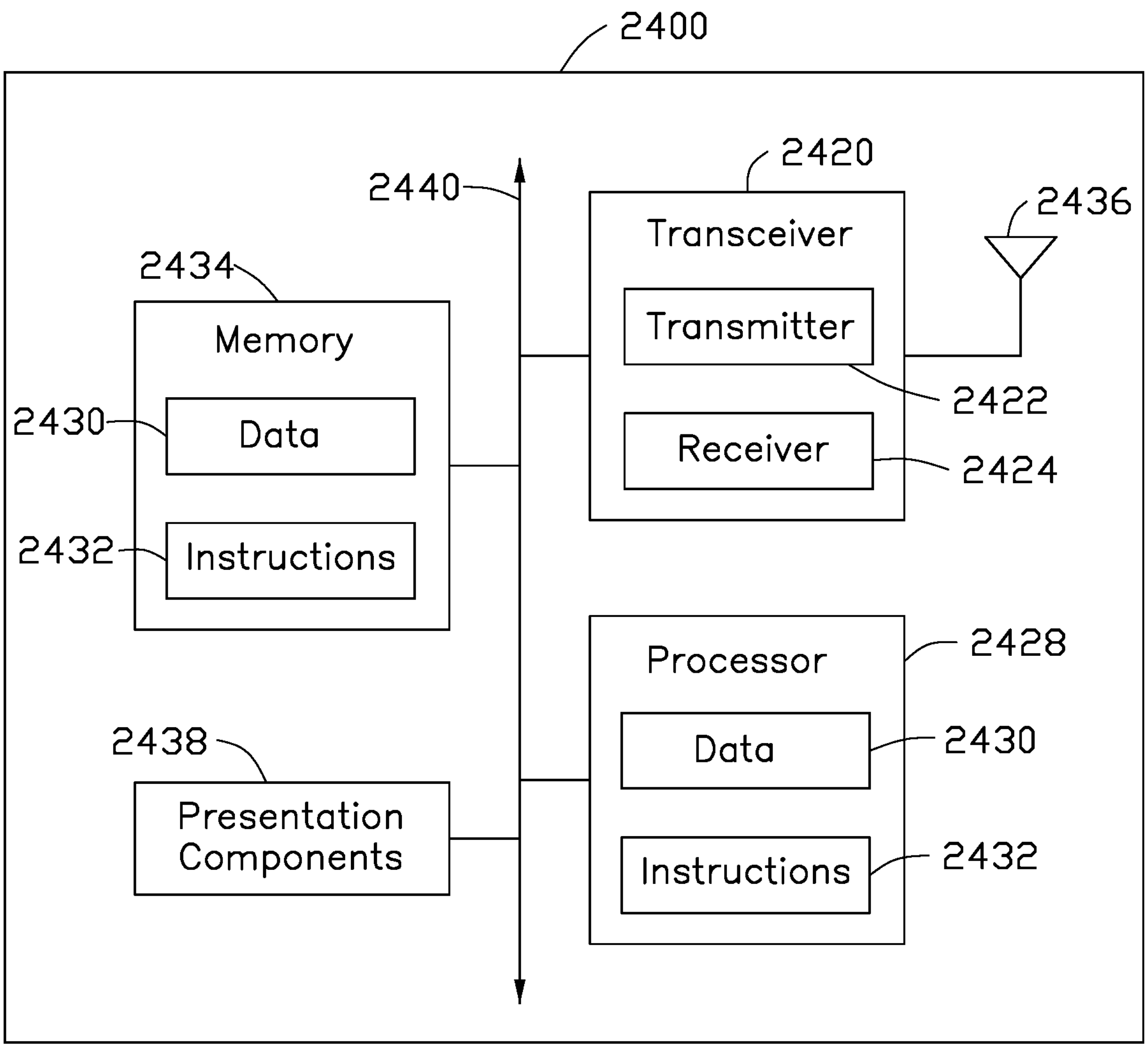

2400
2440
2420
Transceiver
2436
Transmitter
2434
Memory
2422
2430
Data
Receiver
2424
2432
Instructions
Processor
2428
2438
Data
2430
Presentation Components
Instructions
2432

FIG. 24

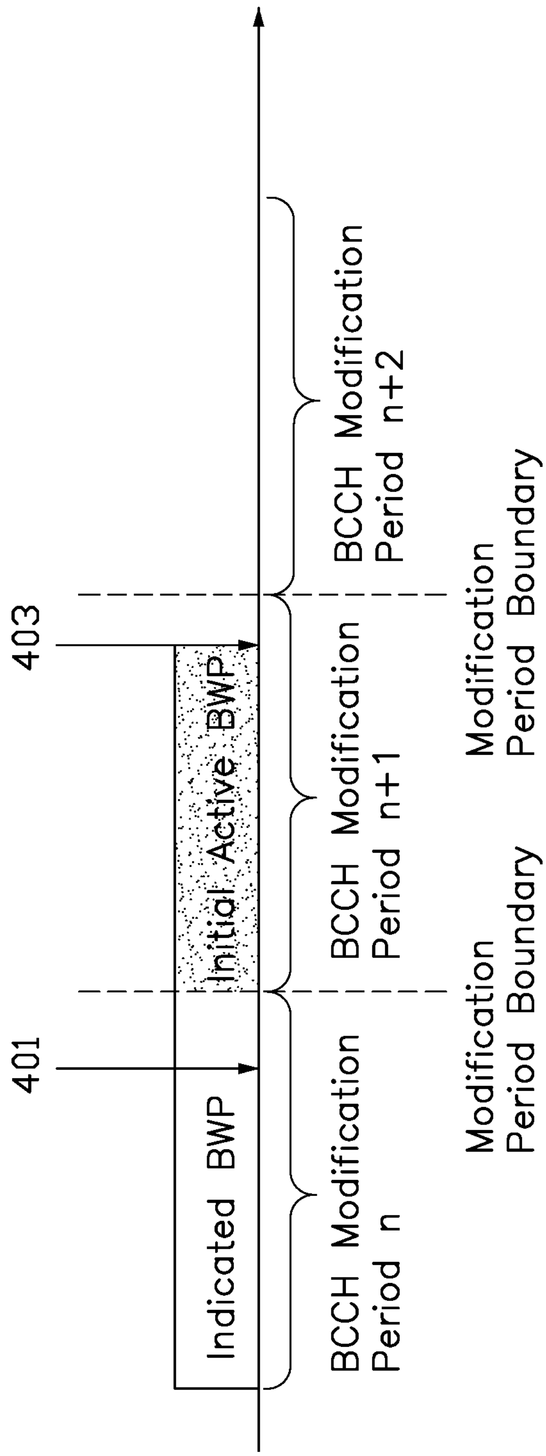

403
401
Initial Active BWP
Indicated BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary

FIG. 4

METHODS AND APPARATUSES FOR OPERATING MULTIPLE ANTENNA PANELS

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present application claims the benefit of and priority to a provisional U.S. Patent Application Ser. No. 62/699,465 filed on Jul. 17, 2018, entitled "Method and Apparatus for leading time of beam switching for multi-panel transmission,".

FIELD

The present disclosure generally relates to wireless communications, and more particularly, to methods and apparatuses for operating multiple antenna panels.

BACKGROUND

Various efforts have been made to improve different aspects of wireless communications (e.g., data rate, latency, reliability, mobility, etc.) for the next generation (e.g., 5G New Radio (NR)) wireless communication systems. Multi Input Multi Output (MIMO) is one of the key features in the next generation wireless communication systems. With the MIMO technology, a number of antenna panels at the transceiver/receiver can bring extra degrees of freedom to increase the data throughput, beamforming gain and coverage.

However, due to the lack of proper signaling mechanisms, the network may not know the current antenna panel status (e.g., how many and/or which of the antenna panels of the user device is turned on/off) at the UE side, resulting in a reduced scheduling performance.

Hence, there is a need in the art for an improved signaling mechanism for operating multiple antenna panels.

SUMMARY

The present disclosure is directed to methods and apparatuses for operating multiple antenna panels.

According to an aspect of the present disclosure, a wireless communication device is provided. The wireless communication device includes a plurality of antenna panels and a processor coupled to the antenna panels. The processor is configured to maintain a plurality of leading time values. The plurality of leading time values may indicate a plurality of leading time durations. The processor is further configured to receive an indicator for antenna panel status information from a base station (BS), and apply one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the indicator for antenna panel status information.

According to another aspect of the present disclosure, a method for operating a plurality of antenna panels is provided. The method includes maintaining, by a wireless communication device, a plurality of leading time values. The plurality of leading time values indicates a plurality of leading time durations. The method further includes receiving, by the wireless communication device, an indicator for antenna panel status information from a BS, and applying, by the wireless communication device, one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the indicator for antenna panel status information.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. Various features are not drawn to scale. Dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

FIG. **1** is a schematic diagram illustrating a wireless communication device including a number of antenna panels, in accordance with example implementations of the present disclosure.

FIG. **2** is a schematic diagram illustrating a timeline of an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIG. **3** is a schematic diagram illustrating a timeline of an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIG. **4** is a schematic diagram illustrating a timeline of an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIG. **5** is an example data structure indicating user equipment (UE) capability information, in accordance with example implementations of the present disclosure.

FIG. **6** is an example data structure indicating a configuration of a timer for antenna panel status, in accordance with example implementations of the present disclosure.

FIG. **7** is a flowchart for a method of selecting a scheduling offset value based on a Transmission Configuration Indicator (TCI) state indicated by a BS, in accordance with example implementations of the present disclosure.

FIG. **8** is an example data structure indicating TCI state configuration, in accordance with example implementations of the present disclosure.

FIG. **9** is an example data structure of an indicator for antenna panel status, in accordance with example implementations of the present disclosure.

FIGS. **10**A and **10**B are schematic diagrams illustrating timelines of an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIGS. **11**A and **11**B are schematic diagrams illustrating timelines of an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIG. **12** is a flowchart for a method of selecting an offset value for receiving an aperiodic Channel State Information Reference Signal (CSI-RS), in accordance with example implementations of the present disclosure.

FIG. **13** is an example data structure indicating an aperiodic CSI RS reception configuration, in accordance with example implementations of the present disclosure.

FIG. **14** is an example of a Media Access Control (MAC)-Control Element (CE) message, in accordance with example implementations of the present disclosure.

FIG. **15** is a schematic diagram illustrating that different triggering offset values are applied for the changes in an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIGS. **16**A and **16**B are schematic diagrams illustrating that different triggering offset values are applied for the changes in an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIG. **17** is a schematic diagram illustrating a timeline of an antenna panel status of a wireless communication device, in accordance with example implementations of the present disclosure.

FIG. **18** is flowchart for a method for determining an antenna panel status of a wireless communication device based on a Discontinuous Reception (DRX) operation, in accordance with example implementations of the present disclosure.

FIG. **19** is an example data structure indicating a Radio Resource Control (RRC) configuration for a UE, in accordance with example implementations of the present disclosure.

FIG. **20** is a schematic diagram illustrating a timeline of an antenna panel status of a wireless communication device and a timing diagram of a DRX cycle, in accordance with example implementations of the present disclosure.

FIG. **21** is an example data structure indicating an RRC configuration for a UE, in accordance with example implementations of the present disclosure.

FIG. **22** is a schematic diagram illustrating a timeline of an antenna panel status of a wireless communication device and a timing diagram of a DRX cycle, in accordance with example implementations of the present disclosure.

FIG. **23** is a flowchart for a method of operating multiple antenna panels, in accordance with example implementations of the present disclosure.

FIG. **24** is a block diagram illustrating a node for wireless communication, in accordance with various aspects of the present disclosure.

DETAILED DESCRIPTION

The following description contains specific information pertaining to example implementations in the present disclosure. The drawings in the present disclosure and their accompanying detailed description are directed to merely example implementations. However, the present disclosure is not limited to merely these example implementations. Other variations and implementations of the present disclosure will occur to those skilled in the art. Unless noted otherwise, like or corresponding elements among the figures may be indicated by like or corresponding reference numerals. Moreover, the drawings and illustrations in the present disclosure are generally not to scale and are not intended to correspond to actual relative dimensions.

For the purpose of consistency and ease of understanding, like features are identified (although, in some examples, not shown) by numerals in the example figures. However, the features in different implementations may be differed in other respects, and thus shall not be narrowly confined to what is shown in the figures.

The description uses the phrases "in one implementation," or "in some implementations," which may each refer to one or more of the same or different implementations. The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The term "comprising," when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the equivalent. The expression "at least one of A, B and C" or "at least one of the following: A, B and C" means "only A, or only B, or only C, or any combination of A, B and C."

Additionally, for the purposes of explanation and non-limitation, specific details, such as functional entities, techniques, protocols, standard, and the like are set forth for providing an understanding of the described technology. In other examples, detailed description of well-known methods, technologies, system, architectures, and the like are omitted so as not to obscure the description with unnecessary details.

Persons skilled in the art will immediately recognize that any network function(s) or algorithm(s) described in the present disclosure may be implemented by hardware, software or a combination of software and hardware. Described functions may correspond to modules may be software, hardware, firmware, or any combination thereof. The software implementation may comprise computer executable instructions stored on computer readable medium such as memory or other type of storage devices. For example, one or more microprocessors or general-purpose computers with communication processing capability may be programmed with corresponding executable instructions and carry out the described network function(s) or algorithm(s). The microprocessors or general-purpose computers may be formed of applications specific integrated circuitry (ASIC), programmable logic arrays, and/or using one or more digital signal processor (DSPs). Although some of the example implementations described in this specification are oriented to software installed and executing on computer hardware, nevertheless, alternative example implementations implemented as firmware or as hardware or combination of hardware and software are well within the scope of the present disclosure.

The computer readable medium includes but is not limited to random access memory (RAM), read only memory (ROM), erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), flash memory, compact disc read-only memory (CD-ROM), magnetic cassettes, magnetic tape, magnetic disk storage, or any other equivalent medium capable of storing computer-readable instructions.

A radio communication network architecture (e.g., a long term evolution (LTE) system, an LTE-Advanced (LTE-A) system, an LTE-Advanced Pro system, or a 5G New Radio (NR) Radio Access Network) typically includes at least one BS, at least one UE, and one or more optional network elements that provide connection towards a network. The UE communicates with the network (e.g., a core network (CN), an evolved packet core (EPC) network, an Evolved Universal Terrestrial Radio Access network (E-UTRAN), a 5G Core (5GC), or an internet), through a radio access network (RAN) established by one or more BSs.

It should be noted that, in the present application, a UE may include, but is not limited to, a mobile station, a mobile terminal or device, a user communication radio terminal. For example, a UE may be a portable radio equipment, which includes, but is not limited to, a mobile phone, a tablet, a wearable device, a sensor, a vehicle, or a personal digital assistant (PDA) with wireless communication capability. The UE is configured to receive and transmit signals over an air interface to one or more cells in a radio access network.

A BS may be configured to provide communication services according to at least one of the following Radio Access Technologies (RATs): Worldwide Interoperability for Microwave Access (WiMAX), Global System for Mobile communications (GSM, often referred to as 2G), GSM EDGE radio access Network (GERAN), General Packet Radio Service (GRPS), Universal Mobile Telecommunication System (UMTS, often referred to as 3G) based on basic Wideband-Code Division Multiple Access (W-CDMA), High-Speed Packet Access (HSPA), LTE, LTE-

A, eLTE (evolved LTE, e.g., LTE connected to 5GC), New Radio (NR, often referred to as 5G), and/or LTE-A Pro. However, the scope of the present application should not be limited to the above-mentioned protocols.

A BS may include, but is not limited to, a Node B (NB) as in the UMTS, an evolved Node B (eNB) as in the LTE or LTE-A, a Radio Network Controller (RNC) as in the UMTS, a Base Station Controller (BSC) as in the GSM/GERAN, a ng-eNB as in an E-UTRA BS in connection with the 5GC, a next generation Node B (gNB) as in the 5G-RAN, and any other apparatus capable of controlling radio communication and managing radio resources within a cell. The BS may connect to serve the one or more UEs through a radio interface to the network.

The BS is operable to provide radio coverage to a specific geographical area using a plurality of cells forming the radio access network. The BS supports the operations of the cells. Each cell is operable to provide services to at least one UE within its radio coverage. More specifically, each cell (often referred to as a serving cell) provides services to serve one or more UEs within its radio coverage (e.g., each cell schedules the downlink and optionally uplink resources to at least one UE within its radio coverage for downlink and optionally uplink packet transmissions). The BS can communicate with one or more UEs in the radio communication system through the plurality of cells. A cell may allocate Sidelink (SL) resources for supporting Proximity Service (ProSe) or Vehicle to Everything (V2X) service. Each cell may have overlapped coverage areas with other cells.

As discussed above, the frame structure for NR is to support flexible configurations for accommodating various next generation (e.g., 5G) communication requirements, such as enhanced Mobile Broadband (eMBB), massive Machine Type Communication (mMTC), Ultra-Reliable and Low-Latency Communication (URLLC), while fulfilling high reliability, high data rate and low latency requirements. The orthogonal frequency-division multiplexing (OFDM) technology as agreed in the 3^{rd} Generation Partnership Project (3GPP) may serve as a baseline for NR waveform. The scalable OFDM numerology, such as the adaptive sub-carrier spacing, the channel bandwidth, and the Cyclic Prefix (CP) may also be used. Additionally, two coding schemes are considered for NR: (1) Low-Density Parity-Check (LDPC) code and (2) polar code. The coding scheme adaption may be configured based on the channel conditions and/or the service applications.

Moreover, it is also considered that in a transmission time interval TX of a single NR frame, a Downlink (DL) transmission data, a guard period, and an uplink (UL) transmission data should at least be included, where the respective portions of the DL transmission data, the guard period, the UL transmission data should also be configurable, for example, based on the network dynamics of NR. In addition, SL resource may also be provided in an NR frame to support ProSe services or V2X services.

In addition, the terms “system” and “network” herein may be used interchangeably. The term “and/or” herein is only an association relationship for describing associated objects and represents that three relationships may exist. For example, A and/or B may indicate that: A exists alone, A and B exist at the same time, and B exists alone. In addition, the character “/” herein generally represents that the former and latter associated objects are in an “or” relationship.

NR power saving is an issue which have been identified in the 3GPP meetings. The objective of this issue is to minimize the power consumption with an improved wake up/go-to-sleep mechanism, and to reduce the power consumption during the network access phase when a UE operates in the RRC_CONNECTED mode. In some power saving schemes the focus is on minimizing the dominate factors of power consumption during the network access phase. Such dominate factors may include, for example, the processing of an aggregated bandwidth, the active Radio Frequency (RF) chain number, the active reception/transmission time, and the dynamic transition to a power efficient mode. In the majority cases of LTE scenarios, since little to no data may be transmitted in a Transmission Time Interval (TTI), a power saving scheme which is capable of dynamically adapting different data arrivals in the RRC_CONNECTED mode may be needed. The dynamic adaptation to the data traffic may be implemented in different dimensions, such as carriers, antennas, beamforming mechanisms, and bandwidths.

Furthermore, approaches to enhance the transition between a normal power consumption mode and a power saving mode may be needed to be considered. For example, both the network-assisted and the UE-assisted approaches may be considered for the UE's power saving mechanism.

Issues related to the leading time for beam switching may affect the power consumption. The leading time for beam switching is, or may reflect, the minimum required time for a UE to set up its antenna panel(s) for providing an indicated RX/TX beam to receive or transmit data. For example, the leading time for beam switching may be the time period between the time the UE receives a command that leads to a change(s) in the Rx beam/antenna panel status and the time that the change(s) actually occurs. In some of the present implementations, if a TCI state has not yet activated by a MAC-CE, the indicated mapping (between the TCI states and the codepoints of a Downlink Control Information (DCI) field “Transmission Configuration Indicator”) should be applied starting from a specific time point (e.g., slot n+3 ms+1), when a Hybrid Automatic Repeat Request Acknowledgement (HARQ-ACK) (which is corresponding to a Physical Downlink Shared Channel (PDSCH) which carries the activation command) is transmitted in the slot n. In some of such implementations, this specific time point may be used as the starting time point of a leading time for beam switching. In some of the present implementations, if the TCI state has been activated by a MAC-CE, the leading time for beam switching may have the same starting time point as the scheduling offset. The scheduling offset, in some implementations, may be a time duration starting from the end of the last symbol of a Physical Downlink Control Channel (PDCCH) to the beginning of the first symbol of a PDSCH.

In addition, the beam switching delay may affect a UE's power consumption in the Frequency Range 2 (FR2). In order for the UE to optimize the power consumption, the UE may need to be given a sufficient leading time for beam switching. For example, the leading time for beam switching may be two milliseconds (ms) from the time a beam switch command is received (e.g., for a control-channel-based way) or acknowledged (e.g., for a MAC-CE based way) to the time the beam switch is completed.

In some implementations of the present disclosure, there may be at least three ms between two consecutive commands indicating a beam switch. Such time value may be adjusted if a longer time value is needed. In addition, from the time the UE receives the beam switch command to the time the UE switches its beam/antenna panel status, the UE may still use the active Rx beam for data reception, and there may be no interruption in the communication with the BS (e.g., a gNB).

FIG. **1** is a schematic diagram illustrating a wireless communication device (e.g., a UE) including a number of antenna panels, in accordance with example implementations of the present disclosure. As shown in FIG. **1**, a wireless communication device **100** includes four antenna panels **102**, **104**, **106** and **108**. The antenna panels described herein may be referred to antenna arrays or antenna ports. The antenna arrays may include a number of physical antennas, while the antenna ports may not correspond to physical antennas, but rather may be logical entities distinguished by their channel models.

The ON/OFF state of each antenna panel **102**, **104**, **106** and **108** may be switched by the wireless communication device **100**. Depending on the ON/OFF state of each antenna panel **102**, **104**, **106** and **108**, the antenna panels **102**, **104**, **106** and **108** may have different antenna panel status. For example, the antenna panel status of the antenna panels **102**, **104**, **106** and **108** may be determined as a first antenna panel status if only the antenna panel **102** is turned on and the other antenna panels **104**, **106** and **108** are turned off, and determined as a second antenna panel status if all of the antenna panels **102**, **104**, **106** and **108** are turned on. It should be noted that the wireless communication device **100** including four antenna panels **102**, **104**, **106** and **108** in FIG. **1** is for illustrative purposes only, and not intended to limit the scope of the present invention. That is, a wireless communication device (e.g., the wireless communication device **100**) may include a different number of antenna panels than 4 (e.g., 6 panels, 8 panels, etc.) in some of the present implementations. Furthermore, the antenna panel status of the antenna panels of the wireless communication device may be defined arbitrarily based on the ON/OFF states and/or the number of the antenna panels.

In many cases, a BS (e.g., a gNB) may not know the current antenna panel status of the UE, which causes some issues since the BS always have to consider the worst case for the UE to perform the beam switching. For example, the BS may need to configure the UE with a leading time for beam switching which is much longer than a leading time the UE actually needs. As the leading time becomes longer, the efficiency and flexibility of the UE's operations may get lower. Hence, a signaling mechanism that helps the BS to obtain the antenna panel status of the UE may enhance the power consumption.

Another issue is related to the scheduling offset values. From Radio layer 1's (RAN1's) perspective, if a UE is configured with a "tci-PresentInDCI" Information Element (IE) set to "enabled" (for a Coreset Resource Set (CORESET) that schedules a PDSCH), the UE may assume that the TCI field is present in the DCI format 1_1 (which is transmitted over the PDCCH of the CORESET). On the other hand, if the tci-PresentInDCI IE is not configured for the CORESET (or the tci-PresentInDCI IE is set to "disabled"), or the PDSCH is scheduled by a DCI format 1_0 (e.g., for determining the PDSCH antenna port's QCL), the UE may assume that the TCI state applied for receiving the PDSCH is identical to the TCI state applied for receiving the PDCCH of the CORESET. In addition, if the tci-PresentInDCI IE is set to "enabled" and the PDSCH is scheduled by the DCI format 1_1, the UE may apply a TCI state which is indicated by the DCI to determine the QCL of the antenna port for the PDSCH. This is because the TCI state may indicate the QCL type and the QCL Reference Signal (RS) corresponding to the RX beam for receiving the PDSCH. If the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than a scheduling offset value (e.g., a threshold called "Threshold-Sched-Offset"), the UE may assume that the antenna ports of one Demodulation Reference Signal (DM-RS) port group of a PDSCH of a serving cell may be QCLed with the RS(s) that is associated with the QCL type parameter(s) given by the indicated TCI state. For DL transmissions, the scheduling offset may be referred as a time period starting from the end of a PDCCH to the beginning of a PDSCH. For example, the scheduling offset may be a time period that starts from the first symbol after the end of the PDCCH to the first symbol of the PDSCH scheduled by the PDCCH. In some implementations of the present disclosure, the scheduling offset value may be determined based on the UE's capability.

However, for a scheduling offset value configured for a UE that includes only one antenna panel (or a single-antenna-panel UE), such value may not fulfill the leading time for beam switching required by another UE that includes multiple antenna panels (or a multiple-antenna-panel UE). Thus, a mechanism that is able to deal with how the UE determines which scheduling offset value (e.g., Threshold-Sched-Offset) to be applied may be needed.

Another issue is related to Sounding Reference Signal (SRS) transmission. Specifically, for aperiodic SRS transmissions and aperiodic CSI-RS receptions, the UE may need to follow the aperiodic slot triggering offset configured in the SRS resource set configuration and the CSI-RS resource set configuration, respectively. Considering that a longer leading time may be applied to the power saving operation in the multiple-antenna-panel cases, the required triggering offset configured for the single-antenna-panel cases and the multiple-antenna-panel cases may be different. Although a BS can solve this issue by configuring multiple triggering offset values for one resource set, it might cause overhead that occupies some bitfields of a DCI trigger state for an SRS request and/or a CSI request. Hence, a mechanism for determining the triggering offset of the aperiodic SRS/CSI-RS transmissions may be needed.

In addition, for SRS transmissions, a UE may be configured to switch its antenna panel status for a sounding procedure for a DL CSI acquisition. If the UE is configured with a higher layer parameter such as "SRS-SetUseusage (or SRS-usage)" in an SRS resource set (e.g., SRS-ResourceSet), and the SRS-SetUseusage (or SRS-usage) is set as "antennaSwitching," the UE may be configured with one of the following configurations depending on the UE's capability: 1TX2RX, 2TX4RX, 1TX4RX, 1TX4RX/2TX4RX, and TX=RX. The BS may configure the UEs having different capabilities with different number of SRS resource sets which contain different SRS resources. For example, for a UE configured with the 1TX2RX configuration, the BS may configure one SRS resource set which may contain two SRS resources. Since the UE needs to select and switch to the TX for transmission, there may be a guard period between each SRS transmission. The guard period may be one or two symbols, depending on the numerology of the SRS resource. However, if the UE has multiple antenna panels and at least parts of the antenna panels are turned off for power saving, the guard period for one or two symbols may not fulfill the leading time of at least 2 ms for turning on the antenna panel(s). Hence, a mechanism for the UE to perform antenna switching may be needed.

In accordance with some implementations of the present disclosure, methods and apparatuses provide techniques for addressing the above-noted issues.

For example, techniques are described for determining the scheduling offset value(s). As described above, the leading time for beam switching may be the minimum required time for a UE to set up the antenna panels for providing an indicated RX/TX beam to receive/transmit the data. If the scheduling offset of a DL/UL RSs/channel reception/transmission cannot fulfill the leading time requirement, the UE may not be able to transmit/receive the RSs/channel successfully. In some implementations of the present disclosure, the leading time may be related to the antenna panel status. In addition, different values of the leading time may be predefined in the 3GPP technical specification(s) for each or all of the antenna panel statuses. For example, each antenna panel status may have its own leading time value. In another example, all antenna panel statuses may have the same leading time value. In some implementations of the present disclosure, the UE may report the required leading time for each or all of the antenna panel statuses. In some implementations of the present disclosure, the UE may be configured with the required leading time by the BS for each or all of the antenna panel statuses.

In some implementations of the present disclosure, the antenna panel status may contain information about how many antenna panels at the UE are used for performing the data reception/transmission of the channel/RSs, or how many antenna panels at the UE are used/active/turned on in a particular time period.

In some implementations of the present disclosure, an indicator for antenna panel status may be transmitted by the BS to indicate to a UE whether to enable/disable a power saving mode or a normal power consumption mode. In the power saving mode, the UE may turn on a smaller number of antenna panels than that in the normal power consumption mode. For example, the UE may turn on only one antenna panel when operating in the power saving mode and turn on all of its antenna panels when operating in the normal power consumption mode.

It should be noted that the two operation modes (e.g., the power saving mode and the normal power consumption mode) described herein is for illustrative purposes and not intended to limit the present invention. For example, the UE may be operable in a number of operation modes different than two. In addition, if only the power saving mode and the normal power consumption mode are involved in the power control scheme of the UE, the UE may enter the normal power consumption mode when the power saving mode is disabled. In contrast, the UE may enter the power saving mode when the normal power consumption mode is disabled.

In some implementations of the present disclosure, the indicator for antenna panel status information may include a single-bit IE. The UE may enable the power saving mode when the single-bit IE is set to a first value, and disable the power saving mode when the single-bit IE is set to a second value. The total number of turn-on/active antenna panels when the power saving mode is enabled may be less than that when the power saving mode is disabled.

In some implementations of the present disclosure, the indicator for antenna panel status information may include a multiple-bit IE. The UE may be configured to turn on a particular number of the antenna panels when the multiple-bit IE is set to a particular value.

In some implementations of the present disclosure, the indicator for antenna panel status transmitted by the BS may be used for indicating which antenna panel status the UE is to apply.

In some implementations of the present disclosure, if the UE is instructed by the BS to perform data reception using multiple antenna panels when the UE is in the power saving mode, the UE may need to apply a longer leading time than a normal leading time. Hence, in accordance with the present disclosure, some techniques are provided for ensuring that the BS and the UE have the same understanding on the antenna panel status of the UE. In some implementations of the present disclosure, the antenna panel status may be used for indicating, explicitly or implicitly, how many, or which, of the antenna panels of the UE are turned on (or active, or able to transmit and receive data), and/or how many, or which, of the antenna panels of the UE are turned off (or inactive, or not able to transmit and receive data).

In some implementations of the present disclosure, the antenna panel status of a UE may be affected by Bandwidth Part (BWP) related operations. The UE may enable the power saving mode or the normal power consumption mode based on whether the UE operates in a particular BWP. For example, when the UE operates on a default, an initial, or a first active DL/UL BWP, the UE may always enable the normal power consumption mode or the power saving mode.

In some implementations of the present disclosure, before the UE receives an RRC configuration/a MAC-CE message/a DCI message for setting the UE's antenna panels status, the UE may operate in the power saving mode or the normal power consumption mode. In some implementations of the present disclosure, the UE may apply the power saving mode or the normal power consumption mode for the antenna panels before the UE reports the UE's capability about the antenna panels.

As described above, in some implementations of the present disclosure, the indicator for antenna panel status may be a single bit IE used for indicating whether the UE is in the power saving mode or not. For example, the UE may be configured with an available number of antenna panels for each BWP configuration. Once the UE receives the indicator for antenna panel status (e.g., in the form of a single bit IE) being set to a first value (e.g., the bit value "0"), the UE may turn on only part of the antenna panels to operate in the power saving mode. In contrast, if the indicator for antenna panel status is set to a second value (e.g., the bit value "1"), the UE may turn on all of the antenna panels to enable the normal power consumption mode (or disable the power saving mode).

In some implementations of the present disclosure, the indicator for antenna panel status may be a multiple-bit IE used for indicating the antenna panels status to the UE. For example, if the UE includes four antenna panels (e.g., the antenna panels **102**, **104**, **106** and **108** shown in FIG. **1**), the bit field of the indicator for antenna panel status may be set as "00" to indicate that all of the antenna panels are turned off/inactive, or set as "01" to indicate that only one antenna panel is active, or set as "10" to indicate that only two antenna panels are active, or set as "11" to indicate that all antenna panels are active. While the indicator for antenna panel status described herein is used to indicate to the UE to turn on a particular number of antenna panels, there are other ways to use the indicator for antenna panel status in some implementations of the present disclosure. For example, the indicator for antenna panel status may be used to indicate to the UE to turn on/off which one or ones of the antenna panels. In addition, it should be noted the examples described herein are not intended for limiting the present invention. For example, the indicator for antenna panel status may have a number of bits, with each bit corresponding to a particular antenna panel status.

The indicator for antenna panel status may be transmitted from the BS to the UE via a DCI message, a MAC-CE massage, or through RRC signaling. For example, the indicator for antenna panel status information may be contained in a TCI state ID indicated by the BS. In some implementations of the present disclosure, the value of the indicator for antenna panel status may be updated and transmitted by the UE to the BS via an Uplink Control Information (UCI) message, a MAC-CE massage, or through RRC signaling.

In some implementations of the present disclosure, the RRC configuration that contains the indicator for antenna panel status may be an independent IE configured per UE-basis. For example, the RRC configuration may be the same for one cell or one cell group. In such cases, the RRC configuration may be a cell level or cell group level configuration. In another example, the RRC configuration may be configured in a specific frequency range. For example, the RRC configuration may only exist in the FR2.

In some implementations of the present disclosure, the UE may choose a leading time for beam switching based on the antenna panel status. For example, during an RRC reconfiguration period, or before the UE receives the first RRC configuration (e.g., while the UE attempts to establish an RRC connection after a successful initial access, or while the UE performs an initial access procedure), the UE may apply a default value of the leading time. Such default value may be predefined in the 3GPP technical specification (e.g., "3 ms" defined in NR Release-15) and determined as the UE's capability for beam switching in the power saving mode. In another example, the UE may apply the longest leading time configured in a UE capability list during this period. In another example, the BS may send an indicator to the UE through an RRC configuration (e.g., powerPrefIndicationConfig), and the UE may transmit or report the current antenna panel status to the BS via another indicator (e.g., powerPrefIndication). For example, the UE may transmit an antenna panel status report to inform the BS of a change in the antenna panel status. For example, the antenna panel status report may be contained in a beam report or a Channel State Information (CSI) report. In some implementations of the present disclosure, the antenna panel status report may include a single-bit IE. The UE may set the single-bit IE to a first value to indicate that a power saving mode is enabled and set the single-bit IE to a second value to indicate that the power saving mode is disabled. In some implementations of the present disclosure, the antenna panel status report may include a multiple-bit IE. The UE may set the multiple-bit IE to a particular value when a particular number of the plurality of antenna panels are turned on.

In some implementations of the present disclosure, the BS may keep the antenna panel status report from the UE and adjust the scheduling offset based on the antenna panel status report. In some implementations of the present disclosure, the BS may configure the UE with a prohibit timer to prevent the UE from reporting the antenna panel status too frequently. The prohibit timer may be used when the UE reports the antenna panel status to the BS through the RRC message (s), MAC-CE massage(s) or DCI message(s). In some implementations of the present disclosure, the prohibit timer may start at the first subframe/slot/OFDM symbol after the UE reports the antenna panel status. For example, the prohibit timer may start at the first subframe/slot/OFDM symbol after a physical resource (e.g., a Physical Uplink Control Channel (PUCCH) or a Physical Uplink Share Channel (PUSCH)) that contains of the antenna panel status report of the UE. In addition, in some implementations of the present disclosure, the UE may not report another antenna panel status when the prohibit timer is running.

In some implementations of the present disclosure, the prohibit timer may be bidirectional. For example, the prohibit timer may start when the antenna panel status transition from the normal power consumption mode to the power saving mode, and vice versa. In some implementations of the present disclosure, the prohibit timer may be unidirectional. For example, the prohibit timer may only start when a specific power preference transition occurs (e.g., transitioning from the power saving mode to the normal power consumption mode). In some implementations of the present disclosure, the prohibit timer may be configured separately for different kinds of power preference transitions.

In some implementations of the present disclosure, the BS may configure multiple antenna panel status to a UE via an RRC configuration, and the BS may indicate one of the multiple antenna panel status through a MAC-CE message (e.g., which is called a "MAC-CE approach"). For example, if the UE is configured with four antenna panel statuses by the RRC configuration, the BS may send a MAC-CE message to indicate to the UE to use one of these four antenna panel statuses. In addition, the BS may assume that the UE may follow the leading time for the indicated antenna panel status during the time period between the reception of the MAC-CE message and the reception of another MAC-CE message that contains an indicator for antenna panel status for switching the antenna panel status.

In some implementations of the present disclosure, the UE may maintain multiple leading time values configured by the BS or predefined in the 3GPP technical specification. These leading time values may be cell-specific values or cell group-specific values.

In some implementations of the present disclosure, after the UE receives the RRC configuration, but before receiving a MAC-CE massage for activation, the UE may apply one of the leading time values configured in an RRC configuration (if the leading time values are configured in the RRC configuration by the BS) as a default value of the leading time.

In some implementations of the present disclosure, more than one antenna panel status may be collected in a list of entries. For example, each of the entries may refer to a particular antenna panel status, and each antenna panel status may be associated with a particular leading time value.

In some implementations of the present disclosure, the default value of the leading time may refer to the first entry (e.g., the entry indexed by "0") in the list of entries in the RRC configuration. In some implementations of the present disclosure, the default value of the leading time may refer to an entry for the longest leading time in the RRC configuration (if the leading time value is RRC-configured).

In some implementations of the present disclosure, a MAC-CE massage containing a number of zero bits may be used. This MAC-CE massage may be used for turning on (or "enabling") or turning off (or "disabling") the power saving mode. The UE may distinguish this MAC-CE massage based on, for example, a Logical Channel Identity (LCID).

In some implementations of the present disclosure, at least one of the following items may be included in a MAC-CE massage: a cell Identity (ID), a BWP ID, and an indicator for antenna panel status. The UE may apply an antenna panel status indicated by the MAC-CE message after the UE transmits an HARQ-ACK to the BS.

In some implementations of the present disclosure, the BS may configure multiple antenna panel statuses to a UE via an RRC configuration, and the BS may indicate one of the multiple antenna panel statuses through a DCI message (e.g., which is called a "DCI approach"). For example, if the UE is configured with eight different antenna panel statuses in the RRC configuration, the BS may transmit a DCI message which may contain an indicator for antenna panel status to the UE to indicate to the UE to use one of the eight antenna panel statuses in the RRC configuration.

In some implementations of the present disclosure, if a UE is configured with multiple leading time values by the BS, the UE may apply one of the leading time values contained in an RRC configuration as a default leading time value after the UE receives the RRC configuration (but before receiving the DCI message). Similar to the MAC CE approach, the default leading time value may refer to the first entry of the multiple antenna panel statuses in the RRC configuration (e.g., the entry with an index value of "0"), or an entry with the longest leading time in the RRC configuration.

In some implementations of the present disclosure, the BS may use a MAC-CE message to select a subset of the leading time values from the RRC configuration and indicate one of the selected leading time value(s) by a DCI message. For example, the BS may configure 16 antenna panel statuses in an RRC configuration, and the BS may transmit a MAC-CE massage to select four of these 16 antenna panel statuses in the RRC configuration. The BS may further transmit a DCI message to indicate to the UE to use one of the four selected antenna panel statuses.

In some implementations of the present disclosure, irrespective of where the leading time values are configured, the BS may need to ensure that the triggering/scheduling offset for the DL/UL channels/signals can fulfill the requirement of leading time for switching the antenna panel status. From UE's perspective, the UE may not be expected to receive data from the BS during the scheduling offset period.

In some implementations of the present disclosure, the antenna panel status may be associated with the TCI states. For example, in addition to the QCL information, some TCI states may further contain the antenna panel status (e.g., which is indicated by an explicit bit). In addition, the maximum number of the TCI states in an RRC configuration, or a DCI message, may be expanded since the BS may need more TCI state(s) to indicate different antenna panel statuses for the same QCL information. For example, if the maximum number of TCI states is expanded from 64 to 96, the TCI state #63 may be used to represent a signal-antenna-panel status which is QCLed with the CSI-RS resource #1, and the TCI state #64 may be used to represent a multi-antenna-panel status which is QCLed with the same CSI-RS resource #1. In some implementations of the present disclosure, once the QCL information of a DL/UL RS/channel is configured with a TCI state (e.g., the TCI state #64) for multiple antenna panels, the UE may attempt to receive/transmit the DL/UL RS/channel based on a leading time for beam switching for the multiple antenna panels.

In some implementations of the present disclosure, a TCI state table may be used when the UE performs data reception/transmission by multiple antenna panels. For example, the BS may configure the UE with multiple TCI state tables. The number of entries in each TCI state table may be the same or different. The UE may select a specific TCI state table from these TCI state tables based on a MAC-CE massage (e.g., used in the MAC-CE approach) or a DCI message (e.g., used in the DCI approach). For example, if the UE receives a DCI message which contains an explicit bit (e.g., used as an indicator for antenna panel status) for indicating the UE to enable the power saving mode, the UE may attempt to receive the PDSCH using a single antenna panel, instead of using multiple antenna panels. In addition, the UE may further apply a leading time corresponding to using the single antenna panel.

In some implementations of the present disclosure, a timer may be used to determine the switch of the antenna panel status. For example, the UE may receive a timer from the BS and switch the antenna panel status from a first antenna panel status to a second antenna panel status after the timer expires. For example, when the timer expires, the UE may transition from the normal power consumption mode (e.g., in which the UE turns on N2 antenna panels) to the power saving mode (e.g., in which the UE turns on N1 antenna panel(s), where N1 is less than N2). In another example, the UE may transition from the power saving mode to the normal power consumption mode when the timer expires.

In some implementations of the present disclosure, the timer may expire when a DRX inactivity timer expires or the UE enters a DRX off-period/sleep mode.

FIG. **2** is a schematic diagram illustrating a timeline of the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure.

In the present implementation, a timer for antenna panel status may (re)start at the first symbol after the end of the PDCCH. As shown in FIG. **2**, in the slot # n, the UE receives an indicator for antenna panel status via a DCI message which is transmitted over a PDCCH **202**. The indicator for antenna panel status may indicate to the UE to switch from a power saving mode (in which there are only N1 antenna panel(s) is active/turned on) to a normal power consumption mode (in which there are N2 antenna panels are active/turned on), where N2 is greater than N1.

As shown in FIG. **2**, there is a time gap **21** between the time the UE receives the indicator for antenna panel status from the PDCCH **202** and the time the UE actually turns on the N2 antenna panels. The time gap **21** may reflect the time required for the UE to turn on the antenna panel(s). In some implementations of the present disclosure, the time gap **21** may be deemed as the leading time for beam switching of the UE.

In some implementations of the present disclosure, the UE may start the timer for antenna panel status at the first symbol after the last symbol of the PDCCH **202** monitor occasion. Also, the UE may further receive a PDSCH **204** scheduled by the PDCCH **202** in the same slot # n.

Before the timer expires, the BS may assume that the UE may keep the antenna panel status indicated by the PDCCH **202**, or applied for the PDSCH **204**. Once the timer expires, the BS may assume that the UE may return to the power saving mode. As shown in FIG. **2**, in the slot # n+2, after the timer expires, the UE may transmit a PUCCH **206** indicated by the PDCCH **202** in the power saving mode.

In some implementations of the present disclosure, if the UE is instructed by the BS to operate in the power saving mode, the timer may not start. In addition, the indicator for antenna panel status may be implemented as any implicit/explicit data structure. For example, the indicator for antenna panel status may include a single-bit IE or a multiple-bit IE or may be contained in a beam report or a CSI report.

In some other implementations of the present disclosure, the timer for antenna panel status may start at different time points, as shown in FIGS. **3** and **4**.

FIG. **3** is a schematic diagram illustrating a timeline of the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure. In the present implementation, the timer for antenna panel status may start at the first symbol after the end of a PUCCH. As shown in FIG. **3**, in the slot

n, the UE receives an indicator for antenna panel status via a DCI message which is transmitted over a PDCCH **302**. The UE may further receive a PDSCH **304** which is scheduled by the PDCCH **302** in the same slot # n.

The indicator for antenna panel status may indicate to the UE to switch from a power saving mode (in which there are only N1 antenna panel(s) is turned on) to a normal power consumption mode (in which there are N2 antenna panels are turned on, where N2 is greater than N1). As shown in FIG. **3**, there is a time gap **31** between the time the UE receives the indicator for antenna panel status from the PDCCH **302** and the time the UE actually turns on the N2 antenna panels. As described above, the time gap **31** may reflect the time required for the UE to turn on the antenna panel(s). In addition, the time gap **31** may be deemed as the leading time for beam switching of the UE.

In the present implementation, the UE may start the timer at the first symbol after the last symbol of a PUCCH **306** monitor occasion. Similar to the implementations provided with reference to FIG. **2**, before the timer expires, the BS may assume that the UE may keep the antenna panel status indicated by the PDCCH **302**, or applied for the PDSCH **304**. Once the timer expires, the BS may assume that the UE may return to the power saving mode. As shown in FIG. **3**, in the slot # n+4, after the timer expires, the UE may turn off (N2−N1) antenna panels to go back to the power saving mode.

FIG. **4** is a schematic diagram illustrating a timeline of the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure. In the present implementation, the timer for antenna panel status may start at the first symbol after the end of a PDSCH. As shown in FIG. **4**, in the slot # n, the UE may receive an indicator for antenna panel status via a DCI message which is transmitted over a PDCCH **402**. The UE may further receive a PDSCH **404**, which is scheduled by the PDCCH **402** in the same slot # n. Then, the UE may transmit a PUCCH **406**, which is indicated by the PDCCH **402**, in the slot # n+2.

The indicator for antenna panel status may indicate to the UE to switch from a power saving mode (in which there are only N1 antenna panel(s) is turned on) to a normal power consumption mode (in which there are N2 antenna panels are turned on, where N2 is greater than N1). As shown in FIG. **4**, there is a time gap **41** between the time the UE receives the indicator for antenna panel status from the PDCCH **402** and the time the UE actually turns on the N2 antenna panels. As noted above, the time gap **41** may reflect the time required for the UE to turn on the antenna panel(s). In addition, the time gap **41** may be deemed as the leading time for beam switching of the UE.

As described above, the UE may start the timer at the first symbol after the last symbol of the PDSCH **404**. Before the timer expires, the BS may assume that the UE may keep the antenna panel status indicated by the PDCCH **402** or applied for the PDSCH **404**. Once the timer expires, the BS may assume that the UE may return to the power saving mode. As shown in FIG. **4**, in the slot # n+4, after the timer expires, the UE may turn off certain antenna panel(s) to transition to the power saving mode.

The timer for antenna panel status may count based on an absolute time unit (e.g., ms), a time slot, a subframe, or an OFDM symbol. In some implementations of the present disclosure, if the timer counts based on a time slot or an OFDM symbol, the numerology of the time unit may be determined based on the PDCCH which carries the scheduling information, or based on the PDSCH/RSs/PUSCH/PUCCH which is scheduled by the PDCCH.

In some implementations of the present disclosure, the timer for antenna panel status may be an optional feature for the UE. For example, the BS may decide whether to configure the timer to the UE based on the UE's capability. In addition, if the UE is not configured with the timer for antenna panel status, the UE may not automatically switch the antenna panel status (e.g., return to the power saving mode automatically). In such a case, the UE may follow the most recently received indicator for antenna panels status (e.g., contained in a DCI message, a MAC-CE massage, or an RRC configuration) from the BS to determine the antenna panels status, until the UE sends a request to the BS and/or receives another indicator for antenna panels status from the BS. In some implementations of the present disclosure, the BS may not configure the UE with the timer for antenna panel status. In such a case, if the BS does not receive a response to the indicator for antenna panel status from the UE, the BS may assume that the UE is in the power saving mode. Hence, the BS may assume that a longer leading time may be adopted by the UE, and the BS may determine a scheduling offset value for the UE based on this assumption.

Some implementations of the present disclosure are described herein for determining the scheduling offset values and the leading time values for different antenna panel statuses.

In some implementations, there is only one leading time value for each DL/UL channel/RSs reception/transmission. Such a leading time value may be defined by the UE's capability for example. However, the above-mentioned mechanism may not be suitable for a situation where the UE needs a longer leading time for beam switching. Although the BS may configure the UE with a scheduling offset that is long enough to fulfill various leading times of different antenna panel statuses, such a configuration may cause some scheduling restrictions (e.g., because the UE may not always need to use a long leading time). Hence, in accordance with some implementations of the present disclosure, some techniques are provided to improve scheduling flexibility and performance of beam switching. For example, all DL/UL channel/RSs may be configured with one or more additional scheduling/triggering offset values for the situations where the UE may need to apply a long leading time value for beam switching, such as a PDSCH scheduling offset, a CSI-RS resource reception, a PUSCH transmission, and an SRS antenna switch.

In some implementations of the present disclosure, multiple scheduling offset values may be predefined for the UE (e.g., based on the 3GPP technical specification) or contained in the RRC configuration. The UE may apply one of the scheduling offset values based on the indicator for antenna panels status received from the BS. For example, the UE may apply a first scheduling offset value for a normal leading time case (e.g., in which the UE may not require to turn on an antenna panel, or only need to turn N1 antenna panel(s)), and apply a second scheduling offset value for a long leading time case (e.g., in which UE may need to turn on all of the antenna panels, or need to turn N2 antenna panels, where N2 is greater than N1).

In some implementations of the present disclosure, the UE may receive a plurality of scheduling offset values (e.g., including the first scheduling offset value and the second scheduling offset value) from the BS. Each of the scheduling offset values may be used for indicating a time duration counting from an end of a PDCCH to a beginning of a PDSCH. The UE may receive a first DCI message for setting the antenna panel status to a first antenna panel status. In response to receiving the first DCI message, the UE may apply the first scheduling offset value to receive first information on a DL channel (e.g., a PDSCH) scheduled by the first DCI message. The UE may further receive a second DCI message for switching the antenna panel status from the first antenna panel status to a second antenna panel status. For example, the second DCI message may include an indicator for antenna panel status information. In response to receiving the second DCI message, the UE may apply the second scheduling offset value to receive second information on a second DL channel (e.g., another PDSCH) scheduled by the second DCI message.

In some implementations of the present disclosure, each DL/UL channel/RS may have its corresponding scheduling offset value. For example, in order to receive an aperiodic CSI-RS resource, the RRC configuration may include two scheduling offset values: one leading time value may be indicated as X1 slot(s) (e.g., one slot) used for a normal leading time case, and another leading time value may be indicated as X2 slots (e.g., three slots) used for a long leading time case, where X2 is greater than X1. The UE may select one of these scheduling offset values based on the indicator for antenna panel status received from the BS. In another example, in order to receive the PDSCH, the RRC configuration may include two scheduling offset values (e.g., the K0 parameters/values in the pdsch-TimeDomainResourceAllocationList IE). For example, one scheduling offset value (K0) may be indicated as X1 slot(s) for the normal leading time case, and another scheduling offset value (K0) may be indicated as X2 slots for the long leading time case. The UE may select one of the scheduling offset values based on the indicator for antenna panel status.

In some implementations of the present disclosure, the UE may receive a scheduling offset value from the BS. The scheduling offset value may include at least one of a K0 parameter/value for a DL channel (e.g., a PDSCH) and a K2 parameter/value for a UL channel (e.g., a PUSCH). If the time duration indicated by the scheduling offset value is less than the leading time duration indicated by a selected leading time value, the UE may further determine that the scheduling offset value is invalid.

In some implementations of the present disclosure, all of the DL/UL channel/RSs may apply the same leading time value for beam switching. For example, when the UE operates in the normal power consumption mode, the PUSCH transmission may be associated with a specific scheduling offset value that is used for the normal leading time case (e.g., a K2 value for determining a PUSCH transmission offset). On the other hand, the PDSCH transmission may be associated with another scheduling offset also for the normal leading time case (e.g., a K0 value for determining a PDSCH reception offset).

In contrast, when the UE operates in the power saving mode, both the PUSCH transmission and the PDSCH reception may apply the same scheduling offset value. This scheduling offset value may be predefined by the 3GPP technical specifications, or configured in the RRC configuration, or determined based on the UE's capability. In some other implementations of the present disclosure, all DL channels/RSs may apply a first scheduling offset value suitable for the long leading time case, while all UL channels/RSs may apply a second scheduling offset value also suitable for the long leading time case, where the first scheduling offset value and the second scheduling offset value may be different. In some of the present implementations, all of the DL/UL channels/RSs may be configured with an additional leading time value for a beam switch case (e.g., a PDSCH scheduling offset, a CSI-RS resource reception, a PUSCH transmission or an SRS antenna switch).

Some implementations of the present disclosure are described herein for providing techniques for helping the BS to acquire information about the antenna panel status of the UE.

In some implementations of the present disclosure, the CSI measurement/report obtained under different antenna panel statuses may be transmitted from the UE to the BS via UCI/MAC-CE messages. In the UCI case, there may be at least two ways for the UE to inform the BS of the antenna panels status. One way is to introduce a particular IE contained in the CSI report, and the other way is to reuse the reserved bit field of an IE contained in the CSI report. In addition, the UE may transmit a CSI parameter to the BS for reporting the antenna panel status. The CSI parameter may include at least one of a Precoding Matrix Indicator (PMI), a Channel Quality Indicator (CQI), a Rank Indication (RI), a Layer Indication (LI), and a Layer 1 Reference Signals Received Power (L1-RSRP).

The information used to help the BS to acquire the antenna panel status of the UE may be referred to as the UE assistance information. In some implementations of the present disclosure, the UE may transmit the UE assistance information to the BS if the UE is not configured with the timer for antenna panel status, or does not have the ability to use the timer. In some implementations of the present disclosure, the UE may transmit the UE assistance information to the BS if the UE is configured to (or have the ability to) switch its antenna panel status only when receiving the indicator for antenna panel status via a MAC-CE massage and/or an RRC message.

An example L1-RSRP report quantized table is shown as follows:

TABLE 1

Bits	RSRP range
0000000	RSRP ≥ −44 dBm
0000001	−44 dBm > RSRP ≥ −45 dBm
0000010	−45 dBm > RSRP ≥ −46 dBm
. . .	. . .
1100000	−139 dBm > RSRP ≥ −140 dBm
1100001	−140 dBm> RSRP
1100011	Antenna panel status #0
1100100	Antenna panel status #1
. . .	. . .
1111111	Reserved

As shown in Table 1, a number of the reserved bit fields (e.g., bit fields "1100011" and "1100100") in the L1-RSRP report quantized table are reused for indicating the antenna panel status. For example, if the UE reports a value of "1100011" as the largest L1 RSRP value in the L1-RSRP report, the BS may assume that the UE is in the power saving mode.

In some implementations of the present disclosure, if the UE is configured to perform a group-based beam reporting procedure (e.g., in which the UE may receive signals simultaneously via a group of RX beams), the antenna panel status of the UE may be indicated by an L1-RSRP related value (e.g., a reserved L1-RSRP value and/or a specific differential L1-RSRP value). For example, if the bit field for the largest L1-RSRP value is a reserved value (e.g., "1100011") and the differential L1-RSRP value is a special value (e.g., "0000"), the BS may assume that the UE is in the power saving mode or in a specific antenna panel status, as shown in Table 1.

In some implementations of the present disclosure, the BS may assume that the indicated antenna panel status will be applied by the UE from the first symbol after the end of the slot at which the UCI or the PUSCH of the MAC-CE massage is transmitted through. For example, if the UE is configured with a timer for antenna panel status (e.g., the timer described with reference to FIGS. **2**, **3** and **4**), this timer may start at the first symbol after the end of the slot at which the UCI or the PUSCH of the MAC-CE massage is transmitted through.

In some implementations of the present disclosure, the mechanisms described above can be applied for the cases that the BS configures the UE to measure the CSI-RS resource/SSB by a single antenna panel, whereas the UE is actually able to (or has to) apply multiple antenna panels in the time resource for receiving the CSI-RS resource/SSB. In some implementations of the present disclosure, the UE may indicate the antenna panel status to the BS via the CSI parameter of the CSI report.

In some implementations of the present disclosure, the UE may report multiple sets of CSI parameters to the BS. For example, among the multiple sets of CSI parameters, one set of the CSI parameters may include CSI parameter(s) received and obtained through a single antenna panel, while another set of the CSI parameters may include CSI parameter(s) received and obtained through multiple antenna panels.

In some implementations of the present disclosure, techniques are described herein for determining the antenna panel status of a UE based on a DRX operation.

The DRX operation is a mechanism that makes a UE discontinuously monitor/receive the PDCCH to reduce the power consumption of the UE. However, when performing the DRX operation, the UE may still need to monitor a number of RSs in a DRX off-duration or a DRX inactive period. Hence, in some implementations of the present disclosure, whether to enable the power saving mode at a UE may be determined based on the DRX operation.

In some implementations of the present disclosure, a UE may decide to operate in the power saving mode when the UE is in a DRX off-duration or a DRX inactive period. For example, a UE may enable the power saving mode when the UE operates in a DRX active time (or a DRX on-duration) and disable the power saving mode when the UE operates in a DRX inactive time (or a DRX off-duration).

In some implementations of the present disclosure, whether to operate in the power saving mode is independent of the DRX operation. For example, a UE may only follow the indicator for antenna panel status received from the BS, without considering whether the UE is currently in a DRX on-duration or the DRX off-duration.

In some implementations of the present disclosure, whether to operate in the power saving mode may be determined based on the length of a DRX cycle (e.g., a time gap between two UE-wake-up instances). For example, the UE may be configured with a particular threshold and determine whether to enable the power saving mode according to a comparison between the threshold and the length of the DRX period. For example, if the threshold is 50 ms and the UE is configured with a DRX period of 40 ms, then the UE may not enable the power saving mode because the length of the DRX period (40 ms) is less than the threshold (50 ms). In the same way, if the UE is configured with a DRX period of 60 ms, the UE may enable the power saving antenna status because the length of the DRX period (60 ms) is greater than the threshold (50 ms). This threshold may be predefined in the 3GPP technical specifications or configured by the BS via an RRC signaling.

In some implementations of the present disclosure, the UE may assume that it will not operate in the power saving mode if the UE is in the active time. For example, the active time may include the time while: 1) a specific timer (e.g., drx-onDurationTimer or drx-InactivityTimer or drx-RetransmissionTimerDL or drx-RetransmissionTimerUL or ra-ContentionResolutionTime) is running; or 2) a scheduling request is sent on a PUCCH and is pending; or 3) a PDCCH indicating a new transmission addressed to the Cell Radio Network Temporary Identifier (C-RNTI) of the MAC entity has not been received after successful reception of a random access response for the random access preamble not selected by the MAC entity among the contention-based random access preamble.

In some implementations of the present disclosure, the UE may automatically enter/stay the normal power consumption mode regardless of the BS's indication. For example, the UE may automatically switch the antenna panel status without further reception of a new indicator for antenna panel status information from the BS.

In some implementations of the present disclosure, if the UE is configured with a timer for antenna panel status, this timer may be affected by the DRX inactivity timer, because from the UE's perspective, whether to operate in the power saving mode may be related to the DRX operations. For example, when the DRX inactivity timer expires while the timer for antenna panel status is still running, the UE may switch to the DRX off duration and enable the power saving mode. In addition, the timer for antenna panel status may then stop. In another example, the operation of the DRX inactivity timer and the timer for antenna panel status are independent.

An illustrative example (denoted as Example 0) will now be provided, where the UE may inform the BS of the UE's capability.

FIG. **5** is an example of a data structure indicating UE capability information, in accordance with example implementations of the present disclosure. As shown in FIG. **5**, UE capability information **502** includes a number of parameters related to the antenna panel status of the UE. The parameters may include at least one of a power saving indicator (which may be used as the indicator for antenna panel status described herein), a timer for antenna panel status (for which the value may be set as "true/support" or "false/not support"), a maximum number of support antenna panels (e.g., one, two, four or eight), a support indication method (e.g., which may indicate whether an RRC, MAC-CE, or DCI approach is supported), a required time for antenna panel status switch (e.g., 1 ms, 2 ms, 3 ms, or 4 ms), and a UE assistance indication (for which the value may be set as "true/support" or "false/not support"). The UE may transmit the UE capability information **502** to the BS after establishing an RRC connection to the BS. If the UE supports the timer for antenna panel status, the BS may configure the length of the timer for antenna panel status to the UE, as shown in FIG. **6**.

FIG. **6** is an example data structure indicating the configuration of the timer for antenna panel status, in accordance with example implementations of the present disclosure. As shown in FIG. **6**, a configuration **602** may indicate that the length/duration of the timer for antenna panel status is four slots.

An illustrative example (Example 1-1) will now be provided, where the scheduling offset value (e.g., K0 value) for

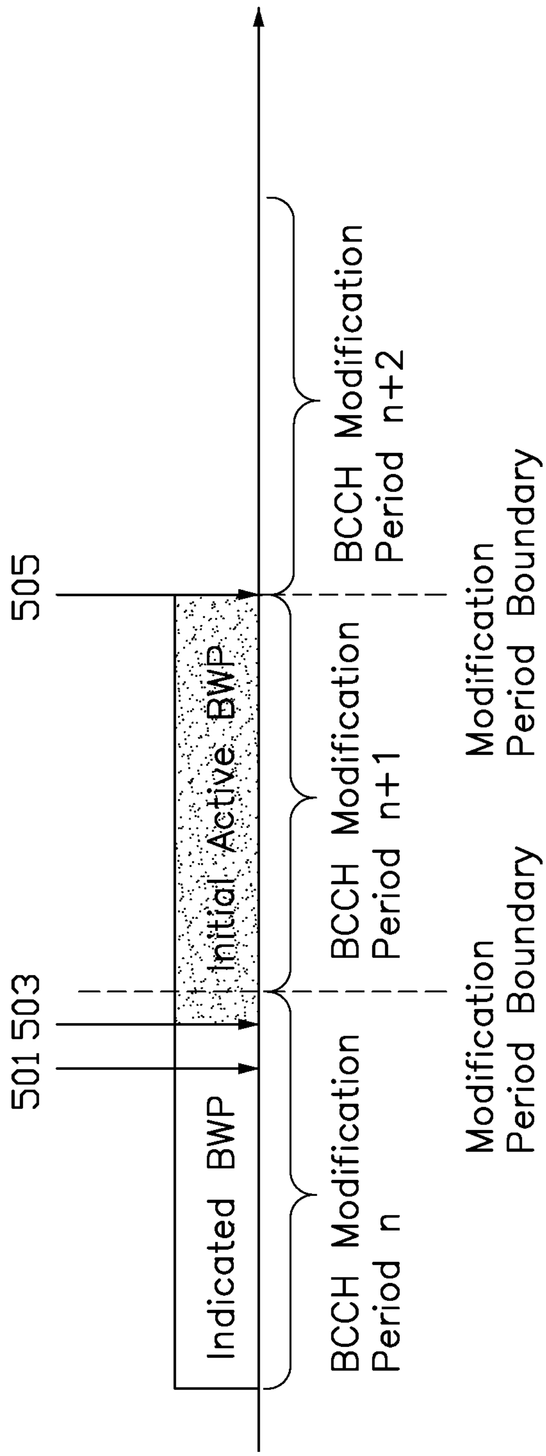

505
501
503
Indicated BWP
Initial Active BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary

FIG. 5

PDSCH reception may be selected based on an indicator for antenna panel status (e.g., contained in a TCI state) from the BS.

FIG. **7** is a flowchart for a method of selecting a scheduling offset value based on a TCI state indicated by the BS, in accordance with example implementations of the present disclosure.

In action **702**, a UE may be configured with multiple sets of parameters corresponding to different operation modes (e.g., the power saving mode and the normal power consumption mode). For example, the UE may be configured with two different leading time values. One leading time value may be 10 μs, and the other one may be 3 ms. As noted above, the UE may apply a first leading time when the UE needs to turn on a first number of antenna panel(s), and apply a second leading time when the UE needs to turn on a second number of antenna panel(s), where the first leading time is longer than the second leading time if the first number is greater than the second number. Hence, in this example, the shorter leading time, 10 μs, may be applied in the case that the UE does not need to further turn on an antenna panel in response to the indicator for antenna panel status, and the longer leading time, 3 ms, may be applied in the case that the UE needs to turn on one or more antenna panels to change the operation mode (e.g., to switch from the power saving mode to the normal power consumption mode).

The leading time values may be predefined in the 3GPP technical specifications or configured by the BS via an RRC signaling. In addition, the UE may be configured with a set of K0 values in the pdsch-TimeDomainResourceAllocationList IE of an RRC configuration. An example of the K0 configuration is as follows.

TABLE 2

Row index	K0 (normal, long)
0	(0 slot, 3 slots)
1	(0 slot, 3 slots)
.	.
.	.
.	.
15	(1 slot, 4 slots)

For each indexed row of the K0 configuration, the UE may determine which of the normal K0 value and the long K0 value should be applied. In addition, the UE may be configured with a certain number of TCI state(s) in the RRC configuration, and each of the TCI state(s) may be associated with a particular antenna panel status.

FIG. **8** is an example data structure indicating TCI state configuration, in accordance with example implementations of the present disclosure. As shown in FIG. **8**, a TCI state configuration **802** includes 64 TCI states, and each TCI state may include a power saving mode IE for indicating whether to enable the power saving mode when the corresponding TCI state is applied.

In addition, the UE may be configured by the BS to enable the power saving mode via an indicator for antenna panel status. FIG. **9** is an example data structure for an indicator for antenna panel status, in accordance with example implementations of the present disclosure. As shown in FIG. **9**, an indicator for antenna panel status **902** includes a power saving mode IE which is set as "true" to indicate to the UE to enable the power saving mode.

It should be noted that the parameter values, data formats, and configurations provided herein are for illustrative purposes only, and not intended to limit the scope of the present invention. For example, the number of slots for each K0 value (e.g., the normal K0 value or the long K0 value) may be different for different numerologies.

Referring back to FIG. **7**. In action **704**, the UE may receive a DCI message from the BS. In action **706**, the UE may apply a TCI state indicated by the DCI message. In action **708**, the UE may apply a K0 value corresponding to the antenna panel status associated with the TCI state.

FIGS. **10**A and **10**B are schematic diagrams illustrating timelines of the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure. It should be noted that the timeline of FIG. **10**B is continued from that of FIG. **10**A. In this example, the total number of turned-on/active antenna panels at the UE is N1 when the power saving mode is enabled and is N2 when the power saving mode is disabled, where N1 is less than N2. For example, N1 may be "1" and N2 may be the number of the antenna panels the UE has.

As shown in FIG. **10**A, the UE may receive and decode a first DCI message DCI_1 which is transmitted over a PDCCH **1002** in the slot # n. The first DCI message DCI_1 may indicate to the UE to apply a particular TCI state (e.g., the TCI state #1 contained in the TCI state configuration **802** in FIG. **8**) for a scheduling PDSCH **1004**. According to FIG. **8**, because the TCI state #1 includes a power saving mode IE which is configured with a "true" value, the UE may follow the TCI state #1 to monitor the scheduling PDSCH **1004** in the power saving mode. In some implementations of the present disclosure, the UE may apply a normal K0 value when the UE does not need to further turn on an antenna panel in response to the indicator for antenna panel status from the BS, and may apply a long K0 value when the UE needs to turn on at least one antenna panel in response to the indicator for antenna panel status. In this example, because the UE has already in the power saving mode before receiving the first DCI message DCI_1, the UE may refer to the K0 configuration in Table 2 to apply a normal K0 value (e.g., 0 slot) contained in the row entry which is indexed by "1" and associated with the TCI state #1. Once the normal K0 value (e.g., 0 slot) is applied, the UE is expected to receive the PDSCH **1004** in the same slot as the PDCCH **1002**, as shown in FIG. **10**A.

After successfully receiving and decoding the PDSCH **1004**, the UE may transmit a HARQ-ACK over a PUCCH **1006** in the slot # n+1 based on the HARQ resource indicator (ARI) contained in the first DCI message DCI_1. Then, the UE may further receive and decode a second DCI message DCI_2 which is transmitted over a PDCCH **1008** in the slot # m. In this example, the second DCI message DCI_2 may indicate to the UE to apply the TCI state #64 for a scheduling PDSCH **1010**. According to FIG. **8**, because the TCI state #64 includes a power saving mode IE which is configured with a "false" value, the TCI state #64 may indicate to the UE to receive the scheduling PDSCH **1010** in the normal power consumption mode, in which there are N2 antenna panels turned on by the UE. As noted above, because the UE needs to turn on a number of antenna panels to enter the normal power consumption mode, the UE may apply a long K0 value for receiving the PDSCH **1010**. For example, the UE may refer to the K0 configuration in Table 2 to apply a long K0 value (e.g., 4 slots) contained in the row entry which is indexed by "15" and associated with the TCI state #64. Once the long K0 value (e.g., 4 slots) is applied, the UE will expect to receive the PDSCH **1010** in the slot m+4, which is the fourth slot after the slot # m, as shown in FIG. **10**A.

After successfully receiving and decoding the PDSCH **1010**, the UE may transmit a HARQ-ACK over a PUCCH **1012** in the slot # m+6 based on the ARI contain in the second DCI message DCI_2, as shown in FIG. **10**B.

Then, the UE may receive and decode a third DCI message DCI_3 which is transmitted over a PDCCH **1014** in the slot # m+7. In this example the third DCI message DCI_3 may indicate to the UE to apply the same TCI state #64 as indicated in second DCI message DCI_2 for a scheduling PDSCH **1016**. Although the TCI state #64 may indicate to the UE to receive the scheduling PDSCH **1016** in the normal power consumption mode, the UE has already operated in the normal power consumption mode before receiving the third DCI message DCI_3. Thus, the UE does not need to further turn on an antenna panel at this moment, and the UE may apply the normal K0 value (e.g., 0 slot) to determine when to receive the PDSCH **1016** (e.g., in the same slot # m+7 as the PDCCH **1014**). After successfully receiving and decoding the PDSCH **1016**, the UE may transmit a HARQ-ACK over a PUCCH **1018** in the slot # k based on the ARI contained in the third DCI message DCI_3, as shown in FIG. **10**B.

An illustrative example (denoted as Example 1-2) will now be provided, where the scheduling offset value (e.g., K0 value) for PDSCH reception may be selected based on the TCI state and the timer for antenna panel status.

In Example 1-2, the UE may be further configured with a timer for antenna panel status in addition to the multiple sets of parameters configured in action **702** of FIG. **7**. For example, the configuration of the timer for antenna panel status may be, but not limited to, the configuration **602** in FIG. **6**. In some implementations of the present disclosure, the numerology of the timer for antenna panel status may be determined based on the scheduling PDSCH of the active DL BWP.

FIGS. **11**A and **11**B are schematic diagrams illustrating timelines of the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure. It should be noted that the timeline of FIG. **11**B is continued from that of FIG. **11**A. In this example, the total number of turned-on/active antenna panels at the UE is N1 when the power saving mode is enabled and is N2 when the power saving mode is disabled, where N1 is less than N2. For example, N1 may be "1" and N2 may be the number of the antenna panels the UE has.

As shown in FIG. **11**A, the UE may receive and decode a first DCI message DCI_1 which is transmitted over a PDCCH **1102** in the slot # n. The first DCI message DCI_1 may indicate to the UE to apply a particular TCI state (e.g., the TCI state #1 contained in the TCI state configuration **802** in FIG. **8**) for a scheduling PDSCH **1104**. According to FIG. **8**, because the TCI state #1 includes a power saving mode IE which is configured with a "true" value, the UE may follow the TCI state #1 to monitor the scheduling PDSCH **1004** in the power saving mode. As noted above, because the UE has already in the power saving mode before receiving the first DCI message DCI_1, the UE may refer to the K0 configuration in Table 2 to apply a normal K0 value (e.g., 0 slot) contained in the row entry which is indexed by "1" and associated with the TCI state #1. Once the normal K0 value (e.g., 0 slot) is applied, the UE is expected to receive the PDSCH **1104** in the same slot as the PDCCH **1002**, as shown in FIG. **11**A.

After successfully receiving and decoding the PDSCH **1104**, the UE may transmit an HARQ-ACK over a PUCCH **1106** in the slot # n+1 based on the ARI contained in the first

DCI message DCI_1. Then, the UE may further receive and decode a second DCI message DCI_2 which is transmitted over a PDCCH **1108** in the slot # m. In this example, the second DCI message DCI_2 may indicate to the UE to apply the TCI state #64 for a scheduling PDSCH **1110**. According to FIG. **8**, because the TCI state #64 includes a power saving mode IE which is configured with a "false" value, the TCI state #64 may indicate to the UE to receive the scheduling PDSCH **1110** in the normal power consumption mode, in which there are N2 antenna panels turned on by the UE. As noted above, because the UE needs to turn on a number of antenna panels to enter the normal power consumption mode, the UE may apply a long K0 value for receiving the PDSCH **1110**. For example, the UE may refer to the K0 configuration in Table 2 to apply a long K0 value (e.g., 4 slots) contained in the row entry which is indexed by "15" and associated with the TCI state #64. Once the long K0 value (e.g., 4 slots) is applied, the UE will expect to receive the PDSCH **1110** in the slot m+4, which is the fourth slot after the slot # m, as shown in FIG. **11**A. In addition, the timer for antenna panel status may start at the end of the slot # m+4.

After successfully receiving and decoding the PDSCH **1110**, the UE may transmit an HARQ-ACK over a PUCCH **1112** in the slot # m+6 based on the ARI contain in the second DCI message DCI_2, as shown in FIG. **11**B.

Then, UE may successfully receive and decode a third DCI message DCI_3 which is transmitted over a PDCCH **1114** in the slot # m+9. The third DCI message DCI_3 may indicate to the UE to apply the TCI state #64 for a scheduling PDSCH **1116**. Because the timer for antenna panel status expires in the end of the slot # m+8, the UE has already switched to the power saving mode when receiving the third DCI message DCI_3. In addition, according to FIG. **8**, the TCI state #64 may indicate to the UE to receive the PDSCH **1116** in the normal power consumption mode. Because the UE needs to turn on at least N2-N1 antenna panels to switch from the power saving mode to the normal power consumption mode, the UE may apply a long K0 value (e.g., 4 slots) based on the K0 configuration (e.g., the K0 configuration shown in Table 2), and receive the PDSCH **1116** in the slot m+13 which is the fourth slot after the slot # m+9. After successfully receiving and decoding the PDSCH **1116**, the UE may transmit an HARQ-ACK in the slot # k based on the ARI in the scheduling DCI (e.g., the third DCI message DCI_3), as shown in FIG. **11**B.

An illustrative example (denoted as Example 2-1) will now be provided, where an RRC-configured offset value for receiving an aperiodic CSI RS may be selected based on a CSI request from the BS.

FIG. **12** is a flowchart for a method of selecting an offset value (e.g. a K0 value) for receiving an aperiodic CSI-RS, in accordance with example implementations of the present disclosure.

In action **1202**, the UE may be configured with multiple sets of parameters corresponding to different operation modes (e.g., the power saving mode and the normal power consumption mode). For example, two different leading times may be predefined in the 3GPP technical specifications for the UE. One may be a shorter leading (e.g., 10 microseconds) to be used in the case that the UE does not need to further turn on an antenna panel, and the other one may be a longer leading time (e.g., 3 ms) to be used in the case that the UE needs to turn on one or more antenna panels to change the operation mode. In addition, the UE may be configured with a set of offset values (e.g., aperiodicTriggeringOffset) in an RRC configuration for receiving an aperiodic CSI-RS, as shown in FIG. **13**.

FIG. **13** is an example data structure indicating an aperiodic CSI RS reception configuration, in accordance with example implementations of the present disclosure. As shown in FIG. **13**, in the aperiodic CSI RS reception configuration (e.g., NZP-CSI-ResourceSet) **1302**, the aperiodicTriggeringOffset may refer to a specific row entry (e.g., indexed by "10") in the K0 configuration **1304**, which is associated with a normal K0 value of 2 slots and a long K0 value of 6 slots. The UE may be further configured in the power saving mode based on an initial indicator for antenna panel status (e.g., the indicator for antenna panel status **902** in FIG. **9**). In addition, the numerology applied in this example may be, but not limited to, 15 KHz.

Referring back to FIG. **12**. In action **1204**, the UE may receive a DCI message containing a CSI request from BS. In action **1206**, the UE may apply a K0 value corresponding to the antenna panel status indicated by the CSI request.

FIG. **14** is an example of a MAC-CE message, in accordance with example implementations of the present disclosure. As shown in FIG. **14**, a MAC-CE message **1402** includes several reserved bits (which are denoted as "R" in FIG. **14**), a cell ID, and a control bit (which is denoted as "C" in FIG. **14**). The cell ID may contain the serving cell ID (e.g., "00000" in this example). The control bit "C" may be used for indicating to the UE to enable/disable the power saving mode. For example, the UE may be indicated to enable the power saving mode when the control bit is set to a first value (e.g., "1"), or indicated to disable the power saving mode when the control bit is set to a second value (e.g., "0"). As shown in FIG. **14**, the MAC-CE message **1402** of which the control bit is set to "0" may be used for indicating to the UE to disable the power saving mode (or to operate in the normal power consumption mode).

FIG. **15** is a schematic diagram illustrating that different triggering offset values (e.g., K0 values) are applied for the changes in the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure. In this example, the total number of turned-on/active antenna panels at the UE is N1 when the UE is in the power saving mode and is N2 when the UE is the normal power consumption mode, where N1 is less than N2. For example, N1 may be "1" and N2 may be the number of the antenna panels the UE has.

As shown in FIG. **15**, in the slot # n, the UE may receive a first DCI message DCI_1 which is transmitted over a PDCCH **1502**, and obtain a MAC-CE message (e.g., the MAC-CE message **1402** in FIG. **14**) based on the first DCI message DCI_1. The MAC-CE message may include an indicator for antenna panel status (e.g., the control bit of the MAC-CE message **1402** in FIG. **14**) used for indicating the UE to operate in the normal power consumption mode (or disable the power saving mode). Then, the UE may monitor a scheduling PDSCH **1504** based on the first DCI message DCI_1 and transmit a HARQ-ACK over a PUCCH **1508** for the MAC-CE message in the slot # n+5.

In this example, the UE may receive a second DCI message DCI_2 which is transmitted over a PDCCH **1506** in the slot # n+1. The second DCI message DCI_2 may contain a CSI request for triggering an aperiodic CSI report. For example, the CSI request for triggering the CSI-RS resource may be indicated by the BS, through the QCL information associated with the CSI-RS resource, to be received by the multiple antenna panels at the UE. In some implementations of the present disclosure, the UE may apply a normal triggering offset value when the UE does not need to further turn on an antenna panel in response to the indicator for antenna panel status obtained from the BS, and apply a long triggering offset value when the UE needs to turn on at least one antenna panel in response to the indicator for antenna panel status received from the BS. Thus, in this example, the UE may apply a long triggering offset value (e.g., aperiodicTriggeringOffset) for the CSI request to switch from the power saving mode to the normal power consumption mode. As shown in FIG. **15**, the BS may transmit the CSI-RS resource in the slot #n+7, which is the sixth time slot after the slot #n+1.

In addition, the UE may further receive a third DCI message DCI_3 which is transmitted over a PDCCH **1510** in the slot # m. The third DCI message DCI_3 may contain a CSI request for triggering an aperiodic CSI report, and the CSI request may indicate the same aperiodic CSI-RS trigger state as indicated by the CSI request contained in the second DCI message DCI_2. Since the CSI-RS resource (which is triggered by the CSI request contained in the third DCI message DCI_3) is indicated to be received by the multiple antenna panels of the UE by the BS (e.g., through the QCL information which is associated with the CSI-RS resource), the UE may decide to apply a normal triggering offset value (e.g., aperiodicTriggeringOffset) of two slots for this CSI request based on the current antenna panel status (e.g., with N2 antenna panels being turned-on). Thus, as shown in FIG. **15**, the UE may receive the corresponding aperiodic CSI-RS resource from the BS in the slot # m+2, which is the first time slot after the slot # m+1.

An illustrative example (denoted as Example 2-2) will now be provided, where an RRC-configured offset value for an aperiodic CSI RS reception may be selected based on a CSI request from the BS and a timer for antenna panel status.

In Example 2-2, the UE may be further configured with a timer for antenna panel status in addition to the multiple sets of parameters configured in action **1202** of FIG. **12**. For example, the configuration of the timer for antenna panel status may be, but not limited to, the configuration **602** in FIG. **6**. In some implementations of the present disclosure, the numerology of the timer for antenna panel status may be determined based on the scheduling PDSCH of the active DL BWP.

FIGS. **16**A and **16**B are schematic diagrams illustrating that different triggering offset values (e.g., K0 values) are applied for the changes in the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure. It should be noted that FIG. **16**B is continued from the FIG. **16**A. In this example, the total number of turned-on/active antenna panels at the UE is N1 when the UE is in the power saving mode and is N2 when the UE is the normal power consumption mode, where N1 is less than N2. For example, N1 may be "1" and N2 may be the number of the antenna panels the UE has.

As shown in FIG. **16**A, in the slot # n, the UE may receive a first DCI message DCI_1 which is transmitted over a PDCCH **1602**, and obtain a MAC-CE message (e.g., the MAC-CE message **1402** in FIG. **14**) based on the first DCI message DCI_1. The MAC-CE message may include an indicator for antenna panel status (e.g., the control bit of the MAC-CE message **1402** in FIG. **14**) that may indicate to the UE to operate in the normal power consumption mode. The UE may monitor a scheduling PDSCH **1604** based on the first DCI message DCI_1 and transmit an HARQ-ACK over a PUCCH **1608** for the MAC-CE message in the slot # n+5.

In addition, the UE may receive a second DCI message DCI_2 which is transmitted over a PDCCH **1606** in the slot

n+1. The second DCI message DCI_2 may contain a CSI request for triggering an aperiodic CSI report. For example, the CSI request for triggering the CSI-RS resource may be indicated by the BS, through the QCL information associated with the CSI-RS resource, to be received by the multiple antenna panels at the UE. As described above, the UE may apply a long triggering offset value (e.g., aperiodicTriggeringOffset) for the CSI request because the UE may need to turn on at least one antenna panel in response to the indicator for antenna panel status obtained from the BS. As shown in FIG. **16**A, the BS may transmit the CSI-RS resource in the slot #n+7, which is the sixth time slot after the slot #n+1. In this example, the timer for antenna panel status may also start at the beginning of the slot #n+7.

Referring to FIG. **16**B. The timer may then expire at the end of the slot n+10, and the UE may switch from the normal power consumption mode to the power saving mode. In addition, the UE may then receive a third DCI message DCI_3 which is transmitted over a PDCCH **1610** in the slot # m, where m>n+10. The third DCI message DCI_3 may contain a CSI request for triggering an aperiodic CSI report, and the CSI request may indicate the same aperiodic CSI-RS trigger state as indicated by the second DCI message DCI_2. Since the CSI-RS resource triggered by the CSI request is indicated by the BS, through the QCL information associated to the CSI-RS resource, to be received by multiple antenna panels of the UE, the UE may decide to apply a long triggering offset value (e.g., aperiodicTriggeringOffset) for this CSI request based on current antenna panels status (e.g., with N1 antenna panels being turned-on). Thus, as shown in FIG. **16**B, the BS may transmit the aperiodic CSI-RS resource in the slot # m+5, which is the fifth time slot after the slot # m.

An illustrative example (denoted as Example 3-1) will now be provided, where a UE may indicate its antenna panel status through at least one explicit bit in a CSI report.

FIG. **17** is a schematic diagram illustrating a timeline of the antenna panel status of a wireless communication device (e.g., a UE), in accordance with example implementations of the present disclosure. In this example, the total number of turned-on/active antenna panels at the UE is N1 when the UE is in the power saving mode and is N2 when the UE is the normal power consumption mode, where N1 is less than N2.

In this example, the UE may be configured with a periodic CSI report and the periodicity for the CSI report may be 20 slots. In addition, the UE may be configured with a timer for antenna panel status. The configuration of the timer for antenna panel status may be, but not limited to, the configuration **602** shown in FIG. **6**. In some implementations of the present disclosure, the numerology of the timer for antenna panel status may be determined based on the scheduling PDSCH of active DL BWP.

Referring back to FIG. **17**, the UE may use N1 antenna panel(s) to receive a CSI-RS #1 for calculating a CSI report which is to be transmitted over a PUCCH **1702** in the slot # n. Hence, the bit field in the CSI report may be set to a first value (e.g., “1”) to indicate that the UE is in the power saving mode.

On the other hand, if the UE changes to use multiple antenna panels to receive the CSI-RS #2 for calculating a CSI report which is to be transmitted over a PUCCH **1704** in the slot # n+20, the bit field in this CSI report may be set to a second value (e.g., “0”) to indicate that the UE is in normal power consumption mode (e.g., by disabling the power saving mode).

An illustrative example (denoted as Example 4-1) will now be provided, where the antenna panel status may be switched based on a DRX operation.

FIG. **18** is a flowchart for a method for determining the antenna panel status of a wireless communication device (e.g., a UE) based on a DRX operation, in accordance with example implementations of the present disclosure. As shown in FIG. **18**, in action **1802**, the UE may be configured with a DRX inactivity timer by the BS. In action **1804**, the UE may switch the antenna panel status based on the DRX inactivity timer.

In some implementations of the present disclosure, the DRX inactivity timer may be used to define how long a UE should remain in the ON state after the reception of a PDCCH. For example, while the DRX inactivity timer is running, the UE may remain in the ON state.

In Example 4-1, the UE may be configured with a DRX period and a timer for antenna panel status. In addition, the BS may indicate to the UE to operate in the normal power consumption mode, as shown in FIG. **19**.

FIG. **19** is an example data structure indicating an RRC configuration for the UE, in accordance with example implementations of the present disclosure. As shown in FIG. **19**, an RRC configuration **1902** may include a DRX configuration and an antenna panel status configuration. The DRX configuration may be configured with a DRX inactivity timer for 2 ms and a DRX cycle of 50 ms. The antenna panel status configuration may indicate that the power saving mode is to be disabled (e.g., with a “false” value) and the length of the timer for the antenna panel status is four slots.

FIG. **20** is a schematic diagram illustrating a timeline of the antenna panel status of a wireless communication device (e.g., a UE) and a timing diagram of a DRX cycle, in accordance with example implementations of the present disclosure. In the present implementation, the timer for antenna panel status may have the same operation as the DRX inactivity timer. In addition, the total number of turned-on/active antenna panels at the UE is N1 when the UE is in the power saving mode and is N2 when the UE is the normal power consumption mode, where N1 is less than N2.

As shown in FIG. **20**, the UE may receive a DCI message in the slot # n at which the UE is in a DRX on-duration. In response to receiving the DCI message, the UE may start both the DRX inactivity timer and the timer for antenna panel status, if the DCI message is used for indicating to the UE to operate in the normal power consumption mode. Then, if the timer for antenna panel status is going to stop/expire at the beginning of the slot # n+4 (e.g., according to the RRC configuration **1902** in FIG. **19**), the DRX inactivity timer may follow the timer for antenna panel status to stop/expire at the same timing (e.g., at the beginning of the slot # n+4). Thus, the UE may enter a DRX off-duration and operate in the power saving mode at the same time.

An illustrative example (denoted as Example 4-2) will now be provided, where the antenna panel status may be switched based on a DRX operation.

In Example 4-2, the UE may be configured with a DRX inactivity timer by the BS. In addition, the UE may be indicated by the BS to operate in the normal power consumption mode based on an RRC configuration, as shown in FIG. **21**.

FIG. **21** is an example data structure indicating an RRC configuration for the UE, in accordance with example implementations of the present disclosure. As shown in FIG. **21** an RRC configuration **2102** may include a DRX configuration and an antenna panel status configuration. The DRX configuration may be configured with a DRX inactivity timer for 2 ms and a DRX cycle of 50 ms. Furthermore, the antenna panel status configuration may indicate that the power saving mode is to be disabled (e.g., with a "False" value).

FIG. **22** is a schematic diagram illustrating a timeline of the antenna panel status of a wireless communication device (e.g., a UE) and a timing diagram of a DRX cycle, in accordance with example implementations of the present disclosure. In the present implementation, the antenna panel status of a UE may follow the DRX cycles. In addition, the total number of turned-on/active antenna panels at the UE is N1 when the UE is in the power saving mode, and is N2 when the UE is the normal power consumption mode, where N1 is less than N2.

As shown in FIG. **22**, the UE may at first operate in the normal power consumption mode based on the most recently received BS instruction (e.g., received through an RRC configuration, a MAC-CE message or a DCI message). If the UE does not receive a PDCCH in the DRX on-duration (at which the UE is in an active state), the UE may then switch to the power saving mode after the UE enters the DRX off-duration (at which the UE is in an inactive/sleep state).

FIG. **23** is a flowchart for a method of operating multiple antenna panels, in accordance with example implementations of the present disclosure.

In action **2302**, a wireless communication device (e.g., a UE) may maintain a plurality of leading time values, wherein the plurality of leading time values may indicate a plurality of leading time durations.

In action **2304**, the wireless communication device may receive an indicator for antenna panel status information from a BS.

In action **2306**, the wireless communication device may apply one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the received indicator for antenna panel status information.

FIG. **24** is a block diagram illustrating a node for wireless communication, in accordance with various aspects of the present application. As shown in FIG. **24**, a node **2400** may include a transceiver **2420**, a processor **2428**, a memory **2434**, one or more presentation components **2438**, and at least one antenna **2436**. The node **2400** may also include an RF spectrum band module, a BS communications module, a network communications module, and a system communications management module, Input/Output (I/O) ports, I/O components, and power supply (not explicitly shown in FIG. **24**). Each of these components may be in communication with each other, directly or indirectly, over one or more buses **2440**. In one implementation, the node **2400** may be a UE or a BS that performs various functions described herein, for example, with reference to FIGS. **1** through **23**.

The transceiver **2420** having a transmitter **2422** (e.g., transmitting/transmission circuitry) and a receiver **2424** (e.g., receiving/reception circuitry) may be configured to transmit and/or receive time and/or frequency resource partitioning information. In some implementations, the transceiver **2420** may be configured to transmit in different types of subframes and slots including, but not limited to, usable, non-usable and flexibly usable subframes and slot formats. The transceiver **2420** may be configured to receive data and control channels.

The node **2400** may include a variety of computer-readable media. Computer-readable media may be any available media that may be accessed by the node **2400** and include both volatile and non-volatile media, removable and non-removable media. By way of example, and not limitation, computer-readable media may comprise computer storage media and communication media. Computer storage media includes both volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or other data.

Computer storage media includes RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, Digital Versatile Disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices. Computer storage media does not comprise a propagated data signal. Communication media typically embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of any of the above should also be included within the scope of computer-readable media.

The memory **2434** may include computer-storage media in the form of volatile and/or non-volatile memory. The memory **2434** may be removable, non-removable, or a combination thereof. Example memory includes solid-state memory, hard drives, optical-disc drives, and etc. As illustrated in FIG. **24**, The memory **2434** may store computer-readable, computer-executable instructions **2432** (e.g., software codes) that are configured to, when executed, cause the processor **2428** to perform various functions described herein, for example, with reference to FIGS. **1** through **23**. Alternatively, the instructions **2432** may not be directly executable by the processor **2428** but be configured to cause the node **2400** (e.g., when compiled and executed) to perform various functions described herein.

The processor **2428** (e.g., having processing circuitry) may include an intelligent hardware device, e.g., a Central Processing Unit (CPU), a microcontroller, an ASIC, and etc. The processor **2428** may include memory. The processor **2428** may process the data **2430** and the instructions **2432** received from the memory **2434**, and information through the transceiver **2420**, the base band communications module, and/or the network communications module. The processor **2428** may also process information to be sent to the transceiver **2420** for transmission through the antenna **2436**, to the network communications module for transmission to a core network.

One or more presentation components **2438** presents data indications to a person or other device. Examples of presentation components **2438** may include a display device, speaker, printing component, vibrating component, etc.

From the above description, it is manifested that various techniques may be used for implementing the concepts described in the present application without departing from the scope of those concepts. Moreover, while the concepts have been described with specific reference to certain implementations, a person of ordinary skill in the art may recognize that changes may be made in form and detail without departing from the scope of those concepts. As such, the described implementations are to be considered in all respects as illustrative and not restrictive. It should also be understood that the present application is not limited to the particular implementations described above, but many rearrangements, modifications, and substitutions are possible without departing from the scope of the present disclosure.

What is claimed is:

1. A wireless communication device comprising:

a plurality of antenna panels;

a processor coupled to the plurality of antenna panels and configured to:

maintain a plurality of leading time values, the plurality of leading time values indicating a plurality of leading time durations;

receive an indicator for antenna panel status information from a base station (BS);

apply one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the indicator for antenna panel status information;

receive a scheduling offset value from the BS, the scheduling offset value comprising at least one of a K0 parameter for a Downlink (DL) channel and a K2 parameter for an Uplink (UL) channel; and

determine that the scheduling offset value is invalid, when a time duration indicated by the scheduling offset value is less than a leading time duration indicated by the applied leading time value.

2. The wireless communication device of claim 1, wherein the processor is further configured to:

receive a timer from the BS; and

switch the antenna panel status from a first antenna panel status to a second antenna panel status after the timer expires.

3. The wireless communication device of claim 2, wherein the timer expires when one of a Discontinuous Reception (DRX) inactivity timer expires and the wireless communication device enters one of a DRX off-period and a sleep mode.

4. The wireless communication device of claim 1, wherein the processor is further configured to:

transmit an antenna panel status report to inform the BS of the switch of the antenna panel status.

5. The wireless communication device of claim 4, wherein the antenna panel status report is contained in one of a beam report and a Channel State Information (CSI) report.

6. The wireless communication device of claim 4, wherein the antenna panel status report comprises a single-bit Information Element (IE), and the processor is further configured to:

set the single-bit IE to a first value to indicate that a power saving mode is enabled; and

set the single-bit IE to a second value to indicate that the power saving mode is disabled,

wherein a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is disabled.

7. The wireless communication device of claim 4, wherein the antenna panel status report comprises a multiple-bit Information Element (IE), and the processor is further configured to:

set the multiple-bit IE to a particular value associated with a particular number of the plurality of antenna panels being turned on.

8. The wireless communication device of claim 1, wherein the indicator for antenna panel status information comprises a single-bit Information Element (IE), and the processor is further configured to:

enable a power saving mode when the single-bit IE is set to a first value; and

disable the power saving mode when the single-bit IE is set to a second value,

wherein a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is disabled.

9. The wireless communication device of claim 1, wherein the indicator for antenna panel status information comprises a multiple-bit Information Element (IE), and the processor is further configured to:

turn on a particular number of the plurality of antenna panels when the multiple-bit IE is set to a particular value.

10. The wireless communication device of claim 1, wherein the indicator for antenna panel status information is contained in a Transmission Configuration Indicator (TCI) state Identity (ID) indicated by the BS.

11. The wireless communication device of claim 1, wherein the plurality of leading time values is one of cell-specific values and cell group-specific values.

12. The wireless communication device of claim 1, wherein the processor is further configured to:

switch the antenna panel status from a first antenna panel status to a second antenna panel status in response to receiving the indicator for antenna panel status information; and

automatically switch the antenna panel status from the second antenna panel status to a third antenna panel status without further reception of an indicator for antenna panel status information from the BS.

13. The wireless communication device of claim 1, wherein the processor is further configured to:

enable a power saving mode when the wireless communication device operates in a Discontinuous Reception (DRX) active time; and

disable the power saving mode when the wireless communication device operates in a DRX inactive time,

wherein a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is disabled.

14. The wireless communication device of claim 1, wherein the processor is further configured to:

enable a power saving mode based on whether the wireless communication device operates in a particular Bandwidth Part (BWP),

wherein:

a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is disabled; and

the particular BWP is one of a default BWP, an initial BWP, and a first active BWP.

15. A method performed by a wireless communication device for operating a plurality of antenna panels, the method comprising:

maintaining a plurality of leading time values, the plurality of leading time values indicating a plurality of leading time durations;

receiving an indicator for antenna panel status information from a base station (BS);

applying one of the plurality of leading time values to switch an antenna panel status of the plurality of antenna panels based on the indicator for antenna panel status information;

receiving a scheduling offset value from the BS, the scheduling offset value comprising at least one of a K0 parameter for a Downlink (DL) channel and a K2 parameter for an Uplink (UL) channel; and

determining that the scheduling offset value is invalid, when a time duration indicated by the scheduling offset value is less than a leading time duration indicated by the applied leading time value.

16. The method of claim **15**, further comprising:

receiving a timer from the BS; and

switching the antenna panel status from a first antenna panel status to a second antenna panel status after the timer expires.

17. The method of claim **16**, wherein the timer expires when one of a Discontinuous Reception (DRX) inactivity timer expires and the wireless communication device enters one of a DRX off-period and a sleep mode.

18. The method of claim **15**, further comprising:

transmitting an antenna panel status report to inform the BS of the switch of the antenna panel status.

19. The method of claim **18**, wherein the antenna panel status report is contained in one of a beam report and a Channel State Information (CSI) report.

20. The method of claim **18**, wherein the antenna panel status report comprises a single-bit Information Element (IE), and the method further comprises:

setting the single-bit IE to a first value to indicate that a power saving mode is enabled; and

setting the single-bit IE to a second value to indicate that the power saving mode is disabled;

wherein a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is disabled.

21. The method of claim **18**, wherein the antenna panel status report comprises a multiple-bit Information Element (IE), and the method further comprises:

setting the multiple-bit IE to a particular value associated with a particular number of the plurality of antenna panels being turned on.

22. The method of claim **15**, wherein the indicator for antenna panel status information comprises a single-bit Information Element (IE), and the method further comprises:

enabling a power saving mode when the single-bit IE is set to a first value; and

disabling the power saving mode when the single-bit IE is set to a second value,

wherein a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is disabled.

23. The method of claim **15**, wherein the indicator for antenna panel status information comprises a multiple-bit Information Element (IE), and the method further comprises:

turning on a particular number of the plurality of antenna panels when the multiple-bit IE is set to a particular value.

24. The method of claim **15**, wherein the indicator for antenna panel status information is contained in a Transmission Configuration Indicator (TCI) state Identity (ID) indicated by the BS.

25. The method of claim **15**, wherein the plurality of leading time values is one of cell-specific values and cell group-specific values.

26. The method of claim **15**, further comprising:

switching the antenna panel status from a first antenna panel status to a second antenna panel status in response to receiving the indicator for antenna panel status information; and

automatically switch the antenna panel status from the second antenna panel status to a third antenna panel status without further reception of an indicator for antenna panel status information from the BS.

27. The method of claim **15**, further comprising:

enabling a power saving mode when the wireless communication device operates in a Discontinuous Reception (DRX) active time; and

disabling the power saving mode when the wireless communication device operates in a DRX inactive time,

wherein a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is disabled.

28. The method of claim **15**, further comprising:

enabling a power saving mode based on whether the wireless communication device operates in a particular Bandwidth Part (BWP),

wherein:

a total number of turned-on antenna panels in the plurality of antenna panels when the power saving mode is enabled is less than a total number of turned-on antenna panels when the power saving mode is disabled; and

the particular BWP is one of a default BWP, an initial BWP, and a first active BWP.

* * * * *

Exhibit 4

US011115165B2

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Tsai et al.

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(45) **Date of Patent: Sep. 7, 2021**

(54) **METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS**

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See application file for complete search history.

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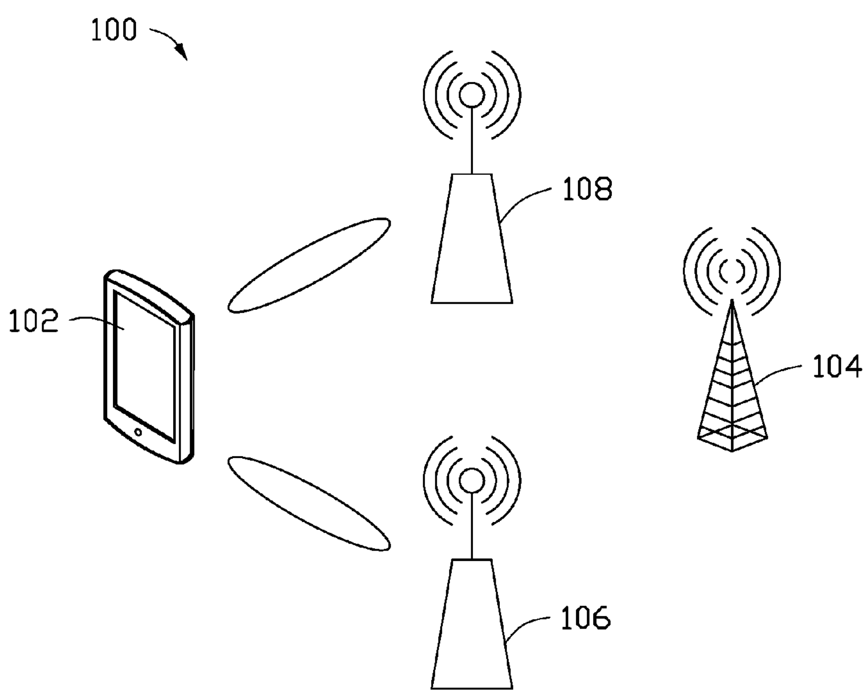
(57) **ABSTRACT**

A method includes receiving, by a User Equipment (UE), Transmission Configuration Indicator (TCI) state data in a Physical Download Control Channel (PDCCH) determining multiple Physical Downlink Shared Channels (PDSCHs), where the TCI state data is associated with multiple Demodulation Reference Signal (DMRS) port groups, and obtaining, by the UE, multiple Quasi Co-Location (QCL) assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

12 Claims, 6 Drawing Sheets



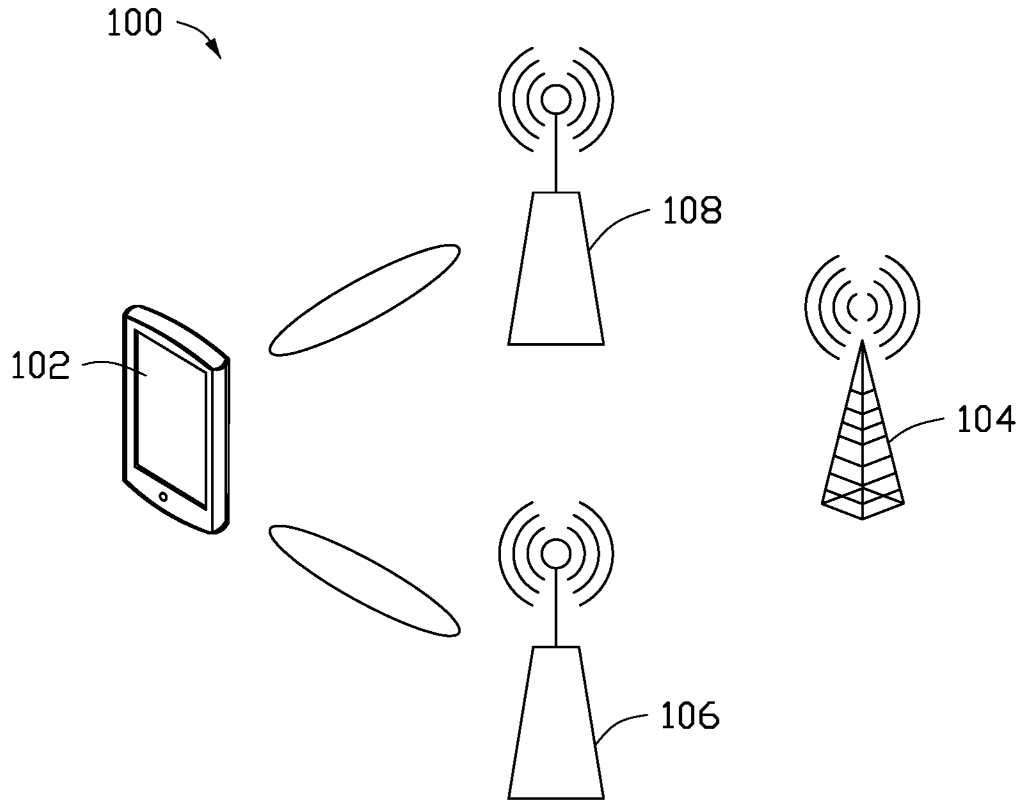


FIG. 1

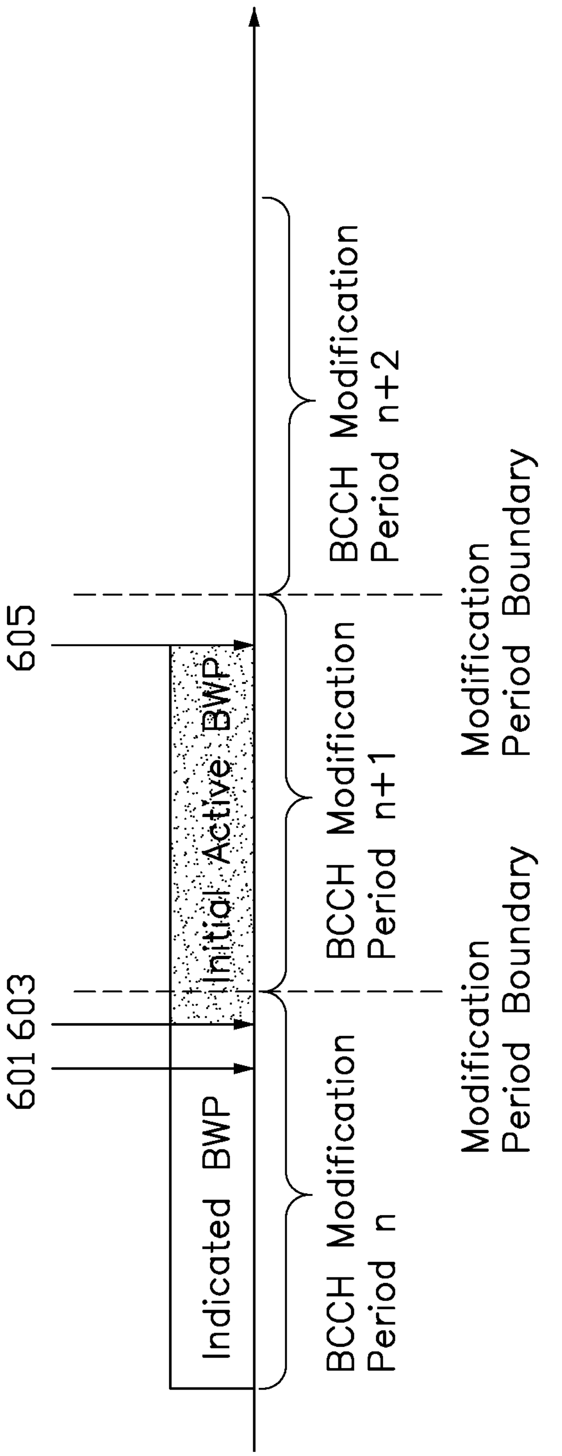

605
601
603
Indicated BWP
Initial Active BWP
BCCH Modification Period n
BCCH Modification Period n+1
BCCH Modification Period n+2
Modification Period Boundary
Modification Period Boundary

FIG. 6

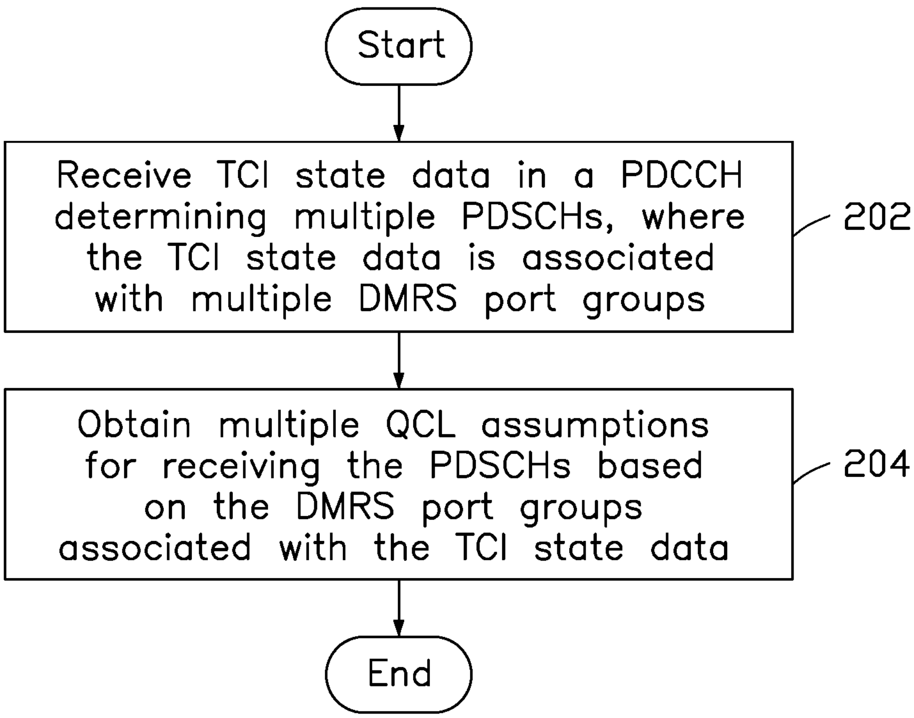

Start
Receive TCI state data in a PDCCH determining multiple PDSCHs, where the TCI state data is associated with multiple DMRS port groups
202
Obtain multiple QCL assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data
204
End

FIG. 2

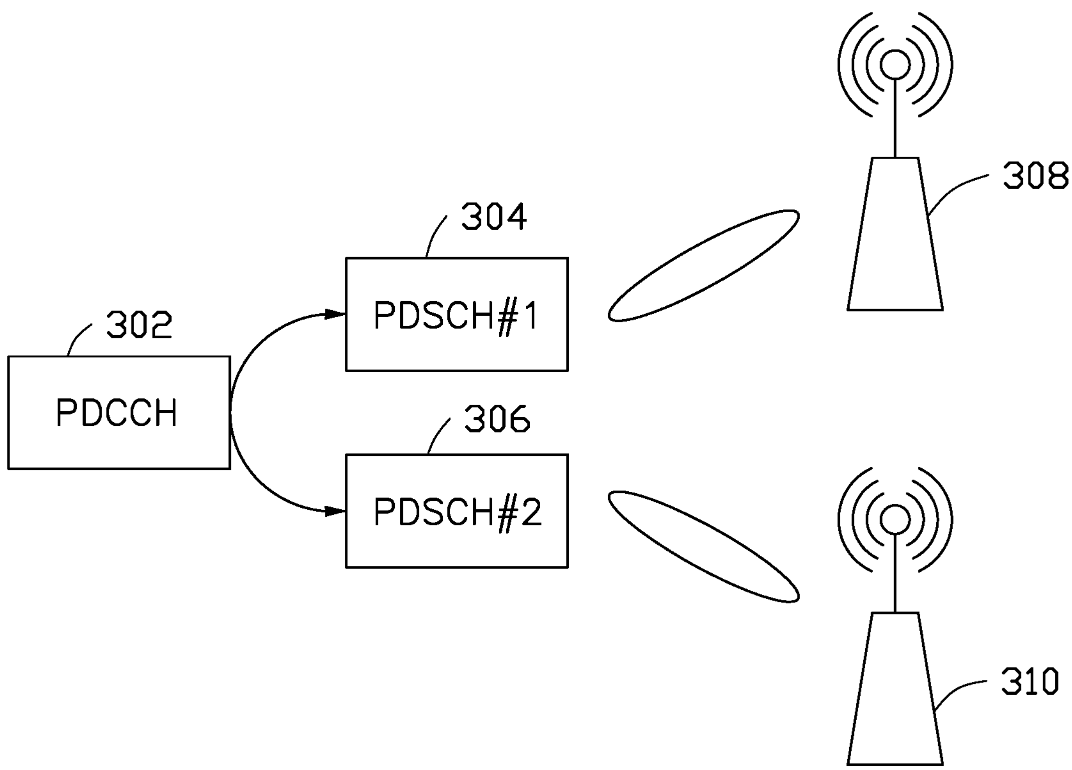


FIG. 3

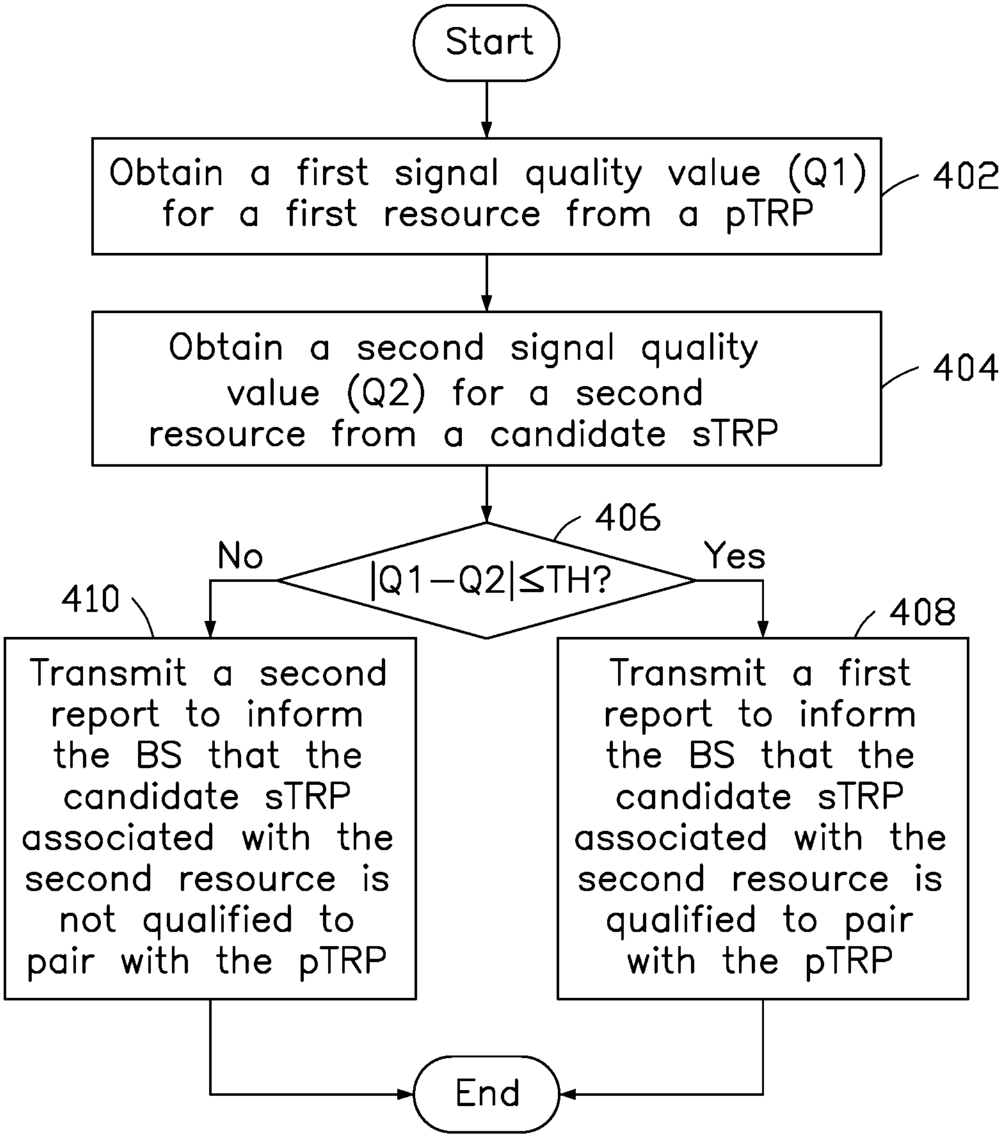

Start
Obtain a first signal quality value (Q1) for a first resource from a pTRP
402
Obtain a second signal quality value (Q2) for a second resource from a candidate sTRP
404
406
|Q1−Q2|≤TH?
No
Yes
410
408
Transmit a second report to inform the BS that the candidate sTRP associated with the second resource is not qualified to pair with the pTRP
Transmit a first report to inform the BS that the candidate sTRP associated with the second resource is qualified to pair with the pTRP
End

FIG. 4

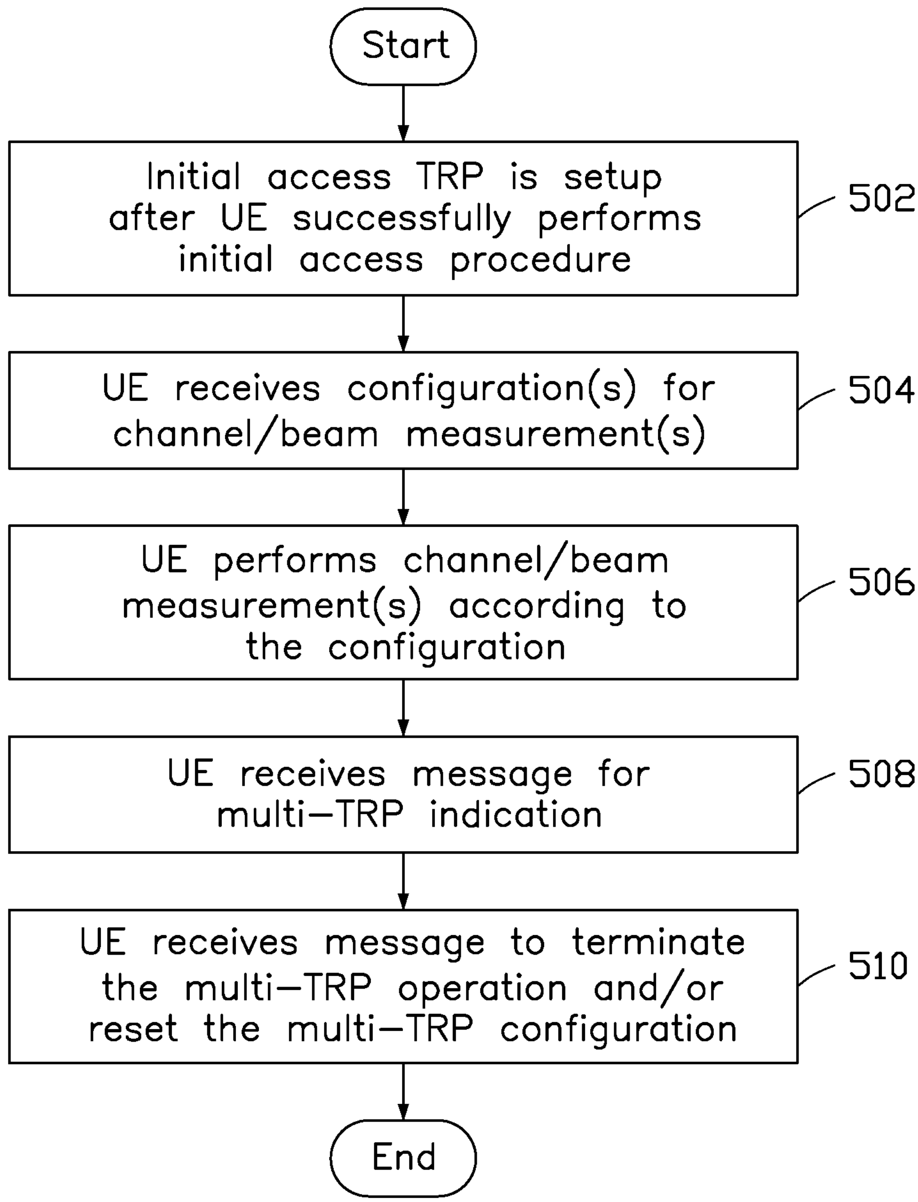

Start
Initial access TRP is setup after UE successfully performs initial access procedure
502
UE receives configuration(s) for channel/beam measurement(s)
504
UE performs channel/beam measurement(s) according to the configuration
506
UE receives message for multi-TRP indication
508
UE receives message to terminate the multi-TRP operation and/or reset the multi-TRP configuration
510
End

FIG. 5

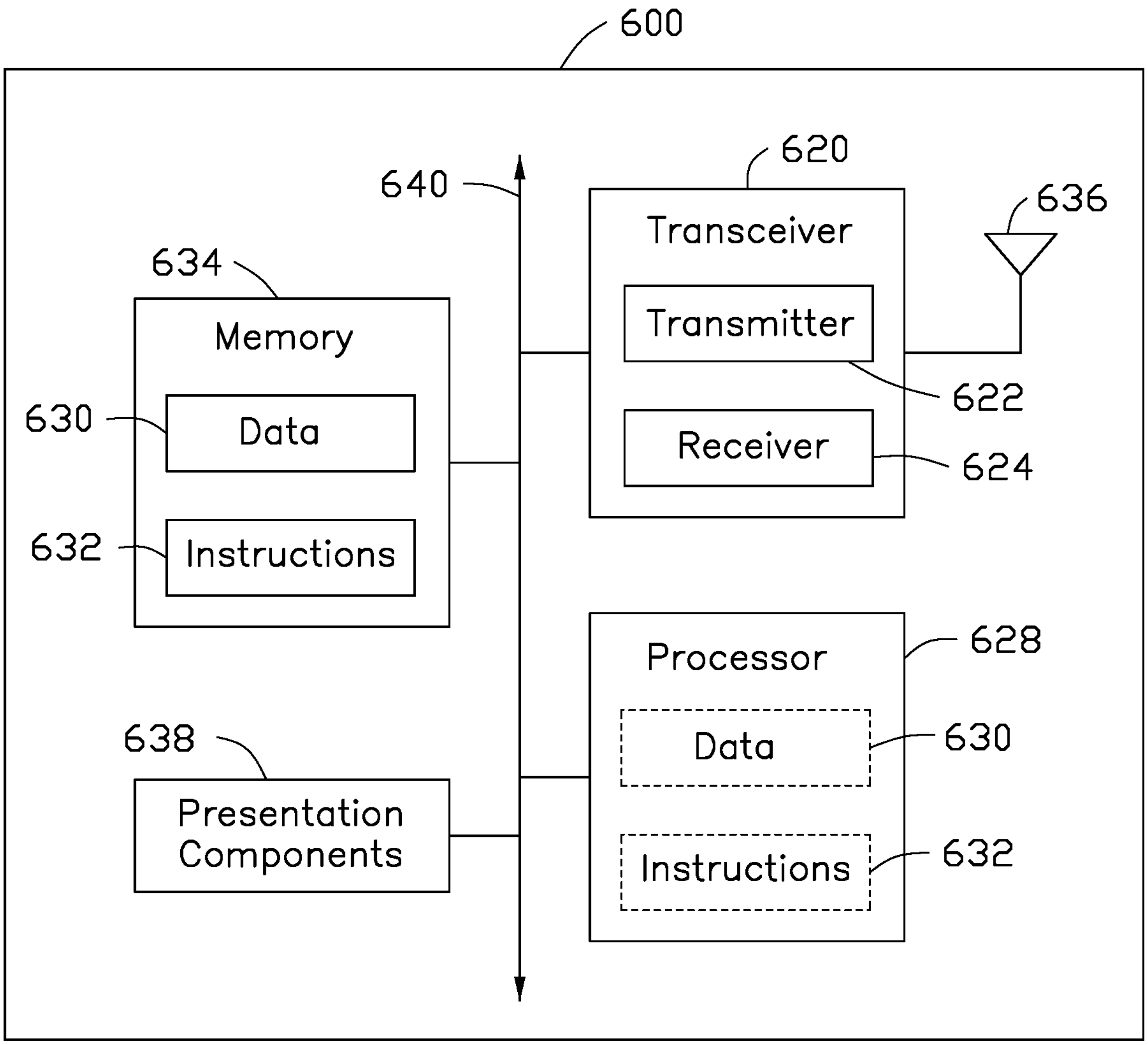

600
620
Transceiver
Transmitter
Receiver
622
624
636
640
634
Memory
Data
Instructions
630
632
Processor
628
Data
630
Instructions
632
638
Presentation Components

FIG. 6

METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present application claims the benefit of and priority to a provisional U.S. Patent Application Ser. No. 62/754,706 filed on Nov. 2, 2018, entitled "Procedure for Multiple Transmit/Receive Point," (hereinafter referred to as "US75391 application"). The disclosure of the US75391 application is hereby incorporated fully by reference into the present application.

FIELD

The present disclosure generally relates to wireless communications, and more particularly, to methods and apparatuses for multiple Transmit/Receive Point (TRP) operations.

BACKGROUND

Various efforts have been made to improve different aspects of wireless communications (e.g., data rate, latency, reliability, mobility, etc.) for the next generation (e.g., Fifth Generation (5G) New Radio (NR)) wireless communication systems. Among the new concepts in the next generation wireless communication systems, leveraging multiple TRPs may be vital to improve coverage, reliability, and capacity performance of the system. For example, in order to support the growth in data traffic in 5G and to enhance the coverage, the wireless devices may be expected to access networks composed of multiple TRPs.

However, in the current multi-TRP environment, all TRPs in a cell may have the same cell Identity (ID), which means a User Equipment (UE) may not be able to distinguish these TRPs from each other if there is no further identification or information for each TRP.

Therefore, there is a need in the art for an improved communication mechanism for multiple TRP operations.

SUMMARY

The present disclosure is directed to methods and apparatuses for multi-TRP operations.

According to an aspect of the present disclosure, a UE is provided. The UE includes one or more non-transitory computer-readable media having computer-executable instructions embodied thereon and at least one processor coupled to the one or more non-transitory computer-readable media. The at least one processor is configured to execute the computer-executable instructions to receive Transmission Configuration Indicator (TCI) state data in a Physical Download Control Channel (PDCCH) determining multiple Physical Downlink Shared Channels (PDSCHs), where the TCI state data is associated with multiple Demodulation Reference Signal (DMRS) port groups. The processor is further configured to obtain multiple Quasi Co-Location (QCL) assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

According to another aspect of the present disclosure, a method of wireless communications is provided. The method includes receiving, by a UE, TCI state data in a PDCCH determining multiple PDSCHs, where the TCI state data is associated with a multiple DMRS port groups. The method further includes obtaining, by the UE, multiple QCL assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. Various features are not drawn to scale. Dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

FIG. **1** is a schematic diagram illustrating a multi-TRP system, in accordance with example implementations of the present application.

FIG. **2** is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present application.

FIG. **3** is a schematic diagram illustrating multiple PDSCHs determined from a single PDCCH, in accordance with example implementations of the present application.

FIG. **4** is a flowchart for a process of identifying a secondary TRP (sTRP), in accordance with example implementations of the present application.

FIG. **5** is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present application.

FIG. **6** is a block diagram illustrating a node for wireless communication, in accordance with example implementations of the present application.

DETAILED DESCRIPTION

The following description contains specific information pertaining to example implementations in the present disclosure. The drawings in the present disclosure and their accompanying detailed description are directed to merely example implementations. However, the present disclosure is not limited to merely these example implementations. Other variations and implementations of the present disclosure will occur to those skilled in the art. Unless noted otherwise, like or corresponding elements among the figures may be indicated by like or corresponding reference numerals. Moreover, the drawings and illustrations in the present disclosure are generally not to scale and are not intended to correspond to actual relative dimensions.

For the purpose of consistency and ease of understanding, like features may be identified (although, in some examples, not shown) by the same numerals in the example figures. However, the features in different implementations may be differed in other respects, and thus shall not be narrowly confined to what is shown in the figures.

The description uses the phrases "in one implementation," or "in some implementations," which may each refer to one or more of the same or different implementations. The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The term "comprising," when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the equivalent. The expression "at least one of A, B and C" or "at least one of the following: A, B and C" means "only A, or only B, or only C, or any combination of A, B and C."

Additionally, for the purposes of explanation and non-limitation, specific details, such as functional entities, techniques, protocols, standard, and the like are set forth for providing an understanding of the described technology. In other examples, detailed description of well-known methods, technologies, systems, architectures, and the like are omitted so as not to obscure the description with unnecessary details.

Persons skilled in the art will immediately recognize that any network function(s) or algorithm(s) described in the present disclosure may be implemented by hardware, software or a combination of software and hardware. Described functions may correspond to modules which may be software, hardware, firmware, or any combination thereof. The software implementation may comprise computer executable instructions stored on computer readable medium such as memory or other type of storage devices. For example, one or more microprocessors or general-purpose computers with communication processing capability may be programmed with corresponding executable instructions and carry out the described network function(s) or algorithm(s). The microprocessors or general-purpose computers may be formed of Applications Specific Integrated Circuitry (ASIC), programmable logic arrays, and/or using one or more Digital Signal Processor (DSPs). Although some of the example implementations described in this specification are oriented to software installed and executing on computer hardware, nevertheless, alternative example implementations implemented as firmware or as hardware or combination of hardware and software are well within the scope of the present disclosure.

The computer readable medium includes but is not limited to Random Access Memory (RAM), Read Only Memory (ROM), Erasable Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM), flash memory, Compact Disc Read-Only Memory (CD-ROM), magnetic cassettes, magnetic tape, magnetic disk storage, or any other equivalent medium capable of storing computer-readable instructions.

A radio communication network architecture (e.g., a Long Term Evolution (LTE) system, an LTE-Advanced (LTE-A) system, an LTE-Advanced Pro system, or a 5G New Radio (NR) Radio Access Network (RAN)) typically includes at least one Base Station (BS), at least one User Equipment (UE), and one or more optional network elements that provide connection towards a network. The UE communicates with the network (e.g., a Core Network (CN), an Evolved Packet Core (EPC) network, an Evolved Universal Terrestrial Radio Access Network (E-UTRAN), a 5G Core (5GC), or an internet), through a RAN established by one or more BSs.

It should be noted that, in the present application, a UE may include, but is not limited to, a mobile station, a mobile terminal or device, a user communication radio terminal. For example, a UE may be a portable radio equipment, which includes, but is not limited to, a mobile phone, a tablet, a wearable device, a sensor, a vehicle, or a Personal Digital Assistant (PDA) with wireless communication capability. The UE is configured to receive and transmit signals over an air interface to one or more cells in a radio access network.

A BS may be configured to provide communication services according to at least one of the following Radio Access Technologies (RATs): Worldwide Interoperability for Microwave Access (WiMAX), Global System for Mobile communications (GSM, often referred to as 2G), GSM Enhanced Data rates for GSM Evolution (EDGE) Radio Access Network (GERAN), General Packet Radio Service (GPRS), Universal Mobile Telecommunication System (UMTS, often referred to as 3G) based on basic Wideband-Code Division Multiple Access (W-CDMA), High-Speed Packet Access (HSPA), LTE, LTE-A, eLTE (evolved LTE, e.g., LTE connected to 5GC), NR (often referred to as 5G), and/or LTE-A Pro. However, the scope of the present application should not be limited to the above-mentioned protocols.

A BS may include, but is not limited to, a node B (NB) as in the UMTS, an evolved Node B (eNB) as in the LTE or LTE-A, a Radio Network Controller (RNC) as in the UMTS, a Base Station Controller (BSC) as in the GSM/GERAN, a ng-eNB as in an Evolved Universal Terrestrial Radio Access (E-UTRA) BS in connection with the 5GC, a next generation Node B (gNB) as in the 5G-RAN, and any other apparatus capable of controlling radio communication and managing radio resources within a cell. The BS may serve one or more UEs through a radio interface.

The BS is operable to provide radio coverage to a specific geographical area using a plurality of cells forming the radio access network. The BS supports the operations of the cells. Each cell is operable to provide services to at least one UE within its radio coverage. More specifically, each cell (often referred to as a serving cell) provides services to serve one or more UEs within its radio coverage (e.g., each cell schedules the downlink and optionally uplink resources to at least one UE within its radio coverage for downlink and optionally uplink packet transmissions). The BS can communicate with one or more UEs in the radio communication system through the plurality of cells. A cell may allocate Sidelink (SL) resources for supporting Proximity Service (ProSe) or Vehicle to Everything (V2X) service. Each cell may have overlapped coverage areas with other cells.

As discussed above, the frame structure for NR is to support flexible configurations for accommodating various next generation (e.g., 5G) communication requirements, such as Enhanced Mobile Broadband (eMBB), Massive Machine Type Communication (mMTC), Ultra-Reliable and Low-Latency Communication (URLLC), while fulfilling high reliability, high data rate and low latency requirements. The Orthogonal Frequency-Division Multiplexing (OFDM) technology as agreed in the 3^{rd} Generation Partnership Project (3GPP) may serve as a baseline for NR waveform. The scalable OFDM numerology, such as the adaptive sub-carrier spacing, the channel bandwidth, and the Cyclic Prefix (CP) may also be used. Additionally, two coding schemes are considered for NR: (1) Low-Density Parity-Check (LDPC) code and (2) Polar Code. The coding scheme adaptation may be configured based on the channel conditions and/or the service applications.

Moreover, it is also considered that in a transmission time interval TX of a single NR frame, a Downlink (DL) transmission data, a guard period, and an Uplink (UL) transmission data should at least be included, where the respective portions of the DL transmission data, the guard period, the UL transmission data should also be configurable, for example, based on the network dynamics of NR. In addition, SL resources may also be provided in an NR frame to support ProSe services or V2X services.

In addition, the terms “system” and “network” herein may be used interchangeably. The term “and/or” herein is only an association relationship for describing associated objects, and represents that three relationships may exist. For example, A and/or B may indicate that: A exists alone, A and B exist at the same time, or B exists alone. In addition, the character “/” herein generally represents that the former and latter associated objects are in an “or” relationship.

FIG. **1** is a schematic diagram illustrating a multi-TRP system **100**, in accordance with example implementations of the present application. As shown in FIG. **1**, the multi-TRP system **100** includes a UE **102**, a BS **104**, and TRPs **106** and **108**. It should be noted that even though two TRPs are included in the example implementation illustrated in FIG. **1**, any number of TRPs may communicate with the UE in some other implementations. In addition, each TRP may communicate with the BS **104** through a wired or wireless connection.

The TRPs **106** and **108** may be macro-cells, small-cells, pico-cells, femto-cells, Remote Radio Heads (RRHs), relay nodes or antenna panels, which may be deployed anywhere such as in the interior of a room, in/on a building, on top of a house or streetlamps. The UE **102** may connect to the BS **104** through the TRPs **106** and **108**.

Each of the TRPs **106** and **108** may have one or more antenna panels to provide directional beams towards the UE **102**. The antenna panels distributed on the TRPs may be jointly used in the data transmissions to the UE, thereby forming a Multi-Input Multi-Output (MIMO) system.

FIG. **2** is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present application.

In action **202**, the UE may receive TCI state data in a PDCCH determining multiple PDSCHs. The TCI state data may be associated with multiple DMRS port groups. In action **204**, the UE may obtain multiple QCL assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

The QCL assumptions may include different parameters, such as the spatial-domain QCL parameters (e.g., QCL TypeD parameter), or other QCL parameters such as, at least one of the average delay, the delay spread, the Doppler shift, and the Doppler spread. For example, each QCL assumption may include at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

In some of the present implementations, the UE may identify different TRPs (e.g., the TRPs **106** and **108** in FIG. **1**) based on the QCL assumptions.

In some of the present implementations, each QCL assumption may correspond to one of the DMRS port groups associated with the TCI state data. For example, the QCL assumptions and the DMRS port groups may have a one-to-one mapping relationship. In some of the present implementations, the UE may receive the DMRS port groups corresponding to the PDSCHs via a Radio Resource Control (RRC) signaling.

In some of the present implementations, the mapping relationship between the QCL assumptions and the DMRS port groups may be modified. For example, the UE may receive an instruction for indicating a relationship (e.g., a mapping relationship) between the QCL assumptions and the DMRS port groups via a Medium Access Control (MAC) Control Element (CE), Downlink Control Information (DCI), or an RRC signaling. In some of the present implementations, indicating the relationship between the QCL assumptions and the DMRS port groups may include at least one of modifying, adding, deleting, and selecting the relationship between the QCL assumptions and the DMRS port groups. In some other implementations, the UE may be configured with a timer, and the mapping relationship between the QCL assumptions and the DMRS port groups may be modified when the timer expires.

In some of the present implementations, the TCI state of a DL channel (e.g., a PDCCH or a PDSCH) may include multiple QCL Reference Signal (RS) sets, and each QCL RS set may correspond to one DMRS port group. For example, the TCI state data may correspond to a TCI state configuration that includes multiple QCL RS sets, and each of the QCL RS sets may correspond to one of the DMRS port groups associated with the TCI state data.

FIG. **3** is a schematic diagram illustrating multiple PDSCHs determined from a single PDCCH, in accordance with example implementations of the present application. As shown in FIG. **3**, the UE may receive DCI that contains a TCI state data (e.g., a TCI code point) from the PDCCH **302**. After successfully decoding the TCI code point, the UE may obtain multiple TCI states each being associated with one DMRS port group. For example, each TCI state may contain parameters for configuring the QCL relationship between the DL/UL RS(s) and the DM-RS port(s) of a corresponding PDSCH. The QCL relationship may be configured by higher layer parameters, such as qcl-Type1 and qcl-Type2. In addition, the QCL type (e.g., QCL-TypeA, QCL-TypeB, QCL-TypeC and QCL-TypeD) corresponding to each DL RS may be given by a higher layer parameter (e.g., qcl-Type) in the QCL assumption/information. In some other implementations, the TCI state data may be a TRP index that is configured per a cell/Component Carrier (CC), or Bandwidth Part (BWP) basis.

In the example implementation, the UE may derive multiple PDSCHs based on the DMRS port groups associated with the TCI state data in the DCI, because each DMRS port group may correspond to one PDSCH. As shown in FIG. **3**, if the TCI state data is associated with DMRS port group #1 and DMRS port group #2, which are configured by the BS via an RRC signaling, the UE may then determine the QCL assumptions for PDSCH #1 **304** and PDSCH #2 **306** based on the DMRS port group #1 and DMRS port group #2, respectively. Each of the PDSCHs (e.g., PDSCH #1 **304** and PDSCH #2 **306**) derived from the PDCCH **302** may correspond to a TRP. As shown in FIG. **3**, the PDSCH #1 **304** and PDSCH #2 **306** may be associated with TRPs **308** and **310**, respectively. In some of the present implementations, after determining the QCL assumptions for the PDSCH #1 **304** and the PDSCH #2 **306**, the UE may use them to identify the TRPs **308** and **310**.

In some other implementations, the DCI in the PDCCH **302** may schedule a single PDSCH (not illustrated in FIG. **3**), and the TRPs **308** and **310** may correspond to different transmission layers of this PDSCH. Each transmission layer may correspond to a data stream from a TRP.

In some of the present implementations, when a UE performs an initial access procedure successfully, the UE may obtain the resource(s) of a Downlink (DL)/Uplink (UL) channel/beam for communicating with the BS through a certain TRP. This TRP may be referred to as an initial access TRP. In some of the present implementations, the resource of a DL channel/beam may be a Synchronization Signal (SS)/Physical Broadcast Channel (PBCH) Block (SSB), and the UL channel/beam may be a Physical Random Access Channel (PRACH). The UE may select the SSB through a random access procedure, and use the corresponding resources (e.g., which are configured with the same spatial QCL (sQCL) assumption as the selected SSB) to perform channel/beam measurements.

In some of the present implementations, the UE may be configured with resources that are orthonormal to the SSB to perform the channel/beam measurements.

In some of the present implementations, a TRP may be classified as a primary TRP (pTRP) or a secondary TRP (sTRP) for further operations. For example, the UE may adopt different time-domain behaviors (e.g., the aperiodic/semi-persistent/periodic reporting behavior) to report Channel State Information (CSI)/beam measurement results to the pTRP(s) and sTRP(s). For example, the UE may adopt a periodic or semi-persistent reporting process with respect to the RS resource(s) coming from the pTRP, and apply an aperiodic reporting process with respect to the RS resource(s) coming from the sTRP.

In some of the present implementations, the UE may perform Beam Management (BM) procedures based on the network-configured resources. The UE may report the measurement results to the BS to help the BS to determine the primary communication link (e.g., including the pTRP) to the UE. For example, the BS may schedule a qualified resource (e.g., a beam/channel with a quality value exceeding a predetermined threshold) as the primary communication link to the UE. In this case, the TRP transmitting the qualified resource may be deemed as the pTRP.

In some of the present implementations, the UE may be notified to change its pTRP if the quality of the resource from the original pTRP changes. It should be noted that the number of the qualified resources and the pTRPs may be arbitrary.

In some of the present implementations, one or more antenna panels may be embedded in a single TRP. Each antenna panel may transmit at least one resource (beam/channel) in a time unit.

In some of the present implementations, the pTRP may be determined in an implicit way. For example, a TRP at which a specific resource is transmitted may be determined as a pTRP. The specific resource may include at least one of an SSB, a Channel State Information Reference Signal (CSI-RS), a Sounding Reference Signal (SRS), a PDCCH, a PDCCH that Control Resource Set (CORESET) #0 or search space #0 is located, a broadcast signal (e.g., a PBCH), a PDSCH of Remaining Minimum System Information (RMSI), and a beam/channel having a quality that exceeds a predetermined threshold. In some other implementations, the pTRP for the UE may be determined in an explicit way. For example, the BS may indicate one or more pTRPs to the UE via an RRC signaling, a MAC-CE or DCI.

In some of the present implementations, for those TRPs that are not selected as the pTRP(s), they may be determined as sTRPs for the UE if these TRPs satisfy certain condition(s), as shown in FIG. **4**.

FIG. **4** is a flowchart for a process of identifying an sTRP, in accordance with example implementations of the present application. In action **402**, the UE may obtain a first signal quality value (Q1) for a first resource from a pTRP. In action **404**, the UE may obtain a second signal quality value (Q2) for a second resource from a candidate sTRP. The values, Q1 and Q2, may be (but not limited to) Layer 1 (L1)-Reference Signals Received Power (RSRP) values, L1-Reference Signals Received Quality (RSRQ) values, L1-Signal to Interference plus Noise Ratio (SINR) values, RSRP values, RSRQ values, SINR values, or any combination thereof.

In action **406**, the UE may determine whether the difference between Q1 and Q2 is less than, or equal to, a predetermined threshold (TH). In some of the present implementations, the predetermined threshold TH may be configured by the BS.

If the outcome of action **406** is "yes", the UE, in action **408**, may transmit a first report to inform the BS that the candidate sTRP associated with the second resource is qualified to pair with the pTRP. In response to the first report, the BS may add this candidate sTRP as an sTRP for the UE, and inform the UE of the information of the pTRP(s) and/or sTRP(s). Conversely, if the outcome of action **406** is "no", the UE, in action **410**, may transmit a second report to inform the BS that the candidate sTRP associated with the second resource is not qualified to pair with the pTRP. In this case, the BS may decide not to add this candidate sTRP as an sTRP for the UE.

In some of the present implementations, the first and second resources described in actions **402** and **404** may be composite resources. A composite resource may be the first one (or a predetermined one) of the resources in a resource set that is configured for the TRP, or a union resource among all the resource(s) in the resource set, or a resource corresponding to a statistical average beam direction of the TRP. The UE may receive the composite resource of a composite beam/channel from each TRP based on a corresponding QCL assumption. In some of the present implementations, the composite resource may be a TRP-specific resource or a cell-specific resource if the composite resource is composited by at least one SSB resource. Conversely, if the composite resource is not composited by any SSB resource, the composite resource may be a UE-specific resource. In some of the present implementations, the composite resource may be transmitted in a broadcast manner, and compared to a resource that is used in a single-TRP BM procedure, the composite resource may correspond to a wider beam.

Using the composite resources may help the UE perform multi-TRP measurements more efficiently, because the UE may only need to measure one resource (composite resource) for each TRP at the beginning of the measurement.

In some of the present implementations, when several TRPs are distributed around the UE, the UE may be configured with a composite resource set. Each composite resource in the composite resource set may represent an average beam direction of an individual TRP. In this manner, the UE may report suitable TRP pairs to the BS quickly.

In some of the present implementations, once the pTRP(s) and sTRP(s) are determined, the BS may collect these pTRP(s) and sTRP(s) in a serving TRP set, and inform the UE of this serving TRP set via RRC signaling, a MAC CE, DCI, or any combination thereof.

In some of the present implementations, a variation in beam/channel quality may lead to a change in the configuration of the pTRP(s) and/or sTRP(s). For example, when the BS detects that the TRP with the best/qualified beam quality has changed, the BS may instruct the UE to modify/select the related configurations of the pTRP(s) and/or sTRP(s) to change the pTRP(s) and/or sTRP(s).

In some of the present implementations, the UE may receive a trigger event with a predetermined offset from the BS. The UE may determine whether the difference between the beam/channel quality of the pTRP and that of the sTRP exceeds this predetermined offset. If the determination's result is positive, the UE may transmit a report to request the BS to modify/select the related configurations of the pTRP(s) and/or sTRP(s).

In some of the present implementations, the UE may monitor the CORESET of a TRP based on a QCL assumption that is made for monitoring a PDCCH that schedules multiple PDSCHs. In this case, each PDSCH may be transmitted from a separate TRP. In some other implementations, the UE may monitor the CORESET of a TRP based on a QCL assumption that is made for monitoring a PDCCH that schedules a single PDSCH. In this case, different transmission layers of this PDSCH may be transmitted by the respective TRPs. In some other implementations, the UE may monitor the CORESET of a TRP based on multiple QCL assumptions that are made for monitoring multiple PDCCHs, each scheduling a PDSCH, and each NR-PDSCH may be transmitted from a separate TRP. In some other implementations, the UE may monitor the CORESET of a

TRP based on multiple QCL assumptions that are made for monitoring multiple PDCCHs, each scheduling a PDSCH, and each NR-PDSCH may be transmitted from a separate TRP.

FIG. **5** is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present disclosure.

In action **502**, an initial access TRP is setup after the UE successfully performs an initial access procedure. For example, after successfully performing the initial access procedure, the UE may get a DL/UL resource (e.g., channel/beam) to communicate with the BS through a TRP. This TRP may be set as the initial access TRP for the UE. The initial access TRP may be used as a pTRP from the UE's perspective.

In action **504**, the UE may receive configuration(s) for channel/beam measurement(s). For example, the UE may receive the configurations of K (e.g., K=0, 1, 2, . . .) resource(s) and/or L (e.g., L=0, 1, 2, . . .) resource for channel/beam measurements. The UE may apply the same QCL assumption as the SSB on which the UE camps during the random access procedure to receive the K resource(s). In addition, the L resource(s) may be orthonormal to the SSB on which the UE camps during the random access procedure. In some of the present implementations, the resources in the same resource set may have the same time-domain behavior, and each RS may correspond to a channel/beam of a TRP.

In action **506**, the UE may perform channel/beam measurement(s) according to the configuration. For example, the UE may perform the channel/beam measurement(s) according to the configuration(s) of the K and/or L resource(s). The UE may obtain the channel/beam statues/quality information (e.g. L1-RSRP, L1-RSRQ, L1-SINR, RSRP, RSRQ, SINR, or any combination thereof) from the channel/beam measurement. In some of the present implementations, the spatial domain filter information for receiving each DL resource may be obtained from the measurement. The spatial domain information may include at least one Receive (RX) radiation pattern and/or RX panel.

In some of the present implementations, the UE may report at least one of the resource indicator (or beam index), the measurement metric information, and the correlation information according to the configuration(s) obtained in action **504**. The resource indicator may be, but not limited to, an SSB resource indicator (if the resource is an SSB), a CSI-RS resource indicator (if the resource is a CSI-RS), a DMRS resource indicator (if the resource is a DMRS), or an SRS resource indicator. The measurement metric information may be, but not limited to, an L1-RSRP, an L1-RSRQ, an L1-SINR, a RSRP, a RSRQ, an SINR, or any combination thereof. In some of the present implementations, the measurement metric information that is related to a resource may be differentially encoded with respective to another resource. For example, a differential L1-RSRP offset level for the 2^{nd} measured resource may be obtained by subtracting L1-RSRP #1 from L1-RSRP #2, where L1-RSRP #1 is an L1-RSRP obtained from the 1^{st} resource measurement, and L1-RSRP #2 is an L1-RSRP obtained from the 2^{nd} resource measurement. The correlation information may include a correlation factor/indicator that indicates the spatial correlation between two or more observed resources. In some of the present implementations, the UE may compare the spatial correlation factor/indicator with a correlation threshold to determine whether the spatial correlation between the observed resources is high or not. The correlation threshold may be configured by the BS or determined based on the UE's implementations. The UE may be instructed to report the highest and/or lowest spatial correlation factor/indicator. In some of the present implementations, the correlation information may include at least one of a high/low correlation indicator and the indicators of the observed resources. The high/low correlation indicator may be used for indicating that the spatial correlation between the observed resources is high/low.

In some of the present implementations, the BS may determine compatible resources for serving the TRPs, based on the correlation information received from the UE, to improve the spatial diversity/multiplexing performance. In some of the present implementations, the correlation factor/indicator may be obtained by calculating the Angle-of-Arrival (AoA) related parameters for the channel/beams of the RS resources from the TRPs.

In action **508**, the UE may receive a message of a multi-TRP indication (e.g., indicating the information of pTRP(s) and/or sTRP(s)). For example, the message for indicating the information of pTRP(s) may contain at least one TCI-state indication that indicates a reference RS resource for a DL control channel and/or an SSB selected through the random access procedure. In this case, CORESET #0 or search space #0 may be located in the reference RS resource. In addition, the message for indicating the information of sTRP(s) may include at least one TCI-state indication that indicates at least one reference resource(s) for the DL shared channel(s). In this case, the UE may know that the TRP transmitting the indicated reference resource is an sTRP. In some of the present implementations, the TCI-state indication may correspond to one or more DMRS port groups, and each DMRS port group ID may correspond to a TRP ID.

In some of the present implementations, the target RS port/resource group (e.g., the DMRS port group of a PDSCH/PDCCH) may have the same QCL assumption as that of the source TRP-RS resource, which means the UE may assume that all ports/resources in the same target RS port/resource group may be from the same TRP, while the ports/resources in different target RS port/resource groups may be from different TRPs.

In action **510**, the UE may receive a message to terminate the multi-TRP operation and/or reset the multi-TRP configuration. For example, after receiving the message, the UE may terminate, cancel, or reset at least one of the correlation information of the reference RS resources among the TRPs, the TRP setting (e.g., including the resource setting and/or reporting setting), and the correspondence among the DMRS ports, DMRS port groups, TCI states, and QCL assumptions. In some of the present implementations, if there is no UE-specific scheduling for a while (e.g., before a timer expires), or a BWP switching happens, the UE may release the previous setting/configuration.

In some of the present implementations, the configuration that the UE receives in action **504** may be the composite resource configuration for the composite beam/channel from each TRP. The UE may perform channel/beam measurements on the composite resources of the respective TRPs. In this manner, the channel/beam measurements may be performed more efficiently, because the UE may only need to measure one resource (composite resource) for each TRP.

In some of the present implementations, the BS may indicate at least one pTRP resource set to the UE through at least one of the configuration of the pTRP, the predetermined resource(s) associated with the pTRP ID, and the best channel quality determined by the BS or UE.

AO 120 (Rev. 08/10)

TO: **Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Western District of Texas on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED 3/28/2022	U.S. DISTRICT COURT Western District of Texas
PLAINTIFF TOGAIL TECHNOLOGIES LTD.		DEFENDANT APPLE INC.

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,743,238	8/11/2020	TOGAIL TECHNOLOGIES LTD.
2 10,791,502	9/29/2020	TOGAIL TECHNOLOGIES LTD.
3 10,972,972	4/6/2021	TOGAIL TECHNOLOGIES LTD.
4 11,115,165	9/7/2021	TOGAIL TECHNOLOGIES LTD.
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

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AO 120 (Rev. 08/10)

TO: **Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Western District of Texas on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED 3/28/2022	U.S. DISTRICT COURT Western District of Texas
PLAINTIFF TOGAIL TECHNOLOGIES LTD.		DEFENDANT GOOGLE INC.

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,743,238	8/11/2020	TOGAIL TECHNOLOGIES LTD.
2 10,791,502	9/29/2020	TOGAIL TECHNOLOGIES LTD.
3 10,972,972	4/6/2021	TOGAIL TECHNOLOGIES LTD.
4 11,115,165	9/7/2021	TOGAIL TECHNOLOGIES LTD.
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

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Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

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AO 120 (Rev. 08/10)

TO: **Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Western District of Texas on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED 3/28/2022	U.S. DISTRICT COURT Western District of Texas
PLAINTIFF TOGAIL TECHNOLOGIES LTD.		DEFENDANT SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS AMERICA, INC.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,743,238	8/11/2020	TOGAIL TECHNOLOGIES LTD.
2 10,791,502	9/29/2020	TOGAIL TECHNOLOGIES LTD.
3 10,972,972	4/6/2021	TOGAIL TECHNOLOGIES LTD.
4 11,115,165	9/7/2021	TOGAIL TECHNOLOGIES LTD.
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/673,151	09/07/2021	11115165	US78241	6936

54000 7590 08/18/2021

ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 88 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

TSUNG-HUA TSAI, Hsinchu, TAIWAN;
FG Innovation Company Limited, Tuen Mun, HONG KONG;
CHIE-MING CHOU, Hsinchu, TAIWAN;

IR103 (Rev. 10/09)

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	16673151
	Filing Date	2019-11-04
	First Named Inventor	TSUNG-HUA TSAI
	Art Unit	
	Examiner Name	
	Attorney Docket Number	US78241

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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Examiner Initial*	Cite No	Publication Number	Kind Code1	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
Change(s) applied to document, /M.G./ 6/22/2021	1	2018302889	A1	2018-10-18	Guo, et al. ~~SAMSUNG ELECTRONICS CO., LTD.~~	the whole document

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Examiner Initial*	Cite No	Foreign Document Number3	Country Code2 i	Kind Code4	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T5
	1	2018128376	WO	A1	2018-07-12	LG ELECTRONICS INC.	description, paragraphs [108], [152]-[153], [162]-[164] and [365]-[382]	
	2	108199819	CN	A	2018-06-22	ZTE CORPORATION	At least the Abstract	X
	3	108092754	CN	A	2018-05-29	ZTE CORPORATION	At least the Abstract	☒

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.G./

PART B – FEE(S) TRANSMITTAL

Complete and send this form, together with the applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

By fax, send to: (571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

54000 7590 06/16/2021
ScienBiziP, P.C.
550 S. Hope Street, Suite 2825
Los Angeles, CA 90071

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO	CONFIRMATION NO
16/673151	11/04/2019	TSUNG-HUA TSAI	US78241	6936

TITLE OF INVENTION:

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	Undiscounted	1200			1200	09/16/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363)

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1. ScienBiziP, P.C.
2.
3.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: FG Innovation Company Limited

(B) RESIDENCE: (CITY and STATE or COUNTRY): Tuen Mun, HONG KONG

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☑ Corporation or other private group entity ☐ Government

4a. Fees Submitted: ☑ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _________

4b. Method of Payment (*Please first reapply any previously paid fee shown above*):

☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 60-2615

5. Change of Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29.
NOTE: Absent a valid Certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27.
NOTE: If the application was previously under micro entity status, checking this box will be taken as a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken as a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Calvin H Chai/ Date 07/29/2021

Typed or printed name Calvin H Chai Registration No. 68009

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	16673151
Filing Date:	04-Nov-2019
Title of Invention:	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
Filer:	Calvin H Chai
Attorney Docket Number:	US78241

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1200**

Electronic Acknowledgement Receipt

EFS ID:	43431221
Application Number:	16673151
International Application Number:	
Confirmation Number:	6936
Title of Invention:	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
Customer Number:	54000
Filer:	Calvin H Chai
Filer Authorized By:	
Attorney Docket Number:	US78241
Receipt Date:	05-AUG-2021
Filing Date:	04-NOV-2019
Time Stamp:	05:12:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1200
RAM confirmation Number	E202185612304599
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	US7824120210729FIF.pdf	322519 07d135f78e457c350d4a7774c0246b4f90743c7e	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37838 cdece9c1901c5a6cf32bc940d5757e6a0aeeb205	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	360357	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

Courtesy Reminder for
Application Serial No: 16/673,151

Attorney Docket No: US78241
Customer Number: 54000
Date of Electronic Notification: 06/16/2021

This is a courtesy reminder that new correspondence is available for this application. If you have not done so already, please review the correspondence. The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

An email notification regarding the correspondence was sent to the following email address(es) associated with your customer number:

eoa-proce@scienbizip.com
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To view your correspondence online or update your email addresses, please visit us anytime at **https://ppair-my.uspto.gov/pair/PrivatePair.**
If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov or call 1-866-217-9197.

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NOTICE OF ALLOWANCE AND FEE(S) DUE

54000 7590 06/16/2021

ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

EXAMINER	
ABELSON, RONALD B	
ART UNIT	PAPER NUMBER
2476	

DATE MAILED: 06/16/2021

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/673,151	11/04/2019	TSUNG-HUA TSAI	US78241	6936

TITLE OF INVENTION: METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	09/16/2021

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
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By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

54000 7590 06/16/2021

ScienBiziP, PC
550 South Hope Street
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Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/673,151	11/04/2019	TSUNG-HUA TSAI	US78241	6936

TITLE OF INVENTION: METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	09/16/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
ABELSON, RONALD B	2476	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1__________________________

2__________________________

3__________________________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies ________________

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. __________

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature ____________________________ Date __________________________

Typed or printed name ____________________________ Registration No. ________________________

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Los Angeles, CA 90071

EXAMINER	
ABELSON, RONALD B	

ART UNIT	PAPER NUMBER
2476	

DATE MAILED: 06/16/2021

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	**Application No.** 16/673,151	**Applicant(s)** TSAI et al.	
	Examiner RONALD B ABELSON	**Art Unit** 2476	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1.☑ This communication is responsive to 6/8/21.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ______.

2.☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ______; the restriction requirement and election have been incorporated into this action.

3.☑ The allowed claim(s) is/are 1-2,4-5,7-10,12-13 and 15-16 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4.☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ______ .
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ______ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5.☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ______ .

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6.☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1.☑ Notice of References Cited (PTO-892)
2.☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ______.
3.☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material ______.
4.☐ Interview Summary (PTO-413), Paper No./Mail Date. ______.
5. ☑ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other ______.

/RONALD B ABELSON/
Primary Examiner, Art Unit 2476

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Examiner's Amendment

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this amendment was given by Amir Bahrami on 6/8/21.

1. (**Currently Amended**) A user equipment (UE) comprising:

one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to:

receive, in a Physical Download Control Channel (PDCCH), Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data, wherein:

each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups,

the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and

each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

2. (**Original**) The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

identify a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

3. (**Canceled**)

4. (**Previously Presented**) The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium Access Control (MAC) Control Element (CE) signaling.

5. (**Original**) The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

indicate a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

6. (**Canceled**)

7. (**Previously Presented**) The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive the plurality of DMRS port groups via Radio Resource Control (RRC) signaling, wherein the plurality of DMRS port groups is associated with the plurality of PDSCHs.

8. (**Original**) The UE of claim 1, wherein each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

9. (**Currently Amended**) A method of wireless communications by a user equipment (UE), the method comprising:

receiving, in a Physical Download Control Channel (PDCCH) Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtaining a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data, wherein:

each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups,

the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and

each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

10. (**Previously Presented**) The method of claim 9, further comprising:

identifying a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

11. (**Canceled**).

12. (**Previously Presented**) The method of claim 9, further comprising:

receiving an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium Access Control (MAC) Control Element (CE) signaling.

13. (**Previously Presented**) The method of claim 9, further comprising:

indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

14. (**Canceled**)

15. (**Previously Presented**) The method of claim 9, further comprising:

receiving the plurality of DMRS port groups via Radio Resource Control (RRC) signaling, wherein the plurality of DMRS port groups is associated with the plurality of PDSCHs.

16. (**Original**) The method of claim 9, wherein each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

Prior Art of Record

Claim 4, 12: Guan US 20200178280 [0372] teaches MAC signaling to indicate QCL relationship with DMRS port group.

Conclusion

Any comments considered necessary by the applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments of Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to RONALD B ABELSON whose telephone number is (571)272-3165. The examiner can normally be reached on M-F 8:00-4:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ayaz Sheikh can be reached on 571-272-3795. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service

Representative or access to the automated information system,

call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/RONALD B ABELSON/
Primary Examiner, Art Unit 2476

Notice of References Cited	Application/Control No. 16/673,151	Applicant(s)/Patent Under Reexamination TSAI et al.	
	Examiner RONALD B ABELSON	Art Unit 2476	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
	A	20200178280	06-2020	Guan	H04B 7/0626	
	B					
	C					
	D					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	**Application/Control No.** 16/673,151	**Applicant(s)/Patent Under Reexamination** TSAI et al.
	Examiner RONALD B ABELSON	**Art Unit** 2476

CPC						
Symbol					**Type**	**Version**
H04L	/	5	/	0048	F	2013-01-01
H04W	/	72	/	042	I	2013-01-01
H04L	/	5	/	0023	I	2013-01-01
H04L	/	5	/	0035	I	2013-01-01
H04L	/	5	/	0053	I	2013-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 12	
/RONALD B ABELSON/ Primary Examiner, Art Unit 2476 10 June 2021 (Primary Examiner) (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

U.S. Patent and Trademark Office Part of Paper No.: 20210605

Issue Classification	Application/Control No. 16/673,151	Applicant(s)/Patent Under Reexamination TSAI et al.
	Examiner RONALD B ABELSON	Art Unit 2476

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04L	/	1	/	00
H04W	/	72	/	04

NON-CLAIMED				
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US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE (Assistant Examiner)	(Date)	Total Claims Allowed: 12	
/RONALD B ABELSON/ Primary Examiner, Art Unit 2476 (Primary Examiner)	10 June 2021 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/673,151	TSAI et al.
	Examiner	**Art Unit**
	RONALD B ABELSON	2476

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	8	10												
2	2		11												
	3	9	12												
3	4	10	13												
4	5		14												
	6	11	15												
5	7	12	16												
6	8														
7	9														

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 12	
/RONALD B ABELSON/ Primary Examiner, Art Unit 2476 (Primary Examiner)	10 June 2021 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Index of Claims	Application/Control No. 16/673,151	Applicant(s)/Patent Under Reexamination TSAI et al.
	Examiner RONALD B ABELSON	Art Unit 2476

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE									
Final	Original	11/22/2020	06/10/2021								
1	1	✓	=								
2	2	✓	=								
	3	O	-								
3	4	O	=								
4	5	O	=								
	6	O	-								
5	7	✓	=								
6	8	✓	=								
7	9	✓	=								
8	10	O	=								
	11	O	-								
9	12	O	=								
10	13	O	=								
	14	O	-								
11	15	✓	=								
12	16	✓	=								

Search Notes	Application/Control No. 16/673,151	Applicant(s)/Patent Under Reexamination TSAI et al.
	Examiner RONALD B ABELSON	Art Unit 2476

CPC - Searched*		
Symbol	**Date**	**Examiner**
h04l5/0048 h04l5/0023 h04l5/0035 h04l5/0053	06/10/2021	RA
h04w72/042	06/10/2021	RA

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
CPC combined with limited text search in EAST	06/10/2021	RA

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
h04l	5/0048, 5/0023, 5/0035, 5/0053	06/10/2021	RA
h04w	72/042	06/10/2021	RA

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	38,009	h04l5/0048 h04l5/0023 h04l5/0035 h04l5/0053 h04w72/042	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/10 07:33
L2	346	quasi adj1 (colocation co adj1 location) near3 assumption with qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/10 07:33
L3	208	L1 and L2	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/10 07:33
L4	208	L3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/10 07:33
L5	1	"20200178280".pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/10 07:34
L6	1	"16673151"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/10 07:38
L7	1	L6	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/10 07:38
S1	1	"16673151"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:49
S2	1	S1 and qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:50
S3	1,899	quasi adj1 (colocation co adj1 location) with qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:51
S4	244	quasi adj1 (colocation co adj1 location) near3 assumption with qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:52
S5	53	pdcch with tci with pdsch same dmrs	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:53
S6	19	pdcch with tci with pdsch same dmrs with port same qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:54

S7	5	pdcch with tci with pdsch same dmrs with port near2 group same qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:57
S8	5	pdcch with tci with pdsch same dmrs with port near2 group$4 same qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:57
S9	16	pdcch with tci with pdsch near3 (multiple plurality)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:10
S10	39	tci with pdsch near3 (multiple plurality)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:13
S11	23	S10 not S9	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:13
S12	2	("20200107353" "20190387579").pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:28
S13	0	S12 and tci with dmrs with port with group	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:28
S14	1	S12 and tci with dmrs	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:29
S15	2	S11 and S12	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:30
S16	0	S14 and qcl with pdsch with dmrs with tci	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:33
S17	1	S14 and qcl same pdsch same dmrs same tci	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:34
S18	1	"20200107353"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:32
S19	33,738	h04l5/0048 h04l5/0023 h04l5/0035 h04l5/0053 h04w72/042	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:43
S20	252	quasi adj1 (colocation co adj1 location) near3 assumption with qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:44
S21	152	S19 and S20	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:44

S22	1	"20200107353".pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:30
S23	0	S22 and tci with dmrs with port with group$3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:32
S24	1	S22 and dmrs with port with group$3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:33
S25	2	("20200107353" "20190387579").pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:35
S26	0	S25 and tci with dmrs with port with group	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:35
S27	16	dmrs with port near3 group$3 with qcl near2 assumption	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:36
S28	4	dmrs with port near3 group$3 with qcl near2 assumption same tci same pdsch	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:37
S29	30	pdcch with tci with pdsch and tci with dmrs near3 port near2 group$3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:42
S30	27	pdcch with tci with pdsch and tci near2 state with dmrs near3 port near2 group$3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:49
S31	27	pdcch with tci near2 state with pdsch and tci near2 state with dmrs near3 port near2 group$3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 07:49
S32	8	pdcch with tci near2 state with pdsch near3 (multiple plurality group$3) and tci near2 state with dmrs near3 port near2 group$3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/10 08:04
S34	1	"16673151"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 07:44
S35	1	S34 and tci	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 07:44
S36	1	S34 and qcl adj1 assumption	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 07:46
S37	1	"20200015200".pn. and qcl adj1 assumption	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:14

S38	435	qcl adj1 assumption with (trp base adj1 station access adj1 point enb enodeb)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:14
S39	7	qcl adj1 assumption with (trp base adj1 station access adj1 point enb enodeb) near4 (id identif$4 identification)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:15
S40	10	qcl adj1 assumption with (trp base adj1 station access adj1 point enb enodeb) near4 (correspond$4 id identif$4 identification)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:17
S41	3	S40 not S39	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:17
S42	1	qcl adj1 assumption with (dmrs near3 port near2 group$4) near4 (correspond$4 id identif$4 identification)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:30
S43	1	qcl adj1 assumption with (dmrs near3 port near2 group$4) with (correspond$4 id identif$4 identification)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:31
S44	7	qcl adj1 assumption with (d port near2 group$4) with (correspond$4 id identif$4 identification)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:31
S46	32	tci with qcl same qcl with dmrs near3 port near2 group$4	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:33
S47	32	tci adj1 state with qcl same qcl with dmrs near3 port near2 group$4	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:34
S48	2	tci adj1 state near3 configuration with qcl near3 (group$4 set) same qcl with dmrs near3 port near2 group$4	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:35
S49	6	dmrs near3 port near2 group$4 with pdsch with rrc	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:36
S50	20	qcl adj1 assumption with (time adj1 frequency spatial) near3 domain	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:42
S51	6	("20200045700" "20200221487" "20200015200" "20170288743" "20140321414" "20190230545").pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 09:57
S52	1	"20200235901".pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/02/11 10:04
S53	24	qcl near3 assumption with dmrs near2(port near2 group$4)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 07:44

S54	0	S53 and ("20200045700" "20200221487").pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:31
S55	1	qcl near3 assumption with dmrs near2(port near2 group$4) same mac	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:39
S56	538	(qcl near3 assumption dmrs near2(port near2 group$4)) same mac	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:39
S57	490	(qcl near3 assumption) same mac	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:40
S58	58	(dmrs near2(port near2 group$4)) same mac	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:40
S59	30	(dmrs near2(port near2 group$4)) with mac	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:40
S60	5	(dmrs near2(port near2 group$4)) with mac and qcl near2 assumption	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:41
S61	27	(qcl near3 assumption dmrs near2(port near2 group$4)) same (timer counter)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:49
S62	1	(qcl near3 assumption with dmrs near2(port near2 group$4)) same (timer counter)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:49
S63	66	tci near2 configur$6 with qcl near3 set	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:57
S64	2	tci near2 configur$6 with qcl near3 set same qcl near3 set with dmrs near2 port near3 group$4	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/05 08:57

6/10/2021 7:38:49 AM
C:\Users\rabelson\Documents\EAST\Workspaces\16673151.wsp

Electronic Acknowledgement Receipt

EFS ID:	42875452
Application Number:	16673151
International Application Number:	
Confirmation Number:	6936
Title of Invention:	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
Customer Number:	54000
Filer:	Amir Bahrami
Filer Authorized By:	
Attorney Docket Number:	US78241
Receipt Date:	02-JUN-2021
Filing Date:	04-NOV-2019
Time Stamp:	12:32:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	US78241210602R1.pdf	116657 22a4c0b869c0a17fa16481490bb2710e8c348469	no	8

Warnings:

Information:	
Total Files Size (in bytes):	116657

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	:	16/673,151
Application Filing Date	:	November 4, 2019
Examiner	:	ABELSON, RONALD B
Art Unit	:	2476
Confirmation No.	:	6936
Attorney Docket No.	:	US78241
First Inventor	:	TSUNG-HUA TSAI
Customer No.	:	54000

AMENDMENT AND RESPONSE TO *NON-FINAL* OFFICE ACTION

Mail Stop Amendment
Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Dear Sir/Madam:

This is in response to the *Non-Final* Office Action dated **April 2, 2021** in the above-referenced patent application. Please kindly enter and consider the following:

A Listing of Claims begins on page **2** of this paper.

Remarks begin on page **6** of this paper.

Listing of Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (**Currently Amended**) A user equipment (UE) comprising:

one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to:

receive, in a Physical Download Control Channel (PDCCH), Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data,

wherein each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups.

2. (**Original**) The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

identify a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

3. (**Canceled**)

4. (**Currently Amended**) The UE of claim [[3]]1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium Access Control (MAC) Control Element (CE) signaling.

5. (**Original**) The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

indicate a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

6. (**Original**) The UE of claim 1, wherein the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

7. (**Currently Amended**) The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive the plurality of DMRS port groups via Radio Resource Control (RRC) signaling, wherein the plurality of DMRS port groups is associated with ~~corresponding to~~ the plurality of PDSCHs ~~via RRC signaling~~.

8. (**Original**) The UE of claim 1, wherein each of the plurality of QCL

assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

9. (**Currently Amended**) A method of wireless communications by a user equipment (UE), the method comprising:

receiving, in a Physical Download Control Channel (PDCCH)~~, by a user equipment (UE),~~ Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtaining~~, by the UE,~~ a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data,

wherein each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups.

10. (**Currently Amended**) The method of claim 9, further comprising:

identifying~~, by the UE,~~ a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

11. (**Canceled**) .

12. (**Currently Amended**) The method of claim [[11]]9, further comprising:

receiving~~, by the UE,~~ an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium

Access Control (MAC) Control Element (CE) signaling.

13. (**Currently Amended**) The method of claim 9, further comprising:

indicating~~, by the UE,~~ a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

14. (**Original**) The method of claim 9, wherein the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

15. (**Currently Amended**) The method of claim 9, further comprising:

receiving~~, by the UE,~~ the plurality of DMRS port groups via Radio Resource Control (RRC) signaling, wherein the plurality of DMRS port groups is associated with ~~corresponding to~~ the plurality of PDSCHs~~ via RRC signaling~~.

16. (**Original**) The method of claim 9, wherein each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

REMARKS

Prior to the present Amendment and Response, claims 1-16 were pending in the present application. Claims 3-6 and 11-14 are objected to, but would be allowable if rewritten into independent form. By the present Amendment and Response, claims 1, 4, 7, 9, 10, 12, 13 and 15 are amended. Claims 3 and 11 are canceled without prejudice or disclaimer. No new matter has been introduced. After the present Amendment and Response, claims 1-2, 4-10, and 12-16 remain pending in the present application.

Applicant respectfully requests reconsideration and allowance of these claims in view of the above amendments and the following remarks. As Applicant's amendments and remarks with respect to the Examiner's rejections are sufficient to overcome these rejections, Applicant's silence as to assertions by the Examiner in the Office Action or certain requirements that may be applicable to such rejections (for example, assertions regarding dependent claims, whether a reference constitutes prior art, whether references are legally combinable for obviousness purposes) is not a concession by Applicant that such assertions are accurate or such requirements have been met, and Applicant reserves the right to analyze and dispute such in the future.

A. Allowable Subject Matter

In the *Non-Final* Office Action dated April 2, 2021 (hereinafter "Office Action"), the Examiner indicates that "[c]laims 3-6 and 11-14 … would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims." *See* page 7, item 7 of the Office Action.

Applicant appreciates the Examiner's indication of the allowable subject matter in claims 3-6 and 11-14. At the same time, Applicant respectfully traverses the rejections, each finding of fact, including each assertion regarding what the references show or teach, any rationales for modifying and/or combining the references, and any implicit and/or explicit reliance on the Office Action, and Applicant does not acquiesce in the validity of the rejections. In addition, Applicant is not conceding in this application that the previously pending claims are not patentable. Rather, any alterations are without conceding to the Examiner's positions, and being made only to expedite prosecution of the present application, and are without prejudice to the presentation or assertion, in the future, of claims relating to the same or similar subject matter as the previously pending claims.

As such, by the present Amendment and Response, Applicant has amended independent claim 1 to incorporate the allowable subject matter in dependent claim 3. Independent claim 9 is also amended to incorporate the allowable subject matter in dependent claim 11.

In addition, claims 4 and 12 are amended to harmonize their recitations with the amendments made to independent claims 1 and 9, from which they respectively depend.

Therefore, Applicant respectfully submits that claims 1-2, 4-10, and 12-16 are now in condition for allowance.

CONCLUSION

In view of the above, the undersigned representative respectfully submits that the foregoing Response places this application in condition for allowance and a Notice to that effect is earnestly solicited. If the Examiner believes that there are any issues that can be resolved by a telephone conference, or that there are any informalities that can be corrected by an Examiner's amendment, please call the undersigned representative at the number given below.

The undersigned representative requests any extension of time that may be deemed necessary to further the prosecution of this application.

The undersigned representative authorizes the Commissioner to charge any additional fees under 37 C.F.R. 1.16 or 1.17 that may be required, or credit any overpayment, to Deposit Account No. 602615, referencing Attorney Docket No.: US78241.

Respectfully submitted,

By / Amir Bahrami, Reg.# 70460/
Amir Bahrami

Registration No.: 70,460
ScienBiziP, P.C.
550 S. Hope Street, Suite 2825
Los Angeles, CA 90071
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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/673,151	Filing Date 11/04/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

	(Column 1)	(Column 2)			
FOR	NUMBER FILED	NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	06/02/2021	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 14	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/DONNA D SMALLS LOGAN/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

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ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

Courtesy Reminder for
Application Serial No: 16/673,151

Attorney Docket No: US78241
Customer Number: 54000
Date of Electronic Notification: 04/02/2021

This is a courtesy reminder that new correspondence is available for this application. If you have not done so already, please review the correspondence. The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

An email notification regarding the correspondence was sent to the following email address(es) associated with your customer number:

eoa-proce@scienbizip.com
eoa-cbd@scienbizip.com
eoa-procc@scienbizippc.com

To view your correspondence online or update your email addresses, please visit us anytime at **https://ppair-my.uspto.gov/pair/PrivatePair.**
If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov or call 1-866-217-9197.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/673,151	11/04/2019	TSUNG-HUA TSAI	US78241	6936

54000 7590 04/02/2021
ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

EXAMINER	
ABELSON, RONALD B	

ART UNIT	PAPER NUMBER
2476	

NOTIFICATION DATE	DELIVERY MODE
04/02/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

eoa-cbd@scienbizip.com
eoa-procc@scienbizippc.com
eoa-proce@scienbizip.com

PTOL-90A (Rev. 04/07)

Office Action Summary	**Application No.** 16/673,151	**Applicant(s)** TSAI et al.	
	Examiner RONALD B ABELSON	**Art Unit** 2476	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
  Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 4/20/20, 11/4/19.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☐ Claim(s) 1-16 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-2,7-10 and 15-16 is/are rejected.

8) ☑ Claim(s) 3-6 and 11-14 is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 11/4/19 is/are: a)☑ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a)☐ All b)☐ Some** c)☐ None of the:
1.☐ Certified copies of the priority documents have been received.
2.☐ Certified copies of the priority documents have been received in Application No. _____.
3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date 4/20/20.

3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date ______.

4) ☐ Other: ______.

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 9 is/are rejected under 35 U.S.C. 103 as being unpatentable over Sun US 20200045700 in view of Lee US 20200221487, and VILAIPORNSAWAI US 20200015200.

Regarding claims 1 and 9, Sun teaches receive, in a Physical Download Control Channel (PDCCH), Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), (a single [redacted] and single physical downlink shared channel (PDSCH) mode, wherein the DCI includes a TCI field to indicate the more than one [redacted] wherein the DCI indicates a set of quasi-co-location (QCL) relationships for different [redacted] TRPs associated with the multi-TRP mode, [0115]).

Although Sun teaches TCI states, the reference is silent on the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups.

Lee teaches the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups ([0427]).

Therefore it would have been obvious to one of ordinary skill in the art, to modify the system of Sun by the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups, as shown by Lee. This modification would benefit the system by inform the mobiles of the port groups.

The combination is silent on obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data.

VILAIPORNSAWAI teaches obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data ([0004]).

Therefore it would have been obvious to one of ordinary skill in the art, to modify the system of the combination by obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data, as shown by VILAIPORNSAWAI. This modification would benefit the system by informing the mobiles of configuration information.

4. Claims 2 and 10 is/are rejected under 35 U.S.C. 103 as being unpatentable over the combination of Sun, Lee, and VILAIPORNSAWAI as applied to claims 1 and 9 above, and further in view of Nam US 20170288743.

The combination is silent on identify a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

Nam teaches identify a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions (For example, assuming the PDSCH layers of a [redacted] to one codeword, then the codeword index for the PDSCH layers can be used to map to a set of UE-specific MRS antenna ports for [redacted] purpose, [0233]).

Therefore it would have been obvious to one of ordinary skill in the art, to modify the system of the combination by identify a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions, as shown by Nam. This modification would benefit the system by enabling the UE to identify the TRP.

5. Claims 7 and 15 is/are rejected under 35 U.S.C. 103 as being unpatentable over the combination of Sun, Lee, and VILAIPORNSAWAI as applied to claims 1 and 9 above, and further in view of Chun US 20140321414.

The combination is silent on receive the plurality of DMRS port groups corresponding to the plurality of PDSCHs via RRC signaling.

Chun teaches receive the plurality of DMRS port groups corresponding to the plurality of PDSCHs via RRC signaling (the base station may inform the UE about a candidate group of e-PDCCH ports and/or a candidate [illegible] through a PDCCH or [illegible] signaling. For example, the base station may define a new [illegible] message such as an e-PDCCH port candidate set information element (IE) or a DMRS port candidate set IE, and may inform the UE about a candidate group of e-PDCCH ports for an e-PDCCH and/or a candidate [illegible] [redacted],[0098]).

Therefore it would have been obvious to one of ordinary skill in the art, to modify the system of the combination by receive the plurality of DMRS port groups corresponding to the plurality of PDSCHs via RRC signaling, as shown by Chun. This modification would benefit the system by using a proven, reliable method for signaling the information to the UE.

6. Claims 8 and 16 is/are rejected under 35 U.S.C. 103 as being unpatentable over the combination of Sun, Lee, and VILAIPORNSAWAI as applied to claims 1 and 9 above, and further in view of Liou US 20190230545.

The combination is silent on each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

Liou teaches each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter ((0469, 0472]).

Therefore it would have been obvious to one of ordinary skill in the art, to modify the system of the combination by each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter, as shown by Liou. This modification would benefit the system by the UE obtaining QCL parameters.

Allowable Subject Matter

7. Claims 3-6 and 11-14 objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to RONALD B ABELSON whose telephone number is (571)272-3165. The examiner can normally be reached on M-F 8:00-4:30.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Ayaz Sheikh can be reached on 571-272-3795. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/RONALD B ABELSON/
Primary Examiner, Art Unit 2476

Notice of References Cited	Application/Control No. 16/673,151	Applicant(s)/Patent Under Reexamination TSAI et al.	
	Examiner RONALD B ABELSON	Art Unit 2476	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
	A	20200221487	09-2020	Lee	H04W 72/12	
	B	20200045700	02-2020	Sun	H04W 72/04	
	C	20200015200	01-2020	VILAIPORNSAWAI	H04W 72/042	
	D	20190230545	07-2019	Liou	H04W 24/10	
	E	20170288743	10-2017	Nam	H04B 7/024	
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No. 16/673,151	Applicant(s)/Patent Under Reexamination TSAI et al.
	Examiner RONALD B ABELSON	Art Unit 2476

CPC - Searched*		
Symbol	**Date**	**Examiner**
h04l5/0048 h04l5/0023 h04l5/0035 h04l5/0053	11/22/2020	RA
h04w72/042	11/22/2020	RA

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
CPC combined with limited text search in EAST	11/22/2020	RA

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

Index of Claims	Application/Control No. 16/673,151	Applicant(s)/Patent Under Reexamination TSAI et al.
	Examiner RONALD B ABELSON	Art Unit 2476

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	11/22/2020								
	1	✓								
	2	✓								
	3	O								
	4	O								
	5	O								
	6	O								
	7	✓								
	8	✓								
	9	✓								
	10	O								
	11	O								
	12	O								
	13	O								
	14	O								
	15	✓								
	16	✓								

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	"20200107353"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:32
L2	33,738	h04l5/0048 h04l5/0023 h04l5/0035 h04l5/0053 h04w72/042	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:43
L3	252	quasi adj1 (colocation co adj1 location) near3 assumption with qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:44
L4	152	2 and L3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/11/22 11:44
S1	1	"16673151"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:49
S2	1	S1 and qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:50
S3	1,899	quasi adj1 (colocation co adj1 location) with qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:51
S4	244	quasi adj1 (colocation co adj1 location) near3 assumption with qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:52
S5	53	pdcch with tci with pdsch same dmrs	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:53
S6	19	pdcch with tci with pdsch same dmrs with port same qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:54
S7	5	pdcch with tci with pdsch same dmrs with port near2 group same qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:57
S8	5	pdcch with tci with pdsch same dmrs with port near2 group$4 same qcl	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 15:57
S9	16	pdcch with tci with pdsch near3 (multiple plurality)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:10

S10	39	tci with pdsch near3 (multiple plurality)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:13
S11	23	S10 not S9	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:13
S12	2	("20200107353" "20190387579").pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:28
S13	0	S12 and tci with dmrs with port with group	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:28
S14	1	S12 and tci with dmrs	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:29
S15	2	S11 and S12	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:30
S16	0	S14 and qcl with pdsch with dmrs with tci	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:33
S17	1	S14 and qcl same pdsch same dmrs same tci	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/10/29 16:34

11/22/2020 11:44:27 AM
C:\Users\rabelson\Documents\EAST\Workspaces\16673151.wsp

Bibliographic Data

Application No: 16/673,151

Foreign Priority claimed:	○ Yes	◉ No	
35 USC 119 (a-d) conditions met:	☐ Yes	☑ No	☐ Met After Allowance
Verified and Acknowledged:	/RONALD B ABELSON/		
	Examiner's Signature		Initials

Title: METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/04/2019	370	2476	US78241
RULE			

APPLICANTS

FG Innovation Company Limited, Tuen Mun, HONG KONG

INVENTORS

TSUNG-HUA TSAI, Hsinchu, TAIWAN

CHIE-MING CHOU, Hsinchu, TAIWAN

CONTINUING DATA

This application has PRO of 62754706 11/02/2018

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

11/20/2019

STATE OR COUNTRY

TAIWAN

ADDRESS

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550 South Hope Street
Suite 2825
Los Angeles, CA 90071
UNITED STATES

FILING FEE RECEIVED

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	16673151
	Filing Date	2019-11-04
	First Named Inventor	TSUNG-HUA TSAI
	Art Unit	
	Examiner Name	
	Attorney Docket Number	US78241

U.S.PATENTS

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	1	2018302889	A1	2018-10-18	SAMSUNG ELECTRONICS CO., LTD.	the whole document

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	1	2018128376	WO	A1	2018-07-12	LG ELECTRONICS INC.	description, paragraphs [108], [152]-[153], [162]-[164] and [365]-[382]	
	2	108199819	CN	A	2018-06-22	ZTE CORPORATION	At least the Abstract	X
	3	108092754	CN	A	2018-05-29	ZTE CORPORATION	At least the Abstract	☒

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16673151
	Filing Date		2019-11-04
	First Named Inventor	TSUNG-HUA TSAI	
	Art Unit		
	Examiner Name		
	Attorney Docket Number		US78241

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1		

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EXAMINER SIGNATURE

Examiner Signature	/RONALD B ABELSON/	Date Considered	11/22/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1 See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. 2 Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). 3 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 4 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 5 Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16673151
	Filing Date	2019-11-04
	First Named Inventor	TSUNG-HUA TSAI
	Art Unit	
	Examiner Name	
	Attorney Docket Number	US78241

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Alvin Koan/	Date (YYYY-MM-DD)	2020-04-15
Name/Print	Alvin Koan	Registration Number	68468

Privacy Act Statement

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/673,151	11/04/2019	TSUNG-HUA TSAI	US78241

CONFIRMATION NO. 6936

PUBLICATION NOTICE

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54000
ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

Title:METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

Publication No.US-2020-0145159-A1
Publication Date:05/07/2020

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The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	16673151
	Filing Date	2019-11-04
	First Named Inventor	TSUNG-HUA TSAI
	Art Unit	
	Examiner Name	
	Attorney Docket Number	US78241

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code1	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	2018302889	A1	2018-10-18	SAMSUNG ELECTRONICS CO., LTD.	the whole document

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FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number3	Country Code2 i	Kind Code4	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T5
	1	2018128376	WO	A1	2018-07-12	LG ELECTRONICS INC.	description, paragraphs [108], [152]-[153], [162]-[164] and [365]-[382]	
	2	108199819	CN	A	2018-06-22	ZTE CORPORATION	At least the Abstract	X
	3	108092754	CN	A	2018-05-29	ZTE CORPORATION	At least the Abstract	☒

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	First Named Inventor	TSUNG-HUA TSAI
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Examiner Signature		Date Considered	

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	Filing Date	2019-11-04
	First Named Inventor	TSUNG-HUA TSAI
	Art Unit	
	Examiner Name	
	Attorney Docket Number	US78241

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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Signature	/Alvin Koan/	Date (YYYY-MM-DD)	2020-04-15
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English Translation of Abstract of China Patent Application No. CN108199819A

Title

The determining method and device of the transmission of control signaling, reception and information

Abstract

The present invention provides the determining method and devices of a kind of transmission of control signaling, reception and information.Including：Second information is determined according to the first information；Wherein, which includes at least one of：Notify to notify the location information of bit used in the first configured transmission in first control signaling in bit number N used in the first configured transmission, the correspondence mappings table in the first control signaling between the index value of the first configured transmission institute reference and the value of first configured transmission, the type of the first configured transmission that predetermined instructions field is notified in the first control signaling, the first control signaling：The first information includes：The relationship between Transmission Time Interval and predetermined threshold K between first control signaling and the first signal, N, K are nonnegative integer：First control signaling is sent, and then solves the problems, such as the bit field of wave beam to be notified not make full use of caused resource utilization relatively low in physical layer dynamic control signaling in the relevant technologies.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 108199819 A
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(21)申请号 201810160248.2

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(74)专利代理机构 北京康信知识产权代理有限责任公司 11240
代理人 江舟 董文倩

(51)Int.Cl.
H04L 5/00(2006.01)
H04L 1/00(2006.01)

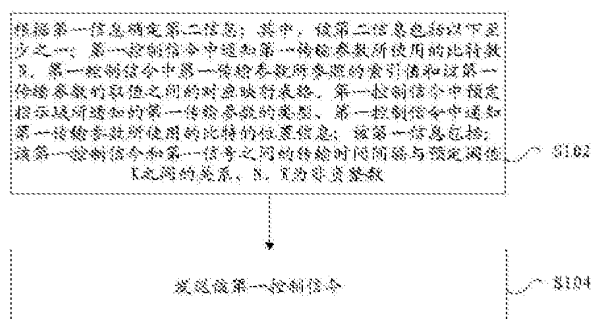
权利要求书11页 说明书42页 附图14页

(54)发明名称

控制信令的发送、接收以及信息的确定方法及装置

(57)摘要

本发明提供了一种控制信令的发送、接收以及信息的确定方法及装置。其中包括：根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和该第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；该第一信息包括：该第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；发送该第一控制信令，进而解决了相关技术中物理层动态控制信令中通知波束的比特域没有充分利用所造成的资源利用率较低的问题。



CN 108199819 A

1.一种控制信令的发送方法,其特征在于,包括:

根据第一信息确定第二信息;其中,所述第二信息包括以下至少之一:第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息;所述第一信息包括:所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系,N、K为非负整数;

发送所述第一控制信令。

2.根据权利要求1所述的方法,其特征在于,

在所述关系为第一关系时,所述N的取值包括N1;

在所述关系为第二关系时,所述N的取值包括N2;

其中,N1、N2为整数。

3.根据权利要求2所述的方法,其特征在于,所述N1和所述N2之间的关系满足以下至少之一:

所述N1大于所述N2;

所述N1与所述N2的差值小于或者等于传输配置指示TCI域所占的比特数;

所述N1与所述N2的差值小于或者等于通知第二传输参数所需要的比特数。

4.根据权利要求1所述的方法,其特征在于,

在所述关系为第一关系时,所述对应映射表格为第一对应映射表格;

在所述关系为第二关系时,所述对应映射表格为第二对应映射表格。

5.根据权利要求4所述的方法,其特征在于,

所述第一对应映射表格、所述第二对应映射表格、传输参数取值集合一以及传输参数取值集合二中的任一项通过以下方式至少之一确定:

方式一、发送的信令信息所包括的内容;

方式二、与接收端预先约定的规则;

其中,所述传输参数取值集合一对应所述第一对应映射表格中包括的所述第一传输参数的取值集合,所述传输参数取值集合二对应所述第二对应映射表格中包括的所述第一传输参数的取值集合,其中所述接收端为接收所述第一控制信令的通信节点。

6.根据权利要求4所述的方法,其特征在于,所述方法满足以下之一:

在所述第一传输参数的类型为TCI时,所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中只包括一个DL-RS;

在所述第一传输参数类型为TCI时,所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中DL-RS两两之间关于空间接收参数满足准共址QCL关系;

在所述第一传输参数类型为TCI时,所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中的DL-RS能被第一通信节点同时接收;

在所述第一传输参数类型为TCI时,所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合为空集;

其中，所述第一通信节点为接收所述第一信号，和/或所述第一控制信令的通信节点。

7.根据权利要求1所述的方法，其特征在于，

所述第一传输参数的类型为所述第一控制信令中包括的除TCI传输参数类型之外的一个或者多个传输参数类型；或者，

所述第一传输参数类型为TCI传输参数。

8.根据权利要求1所述的方法，其特征在于，所述第一传输参数满足以下至少之一：

所述第一传输参数为所述第一信号的传输参数；

所述第一传输参数为第二信号的传输参数。

9.根据权利要求8所述的方法，其特征在于，

所述第一信号或者所述第二信号包括以下信号至少之一：解调参考信号、测量参考信号、控制信道信号、数据信道信号；

所述第一控制信令为物理层控制信令。

10.根据权利要求8所述的方法，其特征在于，所述第一信息还包括以下信息至少之一：

发送的第二控制信令中包括的信息；所述第一控制信令所在的控制资源集合CORESET对应的传输配置指示TCI-PresentInDCI是否使能信息；所述第一信号或者所述第二信号所在的载频与预定阈值G之间的关系；第一通信节点反馈的支持的频率范围能力；所述预设阈值K是否为0；第一通信节点需要检测的CORESET中是否至少存在一个配置了空间接收参数的CORESET；与第一通信节点需要检测专有搜索空间关联的CORESET集合中是否至少存在一个配置了空间接收参数的CORESET；与所述第一信号或者所述第二信号距离最近的时间单元中具有最低控制资源集合标识CORESET ID的CORESET是否配置了空间接收参数；与所述第一信号或者第二信号距离最近的时域符号中具有最低CORESET ID的CORESET是否配置了空间接收参数；与所述第一信号或者所述第二信号关联的TCI状态池中是否至少存在一个TCI状态，其中，所述TCI状态中与参考信号集合对应的QCL参数中包括空间接收参数；与所述第一信号或者所述第二信号关联的激活TCI状态池中，是否至少存在一个TCI状态，所述TCI状态中与所述参考信号集合对应的QCL参数中包括空间接收参数；

其中，所述第一通信节点为接收所述第一信号，和/或第二信号的通信节点。

11.根据权利要求1所述的方法，其特征在于，

在所述关系为第一关系时，所述第一控制信令中预定指示域所通知的所述第一传输参数的类型为第一类型传输参数；

在所述关系为第二关系时，所述第二控制信令中预定指示域所通知的所述第一传输参数的类型为第二类型传输参数。

12.根据权利要求2、4或11所述的方法，其特征在于，

在所述第一控制信令和所述第一信号之间的传输时间间隔小于所述预定阈值K时，所述关系为所述第一关系，在所述控制信令和所述第一信号之间的传输时间间隔大于或者等于所述预定阈值K时，所述关系为所述第二关系；或者，

在所述控制信令和所述第一信号之间的传输时间间隔小于或者等于所述预定阈值K时，所述关系为所述第一关系，在所述控制信令和所述第一信号之间的传输时间间隔大于所述预定阈值K时，所述关系为所述第二关系；或者，

在所述控制信令和所述第一信号之间的传输时间间隔大于或者等于所述预定阈值K

时，所述第一关系为第一关系，在所述控制信令和所述第一信号之间的传输时间间隔小于所述预定阈值K时，所述关系为所述第二关系。

13.一种信息的确定方法，其特征在于，包括：

根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。

14.根据权利要求13所述的方法，其特征在于，所述特定CORESET满足以下特征至少之一：

所述CORESET是距离所述第一信号最近的时域符号中具有最低控制资源集合标识CORESET ID的CORESET；

所述CORESET是距离所述第一信号最近的时间单元中具有最低CORESET ID的CORESET；

在所述CORESET中终端需要检测调度下行信号和/或信道的下行控制信息DCI；

在所述CORESET中不包括调度所述第一信号的控制信令信息；

在所述CORESET中包括调度所述第二信号的控制信令信息；

所述CORESET至少与一个专有搜索空间关联；

所述CORESET是距离所述第一信号和/或所述第二信号最近的时间单元中的所有载波单元CC具有最低CORESETID的CORESET；

所述CORESET是距离所述第一信号和/或所述第二信号最近的时间单元中的预定CC中具有最低CORESETID的CORESET；

所述CORESET是距离所述第一信号和/或所述第二信号最近的时间单元中的预定CC组中具有最低CORESETID的CORESET；

所述CORESET是一个时间单元中预定M个时域符号中的CORESET，其中，M小于或者等于所述时间单元中包括的时域符号个数。

15.根据权利要求13所述的方法，其特征在于，

在所述第一信号和所述CORESET之间的时间间隔小于所述预定阈值X1时，所述第一信号的QCL参数根据所述CORESET的QCL参数获取；

在所述第一信号和所述CORESET之间的间隔大于或者等于所述预定阈值X1时，所述第一信号的QCL参数通过所述第一信号的配置信息中配置的QCL参数获取。

16.根据权利要求13所述的方法，其特征在于，

在所述第一信号和所述CORESET之间的间隔小于所述预定阈值X1时，所述第一信号的QCL参数优先级高于所述第二信号的QCL参数；

在所述第一信号和所述CORESET之间的间隔大于或者等于所述预定阈值X1时，所述第一信号的QCL参数优先级低于所述第二信号的QCL参数。

17.根据权利要求13所述的方法，其特征在于，

在所述第一信号和所述CORESET之间的间隔小于所述预定阈值X1时，所述第一信号和所述第二信号之间不允许采用频分复用的方式；

在所述第一信号和所述CORESET之间的间隔大于或者等于所述预定阈值X1时，所述第一信号和所述第二信号允许采用频分复用的方式。

18.根据权利要求13所述的方法，其特征在于，

所述第一信号和/或所述第二信号包括以下信号至少之一：下行测量参考信号、下行同步信号、下行解调参考信号、下行数据信道信号、下行控制信道信号。

19.根据权利要求13所述的方法，其特征在于，

所述预定阈值X1与预定阈值X2相等；和/或

所述第二信号的QCL参数根据调度所述第二信号的控制信息和所述第二信号之间的间隔与所述预定阈值X2之间的关系确定。

20.根据权利要求13所述的方法，其特征在于，

所述第一信号满足如下特征至少之一：所述第一信号为物理层动态控制信令调度的下行信号；所述第一信号为下行物理控制信道信号；调度所述第一信号的控制信令和所述第一信号之间的间隔小于所述预定阈值X1。

21.根据权利要求13所述的方法，其特征在于，所述第二信号满足以下特征至少之一：

调度所述第二信号的控制信令在所述第一信号所在的时域符号之前；

调度所述第二信号的控制信令和所述第一信号所在的时域符号之间的间隔大于或者等于所述预定阈值X3；

调度所述第二信号的控制信令和所述第二信号所在的起始时域符号之间的间隔大于或者等于所述预定阈值X3；

所述第二信号是物理层动态控制信令调度的下行信号；

所述第二信号为周期下行测量参考信号；

其中X3为实数。

22.根据权利要求13所述的方法，其特征在于，

在所述CORESET之后预定时间窗中存在所述第二信号时，所述第一信号的QCL参数根据所述第二信号的QCL参数确定；

在所述CORESET之后预定时间窗中不存在所述第二信号时，所述第一信号的QCL参数不根据所述第二信号的QCL参数确定；和/或

在所述CORESET之后预定时间窗中存在所述第二信号，所述第一信号和调度所述第一信号的控制信令之间的间隔小于所述预定阈值X1时，所述第一信号的QCL参数不根据所述CORESET的QCL参数获取；

在所述CORESET之后预定时间窗中不存在所述第二信号，所述第一信号和调度所述第一信号的控制信令之间的间隔小于所述预定阈值X1时，所述第一信号的QCL参数根据CORESET的QCL参数获取。

23.根据权利要求13所述的方法，其特征在于，

所述第一信号和所述第二信号之间满足以下特征至少之一：

所述第二信号的空间接收参数和所述第一信号的空间接收参数不同；

所述第二信号的空间接收参数对应的空间滤波器和所述第一信号的空间接收参数对

应的空间滤波器在第一通信节点不能同时打出；

所述第二信号和所述第一信号属于不同的CC；

所述第一信号所在的时域位置和所述第二信号所在的时域位置之间的交集为非空集合；

所述第一信号和所述第二信号在相同的时域位置上；

所述第二信号的优先级高于所述第一信号的优先级。

24.根据权利要求13所述的方法，其特征在于，在所述第二信息为所述第一信号的准共址QCL参数时，所述根据第一信息确定第二信息包括：根据所述第一信息确定如下信息至少之一：

所述第一信号和所述第二信号的QCL参数之间的优先级；所述第一信号的配置信息中配置的QCL参数和特定CORESET的QCL参数之间的优先级；当所述第一信号和调度所述第一信号的控制信令之间的间隔小于所述预定阈值X1时，所述第一信号的QCL参数是否根据特定CORESET的QCL参数获取。

25.根据权利要求13所述的方法，其特征在于，在所述第二信息为第二信号所在的时域位置上第一信号的接收方式时，所述根据第一信息确定第二信息包括根据所述第一信息确定如下信息至少之一：

是否在所述第二信号所在的时域位置上接收所述第一信号；

是否在所述第二信号所在的时域位置上检测控制信道；

在所述第二信号所在的时域位置上，所述第一信号的QCL参数和所述第二信号的QCL参数之间的优先级；

所述第一信号和所述第二信号之间能否频分复用；

所述第一信号可在的时域位置是否包括第二信号所在的时域位置。

26.根据权利要求13所述的方法，其特征在于，在所述第二信息为第二信号所在的时域位置上第一信号的发送方式时，所述根据第一信息确定第二信息包括根据所述第一信息确定如下信息至少之一：

是否在所述第二信号所在的时域位置上发送所述第一信号；

是否在所述第二信号所在的时域位置上发送控制信道；

在所述第二信号所在的时域位置上，所述第一信号的QCL参数和所述第二信号的QCL参数之间的优先级；

所述第一信号和所述第二信号之间能否频分复用；

所述第一信号可在的时域位置是否包括第二信号所在的时域位置。

27.根据权利要求13所述的方法，其特征在于，所述第二信号所在的时域位置包括如下时域位置之一：

所述第二信号所在的时域符号；

所述第二信号所在的时间单位。

28.根据权利要求13所述的方法，其特征在于，所述方法还包括：

不接收满足以下特征的配置：当调度所述第一信号的所述第一控制信令和所述第一信号之间的间隔大于或者等于所述预定阈值X1，调度所述第二信号的所述第二控制信令和所述第二信号之间的间隔大于或者等于所述预定阈值X2时，所述第一信号和所述第二信号关

于空间接收参数不满足QCL关系；

当调度所述第一信号的所述第一控制信令和所述第一信号之间的间隔小于所述预定阈值X1，调度所述第二信号的所述第二控制信令和所述第二信号之间的间隔大于或者等于所述预定阈值X2时，所述第一信号的QCL参数根据所述第二信号的QCL参数确定；

当调度所述第一信号的所述第一控制信令和所述第一信号之间的间隔小于所述预定阈值X1，调度所述第二信号的所述第二控制信令和所述第二信号之间的间隔小于所述预定阈值X2时，所述第一信号的QCL参数和所述第二信号的QCL参数的优先级根据约定规则或者信令信息获取。

29.根据权利要求13所述的方法，其特征在于，所述第一信息还包括以下信息至少之一：

所述特定CORESET中包括的控制信令中是否包括传输配置指示TCI指示域；所述第一信号和/或所述第二信号所在的载频与预定阈值G之间的关系；所述预设阈值X1和/或所述预定阈值X2是否为0；特定CORESET中是否至少存在一个配置了空间接收参数的CORESET；所述第一通信节点需要检测的CORESET集合中是否至少存在一个配置了空间接收参数的CORESET；与所述第一信号或者所述第二信号关联的TCI状态池中是否至少存在一个TCI状态，其中，所述TCI状态中与参考信号集合对应的QCL参数中包括空间接收参数；与所述第一信号或者第二信号关联的激活TCI状态池中，是否至少存在一个TCI状态，所述TCI状态中与所述参考信号集合对应的QCL参数中包括空间接收参数；

其中，所述第一通信节点为接收所述第一信号的通信节点。

30.根据权利要求13所述的方法，其特征在于，在所述第一信息为第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系时，所述根据第一信息确定第二信息包括如下方式至少之一：

所述第一信号和所述第二信号关于空间接收参数满足QCL关系时，所述第一信号可在的时域符号包括所述第二信号所在的时域符号；

所述第一信号和所述第二信号关于空间接收参数不满足QCL关系时，所述第一信号可在的时域符号不包括所述第二信号所在的时域符号；

在所述第一空间接收参数对应的空间滤波器和所述第二空间接收参数对应的空间滤波器第一通信节点能同时产生时，所述第一信号可在的时域符号包括所述第二信号所在的时域符号；

在所述第一空间接收参数对应的空间滤波器和所述第二空间接收参数对应的空间滤波器第一通信节点不能同时产生时，所述第一信号可在的时域符号不包括所述第二信号所在的时域符号。

31.根据权利要求13所述的方法，其特征在于，在所述第一信息为所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信息为第一信号的准共址QCL参数时，所述根据第一信息确定第二信息包括以下至少之一：

所述第一信号在一个时间单元的不同时域符号上，所述QCL参数保持不变；

所述第一信号在不同时间单元上，所述QCL参数可以不同；

所述第一信号B1套QCL参数和A个时间单元之间存在对应关系；

在所述第一信号所在的A个时间单元中的每个时间单元中的所述第一信号的QCL参数

根据距离该时间单元最近的时间单元中具有预定特定的CORESET的QCL参数获取；

在所述第一信号所在的A个时间单元中根据每个时间单元中所述第一信号和所述第一控制信令之间的时间间隔与所述预定阈值X1之间的关系，确定该时间单元中所述第一信号的QCL参数；

其中，所述第一信号占有A个时间单元中，A为大于1的自然数，其中B1为小于或者等于A的非负整数。

32.根据权利要求13所述的方法，其特征在于，

在所述第一信息为所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信息为第一信号的准共址QCL参数时，所述根据第一信息确定第二信息包括以下至少之一：

根据A个时间单元中最前面的一个时间单元中所述第一信号和所述第一控制信令之间的时间间隔与所述预定阈值X1之间的关系，确定所述第一信号的QCL参数，所述第一信号在所述A个时间单元中的QCL参数保持不变；

在所述第一信号所在的A1个时间单元中的每个时间单元中的所述第一信号的QCL参数根据距离该时间单元最近的时间单元中具有预定特定的CORESET的QCL参数获取，其中所述A1个时间单元中的最后一个时间单元中的所述第一信号和所述第一控制信令之间的间隔小于所述预定阈值X1；

在所述第一信号所在的A2个时间单元中所述第一信号的QCL参数保持不变；

所述第一信号B2套QCL参数和所述A2个时间单元之间存在对应关系；

在所述第一信号所在的A2个时间单元中所述第一信号的QCL参数保持不变，在所述第一信号在所述A2个时间单元中的QCL参数根据所述第一控制信令通知的信息确定，其中所述A2个时间单元中最前面的时间单元中的所述第一信号和所述第一控制信令之间的间隔大于或者等于所述预定阈值X1；

其中，所述第一信号占有A个时间单元中，A为大于1的自然数，A1，A2为小于或者等于所述A值的非负整数，B2为小于或者等于A2的非负整数。

33、一种控制信令的接收方法，其特征在于，包括：

根据第一信息确定第二信息；

根据所述第二信息接收第一控制信令；

其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

34、根据权利要求33所述的方法，其特征在于，

在所述关系为第一关系时，所述N的取值包括N1；

在所述关系为第二关系时，所述N的取值包括N2；

其中，N1、N2为整数。

35、根据权利要求34所述的方法，其特征在于，所述N1和所述N2之间的关系满足以下至少之一：

所述N1大于所述N2；

所述N1与所述N2的差值小于或者等于传输配置指示TCI域所占的比特数；

所述N1与所述N2的差值小于或者等于通知第二传输参数信息所需要的比特数。

36.根据权利要求33所述的方法，其特征在于，

在所述关系为第一关系时，所述对应映射表格为第一对应映射表格；

在所述关系为第二关系时，所述对应映射表格为第二对应映射表格。

37.根据权利要求36所述的方法，其特征在于，

所述第一对应映射表格、所述第二对应映射表格、传输参数取值集合一以及传输参数取值集合二中的任一项通过以下方式至少之一确定：

方式一、接收的信令信息所包括的内容；

方式二、与发送端预先约定的规则；

其中，所述传输参数取值集合一对应所述第一对应映射表格中包括的所述第一传输参数的取值集合，所述传输参数取值集合二对应所述第二对应映射表格中包括的所述第一传输参数的取值集合；其中所述发送端为发送所述第一控制信令的通信节点。

38.根据权利要求36所述的方法，其特征在于，所述方法满足以下之一：

在所述第一传输参数的类型为TCI时，所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中只包括一个DL-RS；

在所述第一传输参数类型为TCI时，所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中DL-RS两两之间关于空间接收参数满足准共址QCL关系；

在所述第一传输参数类型为TCI时，所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中的DL-RS能被第一通信节点同时接收；

在所述第一传输参数类型为TCI时，所述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合为空集；

其中，所述第一通信节点为接收所述第一信号，和/或所述第一控制信令的通信节点。

39.根据权利要求33所述的方法，其特征在于，

所述第一传输参数的类型为所述第一控制信令中包括的除TCI传输参数类型之外的一个或者多个传输参数类型；或者，

所述第一传输参数类型为TCI传输参数。

40.根据权利要求33所述的方法，其特征在于，所述第一传输参数满足以下至少之一：

所述第一传输参数为所述第一信号的传输参数；

所述第一传输参数为第二信号的传输参数。

41.根据权利要求40所述的方法，其特征在于，

所述第一信号或者所述第二信号包括以下信号至少之一：解调参考信号、测量参考信号、控制信道信号、数据信道信号；

所述第一控制信令为物理层控制信令。

42.根据权利要求40所述的方法，其特征在于，所述第一信息还包括以下信息至少之一：

接收的第二控制信令中包括的信息；所述第一控制信令所在的控制资源集合CORESET对应的传输配置指示TCI-PresentInDCI是否使能信息；所述第一信号或者所述第二信号所在的载频与预定阈值G之间的关系；第一通信节点反馈的支持的频率范围能力；所述预设阈值K是否为0；第一通信节点需要检测的CORESET中是否至少存在一个配置了空间接收参数的CORESET；与第一通信节点需要检测专有搜索空间关联的CORESET集合中是否至少存在一个配置了空间接收参数的CORESET；与所述第一信号或者所述第二信号距离最近的时间单元中具有最低控制资源集合标识CORESET ID的CORESET是否配置了空间接收参数；与所述第一信号或者第二信号距离最近的时域符号中具有最低CORESET ID的CORESET是否配置了空间接收参数；与所述第一信号或者所述第二信号关联的TCI状态池中是否至少存在一个TCI状态，其中，所述TCI状态中与参考信号集合对应的QCL参数中包括空间接收参数；与所述第一信号或者所述第二信号关联的激活TCI状态池中，是否至少存在一个TCI状态，所述TCI状态中与所述参考信号集合对应的QCL参数中包括空间接收参数；

其中，所述第一通信节点为接收所述第一信号，和/或第二信号，和/或接收所述第一控制信令的通信节点。

43.根据权利要求33所述的方法，其特征在于，

在所述关系为第一关系时，所述第一控制信令中预定指示域所通知的所述第一传输参数的类型为第一类型传输参数；

在所述关系为第二关系时，所述第二控制信令中预定指示域所通知的所述第一传输参数的类型为第二类型传输参数。

44.根据权利要求34、36或43所述的方法，其特征在于，

在所述第一控制信令和所述第一信号之间的传输时间间隔小于所述预定阈值K时，所述关系为所述第一关系，在所述控制信令和所述第一信号之间的传输时间间隔大于或者等于所述预定阈值K时，所述关系为所述第二关系；或者，

在所述控制信令和所述第一信号之间的传输时间间隔小于或者等于所述预定阈值K时，所述关系为所述第一关系，在所述控制信令和所述第一信号之间的传输时间间隔大于所述预定阈值K时，所述关系为所述第二关系；或者，

在所述控制信令和所述第一信号之间的传输时间间隔大于或者等于所述预定阈值K时，所述第一关系为第一关系，在所述控制信令和所述第一信号之间的传输时间间隔小于所述预定阈值K时，所述关系为所述第二关系。

45.一种控制信令的发送装置，应用于第一通信节点，其特征在于，包括：

第一确定模块，用于根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；

第一发送模块，用于发送所述第一控制信令。

46.一种信息的确定装置，应用于第一通信节点，其特征在于，包括：

第二确定模块，用于根据第一信息确定第二信息；其中，所述第二信息包括以下至少之

一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。

47.一种控制信令的接收装置，应用于第二通信节点，其特征在于，包括：

第三确定模块，用于根据第一信息确定第二信息；

接收模块，用于根据所述第二信息接收第一控制信令；

其中，所述第二信息为根据第一信息确定的信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

48.一种存储介质，其特征在于，所述存储介质中存储有计算机程序，其中，所述计算机程序被设置为运行时执行所述权利要求1至12、权利要求13至32以及权利要求33至44任一项中所述的方法。

49.一种电子装置，包括存储器和处理器，其特征在于，所述存储器中存储有计算机程序，所述处理器被设置为运行所述计算机程序以执行所述权利要求1至12、权利要求13至32以及权利要求33至44任一项中所述的方法。

50.一种基站，其特征在于，包括：

处理器以及存储有所述处理器可执行指令的存储器，当所述指令被处理器执行时，执行如下操作：根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；

发送所述第一控制信令。

51.一种基站，其特征在于，包括：

处理器以及存储有所述处理器可执行指令的存储器，当所述指令被处理器执行时，执行如下操作：根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈

值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。

52.一种终端，其特征在于，包括：

处理器以及存储有所述处理器可执行指令的存储器，当所述指令被处理器执行时，执行如下操作：根据第一信息确定第二信息；根据所述第二信息接收第一控制信令；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

控制信令的发送、接收以及信息的确定方法及装置

技术领域

[0001] 本发明涉及通信领域，具体而言，涉及一种控制信令的发送、接收以及信息的确定方法及装置。

背景技术

[0002] 高频通信作为5G的核心技术之一，为未来通信的高速率大带宽提供有力支持，但是高频通信的一个核心问题是路径损耗比较大，同时考虑到天线尺寸比较小，可以采用多天线形成波束，抵抗路径损耗。

[0003] 为了提高系统效率，抵抗波束阻挡场景，快速链路恢复，下行信号的波束可以通过物理层动态控制信令通知，当控制信令和下行信号之间的间隔小于预定门限时，终端不能通过物理层动态控制信令通知的信息获取下行信号的接收波束。

[0004] 现有NR协议中是当物理层动态控制信令和下行信号之间的间隔小于预定门限时，采用最近slot中的具有最低CORESETID的CORESET的波束来缓存数据。

[0005] 上述方案会存在如下两个问题，第一个问题是当物理层动态控制信令和下行信号之间的间隔小于预定门限时，物理层动态控制信令中通知波束的比特域没有充分利用，第二个问题是，由于在未解码到物理层动态控制信令之前，需要缓存下行信号，但是实际下行信号基站可能没有调度，但是如果按照规定终端需要按照最近CORESETID的CORESET缓存动态调度的潜在下行信号，但是在这些潜在下行信号所在的位置可能还存在之前调度的信号，当之前调度的下行信号和潜在下行信号的波束终端不能同时打出时，需要基站和终端约定行为，从而保证通信的有效性。

[0006] 针对上述技术问题，相关技术中尚未提出有效的解决方案。

发明内容

[0007] 本发明实施例提供了一种控制信令的发送、接收以及信息的确定方法及装置，以至少解决相关技术中当物理层动态控制信令和下行信号之间的间隔小于预定门限时，物理层动态控制信令中通知波束的比特域没有充分利用所造成的资源利用率较低的问题以及潜在下行信号所在的位置可能还存在之前调度的信号，当之前调度的下行信号和潜在下行信号的波束终端不能同时打出时无法保证通信的有效性的问题。

[0008] 根据本发明的一个实施例，提供了一种控制信令的发送方法，包括：根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；发送所述第一控制信令。可选地，根据所述确定的第二信息发送所述第一控制信令。

[0009] 根据本发明的另一个实施例，提供了一种信息的确定方法，包括：根据第一信息确

定第二信息；其中，所述第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。可选地，根据所述确定的第二信息发送或者接收所述第一信号。

[0010] 根据本发明的另一个实施例，提供了一种控制信令的接收方法，包括：根据第一信息确定第二信息；根据所述第二信息接收第一控制信令；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

[0011] 根据本发明的另一个实施例，提供了一种控制信令的发送装置，应用于第一通信节点，包括：第一确定模块，用于根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；第一发送模块，用于发送所述第一控制信令。可选地，根据所述确定的第二信息发送所述第一控制信令。

[0012] 根据本发明的另一个实施例，提供了一种信息的确定装置，应用于第一通信节点，包括：第二确定模块，用于根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。可选地，根据所述确定的第二信息发送或者接收所述第一信号。

[0013] 根据本发明的另一个实施例，提供了一种控制信令的接收装置，应用于第二通信节点，包括：第三确定模块：根据第一信息确定第二信息；接收模块：根据所述第二信息接收第一控制信令；其中，所述第二信息为根据第一信息确定的信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令

中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

[0014] 根据本发明的又一个实施例，还提供了一种存储介质，所述存储介质中存储有计算机程序，其中，所述计算机程序被设置为运行时执行上述任一项方法实施例中的步骤。

[0015] 根据本发明的又一个实施例，还提供了一种电子装置，包括存储器和处理器，所述存储器中存储有计算机程序，所述处理器被设置为运行所述计算机程序以执行上述任一项方法实施例中的步骤。

[0016] 通过本发明，根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和该第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；该第一信息包括：该第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；发送该第一控制信令。也就是说，通过第二信息确定控制信令的格式，然后根据确定的格式发送控制信令，解决了相关技术中当物理层动态控制信令和下行信号之间的间隔小于预定门限时，物理层动态控制信令中通知波束的比特域没有充分利用所造成的资源利用率较低的问题，达到了提高控制信令资源利用率的技术效果。

[0017] 同时本发明通过第一信息确定第二信息，所述第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。可选地，根据所述确定的第二信息发送或者接收所述第一信号。也即通过信号和控制信道资源，或者信号和调度信号的控制信令之间的时间间隔与预定阈值之间的关系，确定两个信号之间的复用问题，或者两个信号的接收问题，解决了相关技术中终端检测控制信令存在延迟，以及同一时刻打出的射频波束有限所导致的无法正确接收信号的问题。

附图说明

[0018] 此处所说明的附图用来提供对本发明的进一步理解，构成本申请的一部分，本发明的示意性实施例及其说明用于解释本发明，并不构成对本发明的不当限定。在附图中：

[0019] 图1是根据本发明实施例的控制信令的发送方法流程图；

[0020] 图1a是根据本发明实施例的PDSCH2的Spatial Rx parameter参数根据PDSCH1的Spatial Rx parameter参数获取的示意图；

[0021] 图1b是根据本发明实施例的PDSCH的Spatial Rx parameter参数根据CSI-RS的Spatial Rx parameter参数获取的示意图；

[0022] 图1c是根据本发明实施例的PDSCH的Spatial Rx parameter参数根据距离PDSCH

最近的时域符号中的最低CORESETID的CORESET的Spatial Rx parameter参数获取的示意图；

[0023] 图1d是根据本发明实施例的PDSCH的Spatial Rx parameter参数对应的接收波束和相同时域符号中的CORESET的Spatial Rx parameter参数对应的接收波束不同的示意图一；

[0024] 图1e是根据本发明实施例的PDSCH的Spatial Rx parameter参数对应的接收波束和相同时域符号中的CORESET的Spatial Rx parameter参数对应的接收波束不同的示意图二；

[0025] 图1f是根据本发明实施例的PDSCH的Spatial Rx parameter参数对应的接收波束和相同时域符号中的CORESET的Spatial Rx parameter参数对应的接收波束不同的示意图三；

[0026] 图2是根据本发明实施例的周期CSI-RS的至少Spatial Rx parameter参数根据周期CSI-RS和距离周期CSI-RS最近的具有最低CORESETID的CORESET之间的距离与预定阈值之间的关系确定的示意图；

[0027] 图3是根据本发明实施例的周期CSI-RS和PDSCH的至少Spatial Rx parameter参数的优先级根据周期CSI-RS和距离周期CSI-RS最近的具有最低CORESETID的CORESET之间的距离与预定阈值之间的关系确定的示意图；

[0028] 图4a是根据本发明实施例的一个PDSCH占有多个slot时，各个slot中PDSCH的Spatial Rx parameter参数的获取方式的示意图一；

[0029] 图4b是根据本发明实施例的一个PDSCH占有多个slot时，各个slot中PDSCH的Spatial Rx parameter参数的获取方式的示意图二；

[0030] 图4c是根据本发明实施例的一个PDSCH占有多个slot时，各个slot中PDSCH的Spatial Rx parameter参数的获取方式的示意图三；

[0031] 图4d是根据本发明实施例的一个PDSCH占有多个slot时，各个slot中PDSCH的Spatial Rx parameter参数的获取方式的示意图四；

[0032] 图4e是根据本发明实施例的一个PDSCH占有多个slot时，各个slot中PDSCH的Spatial Rx parameter参数的获取方式的示意图五；

[0033] 图4f是根据本发明实施例的一个PDSCH占有多个slot时，各个slot中PDSCH的Spatial Rx parameter参数的获取方式的示意图六；

[0034] 图5是根据本发明实施例的索引值和传输参数值的对应多个表格对应不同的时域位置的示意图；

[0035] 图6a是根据本发明实施例的不同CC的两个PDSCH之间是QCL的示意图；

[0036] 图6b是根据本发明实施例的不同CC的PDSCH和CORESET之间是QCL的示意图；

[0037] 图6c是根据本发明实施例的不同CC的两个CORESET之间是QCL的示意图；

[0038] 图6d是根据本发明实施例的不同CC的PDSCH和CSI-RS之间是QCL的示意图；

[0039] 图7a是根据本发明实施例的属于一个CC的两个PDSCH之间是QCL的示意图；

[0040] 图7b是根据本发明实施例的属于一个CC的PDSCH和CORESET之间是QCL的示意图；

[0041] 图7c是根据本发明实施例的属于一个CC的两个CORESET之间是QCL的示意图；

[0042] 图7d是根据本发明实施例的属于一个CC的PDSCH和CSI-RS之间是QCL的示意图；

[0043] 图7e是根据本发明实施例的属于一个CC的两个CSI-RS之间是QCL的示意图；

[0044] 图8a是根据本发明实施例的一个CORESET的QCL参数与终端是否检测波束恢复请求信号有关的示意图；

[0045] 图8b是根据本发明实施例的调度非周期测量参考信号的DCI在非周期测量参考信号之后的示意图一；

[0046] 图8c是根据本发明实施例的调度非周期测量参考信号的DCI在非周期测量参考信号之后的示意图二；

[0047] 图9是根据本发明实施例的控制信令的接收方法流程图；

[0048] 图10是根据本发明实施例的信息的确定方法流程图；

[0049] 图11是根据本发明实施例的控制信令的发送装置的结构框图；

[0050] 图12是根据本发明实施例的控制信令的接收装置的结构框图；

[0051] 图13是根据本发明实施例的信息的确定装置的结构框图；

具体实施方式

[0052] 下文中将参考附图并结合实施例来详细说明本发明。需要说明的是，在不冲突的情况下，本申请中的实施例及实施例中的特征可以相互组合。

[0053] 需要说明的是，本发明的说明书和权利要求书及上述附图中的术语“第一”、“第二”等是用于区别类似的对象，而不必用于描述特定的顺序或先后次序。

[0054] 实施例1

[0055] 在本实施例中提供了一种控制信令的发送方法，图1是根据本发明实施例的控制信令的发送方法流程图，如图1所示，该流程包括如下步骤：

[0056] 步骤S102，根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和该第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；该第一信息包括：该第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；

[0057] 步骤S104，发送该第一控制信令。

[0058] 可选地，根据该确定的第二信息发送该第一控制信令。

[0059] 通过上述步骤，根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和该第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；该第一信息包括：该第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；发送该第一控制信令。也就是说，通过第二信息确定控制信令的格式，然后发送新的控制信令，解决了相关技术中当物理层动态控制信令和下行信号之间的间隔小于预定门限时，物理层动态控制信令中通知波束的比特域没有充分利用所造成的资源利用率较低的问题，达到了提高控制信令资源利用率的技术效果。

[0060] 可选地，上述步骤的执行主体可以为基站等，但不限于此。

[0061] 可选地，步骤S102和步骤S104的执行顺序是可以互换的，即可以先执行步骤S104，然后再执行S102。

[0062] 可选地，在上述关系为第一关系时，上述N的取值包括N1；在上述关系为第二关系时，上述N的取值包括N2；其中，N1、N2为整数。

[0063] 其中，上述N1和上述N2之间的关系满足以下至少之一：上述N1大于上述N2；上述N1与上述N2的差值小于或者等于传输配置指示(Transmission configuration indication，简称为TCI)域所占的比特数；上述N1与上述N2的差值小于或者等于通知第二传输参数信息所需要的比特数。

[0064] 可选地，在上述关系为第一关系时，上述对应映射表格为第一对应映射表格；在上述关系为第二关系时，上述对应映射表格为第二对应映射表格；

[0065] 可选地，上述第一对应映射表格、上述第二对应映射表格、传输参数取值集合一以及传输参数取值集合二中的任一项通过以下方式至少之一确定：方式一、发送的信令信息所包括的内容；方式二、发送端和接收端预先约定的规则；其中，上述传输参数取值集合一对应上述第一对应映射表格中包括的上述第一传输参数的取值集合，上述传输参数取值集合二对应上述第二对应映射表格中包括的上述第一传输参数的取值集合。

[0066] 在一个可选地实施方式中，在上述第一传输参数的类型为TCI时，上述第一对应映射表格中各个状态中关联空间接收参数Spatial Rx parameter的下行链路参考信号(Down link reference signal，简称为DL-RS)构成的DL-RS集合中只包括一个DL-RS；在上述第一传输参数类型为TCI时，上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中DL-RS两两之间关于空间接收参数满足准共址(quasi co-location，简称为QCL)关系；

[0067] 在上述第一传输参数类型为TCI时，上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中的DL-RS能被第一通信节点同时接收；在上述第一传输参数类型为TCI时，上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合为空集；其中，上述第一通信节点为接收上述第一信号，和/或上述第一控制信令的通信节点。

[0068] 可选地，上述第一传输参数的类型为上述第一控制信令中包括的除TCI传输参数类型之外的一个或者多个传输参数类型；或者，上述第一传输参数类型为TCI传输参数。

[0069] 可选地，上述第一传输参数满足以下至少之一：上述第一传输参数为上述第一信号的传输参数；上述第一传输参数为第二信号的传输参数。

[0070] 可选地，上述第一信号或者上述第二信号包括以下信号至少之一：解调参考信号、测量参考信号、控制信道信号、数据信道信号；上述第一控制信令为物理层控制信令。

[0071] 在一个可选地实施方式中，上述第一信息还包括以下信息至少之一：第二控制信令中包括的信息；上述第一控制信令所在的控制资源集合(control resource set，简称为CORESET)对应的传输配置指示(transmission configuration indication，简称为TCI-PresentInDCI)是否使能信息；上述第一信号或者上述第二信号所在的载频与预定阈值G之间的关系；第一通信节点反馈的支持的频率范围能力；上述预设阈值K是否为0；第一通信节点需要检测的CORESET中是否至少存在一个配置了空间接收参数的CORESET；与上述第一通信节点需要检测专有搜索空间关联的CORESET集合中是否至少存在一个配置了空间接收参

数的CORESET；与上述第一信号或者上述第二信号距离最近的时间单元中具有最低控制资源集合标识(control resource set identity，简称为CORESETID)的CORESET是否配置了空间接收参数的CORESET；与上述第一信号或者上述第二信号距离最近的时域符号中具有最低CORESETID的CORESET是否配置了空间接收参数的CORESET；与上述第一信号或者上述第二信号关联的TCI状态池中是否至少存在一个TCI状态，其中，上述TCI状态中与参考信号集合参考结合reference RS set对应的QCL参数中包括空间接收参数；与上述第一信号或者第二信号关联的激活TCI状态池中，是否至少存在一个TCI状态，上述TCI状态中于所述参考信号集合reference RS set对应的QCL参数中包括空间接收参数；其中，上述第一通信节点为接收上述第一信号，和/或上述第二信号的通信节点。

[0072]　可选地，在上述关系为第一关系时，上述第一控制信令中预定指示域所通知的上述第一传输参数的类型为第一类型传输参数；在上述关系为第二关系时，上述第二控制信令中预定指示域所通知的上述第一传输参数的类型为第二类型传输参数。

[0073]　可选地，在上述第一控制信令和上述第一信号之间的传输时间间隔小于上述预定阈值K时，上述关系为上述第一关系，在上述控制信令和上述第一信号之间的传输时间间隔大于或者等于上述预定阈值K时，上述关系为上述第二关系；或者，在上述控制信令和上述第一信号之间的传输时间间隔小于或者等于上述预定阈值K时，上述关系为上述第一关系，在上述控制信令和上述第一信号之间的传输时间间隔大于上述预定阈值K时，上述关系为上述第二关系；或者，在上述控制信令和上述第一信号之间的传输时间间隔大于或者等于上述预定阈值K时，上述第一关系为第一关系，在上述控制信令和上述第一信号之间的传输时间间隔小于上述预定阈值K时，上述关系为上述第二关系。

[0074]　下面结合可选实施例，对本实施例进行举例说明。

[0075]　可选实施例1

[0076]　在基于波束的通信中，物理共享信道(Physical share channel，简称为PDSCH)的波束可以通过下行控制信息(Down control information，简称为DCI)通知，当DCI和PDSCH之间的间隔小于K时，终端还没有解码出DCI就需要射频接收缓存PDSCH，所以现在NR规定当DCI和PDSCH之间的间隔小于预定阈值K时，根据最近slot中的最低CORESETID对应的QCL参数获取PDSCH的DMRS的QCL参数，当DCI和PDSCH之间的间隔大于或者等于预定阈值K时，采用DCI中指示的QCL信息获取PDSCH的DMRS的QCL参数。但是为了降低终端的盲检PDCCH复杂度，DCI和PDSCH之间的间隔小于K时PDCCH的负载与DCI和PDSCH之间的间隔大于或者等于K时PDCCH的负载相同。这样在DCI和PDSCH之间的间隔小于K时，DCI中的3比特TCI通知域(TCI通知域用于通知PDSCH的DMRS的QCL参数)存在，但是没有利用，现在NR的版本中，TCI通知域占有3比特。由此提出如下增强方案。

[0077]　当DCI和PDSCH之间的间隔小于K时，DCI中的3比特TCI通知域可以通知DCI中除TCI传输参数之外的一个或者多个传输参数(即所述第一传输参数)，现在NR DCI format1_1中的传输参数按照顺序如表1所示。从表1可以看出，DCI和PDSCH之间的间隔可以通过传输参数指示域5中指示的信息确定。

[0078]　表1

[0079]

传输参数指	传输参数	所占比特数

[0080]

示域编号		
1	Carrier indicator (载波指示域)	
2	Identifier for DCI formats (DCI format 指示域)	
3	Bandwidth part indicator(BWP 指示域)	
4	Frequency domain resource assignment(频域资源指示域)	
5	Time domain resource assignment(时间资源指示域)	
6	VRB-to-PRB mapping(虚拟资源块到物理资源块的映射方式指示域)	
7	PRB bundling size indicator(PRB Bundling size 指示域)	
8	Rate matching indicator (速率匹配信息指示域)	
9	For transport block 1(MCS，NDI，RV)(第一传输块的编码速率 MCS，新数据指示 NDI，冗余版本 RV 指示域)	
10	For transport block 2(MCS，NDI，RV)(第二传输块的编码速率 MCS，新数据指示 NDI，冗余版本 RV 指示域)	
11	HARQ process number(进程号指示域)	
12	Downlink assignment index(下行指派指示域)	
13	TPC command for scheduled	

[0081]

	PUCCH(PUCCH 的 TPC 功率指示域)	
14	PUCCH resource indicator(PUCCH 资源指示域)	2 比特
15	PDSCH-to-HARQ_feedback timing indicator(PDSCH to HARQ 的时间差指示域)	
16	Antenna port(s) (天线端口指示域，主要解调参考信号指示域)	
17	Transmission configuration indication(TCI 指示域，用于指示 PDSCH 的解调)	3 比特
18	SRS request(上行参考信号的触发信令)	
19	CBG transmission information (CBGTI)	
20	CBG flushing out information (CBGFI)	
21	DMRS sequence initialization(DMRS 序列初始化值)	

[0082] 比如所述第一传输参数为如表1中编号为14的传输参数，当DCI和PDSCH的间隔小于K时，PUCCH的资源指示域可以采用表1中的编号为14的比特域和编号为17的比特域总共5比特指示最多从32个PUCCH资源中选择其中一个PUCCH资源，当DCI和PDSCH之间的间隔大于或者等于K时，PUCCH的资源只用表1中编号为14的指示域指示最多从4个PUCCH资源中选择其中一个PUCCH资源。DCI和PDSCH的间隔小于K时，DCI中的指示域的顺序可以继续沿用表1的顺序，只是指示域14联合指示域17共同构成PUCCH资源指示域。或者此时也可以采用如表2所示的传输参数指示域顺序，表2相比表1的变化在于取消传输参数指示域17，传输参数指示域14的比特数变为5比特。

[0083] 表2

[0084]

传输参数指	传输参数	所占比特数

[0085]

示域编号		
1	Carrier indicator (载波指示域)	
2	Identifier for DCI formats (DCI format 指示域)	
3	Bandwidth part indicator(BWP 指示域)	
4	Frequency domain resource assignment(频域资源指示域)	
5	Time domain resource assignment(时间资源指示域)	
6	VRB-to-PRB mapping(虚拟资源块到物理资源块的映射方式指示域)	
7	PRB bundling size indicator(PRB Bundling size 指示域)	
8	Rate matching indicator (速率匹配信息指示域)	
9	For transport block 1(MCS, NDI, RV)(第一传输块的编码速率 MCS, 新数据指示 NDI, 冗余版本 RV 指示域)	
10	For transport block 2(MCS, NDI, RV)(第二传输块的编码速率 MCS, 新数据指示 NDI, 冗余版本 RV 指示域)	
11	HARQ process number(进程号指示域)	
12	Downlink assignment index(下行指派指示域)	

[0086]

13	TPC command for scheduled PUCCH(PUCCH 的 TPC 功率指示域)	
14	PUCCH resource indicator(PUCCH 资源指示域)	5 比特
15	PDSCH-to-HARQ_feedback timing indicator(PDSCH to HARQ 的时间差指示域)	
16	Antenna port(s) (天线端口指示域，主要解调参考信号指示域)	
18	SRS request(上行参考信号的触发信令)	
19	CBG transmission information (CBGTI)	
20	CBG flushing out information (CBGFI)	
21	DMRS sequence initialization(DMRS 序列初始化值)	

[0087] 这样在DCI和PDSCH之间的传输间隔小于预定K值时，DCI就可以在32个PUCCH资源中动态选择，如表3所示；当DCI和PDSCH之间的传输间隔大于或者等于预定K值时，DCI只能在4个PUCCH资源中动态选择，如表4所示。

[0088] 表3

[0089]

DCI 中 PUCCH 资源选择参数索引值	PUCCH 资源
0	PUCCH 资源 1
1	PUCCH 资源 2

[0090]

2	PUCCH 资源 3
3	PUCCH 资源 4
…	…
31	PUCCH 资源 32

[0091]　表4

[0092]

DCI中PUCCH资源选择参数指示值	PUCCH资源
0	PUCCH资源1
1	PUCCH资源2
2	PUCCH资源3
3	PUCCH资源4

[0093]　在表3和表4中，表4中的4个PUCCH资源，和表3中的前4个PUCCH资源相同，这样基站在通知的时候，只需要通知32个PUCCH资源就可以，当然本实施例也不排除表3中的PUCCH资源和表4中的PUCCH资源可以不同。这样基站在用高层信令通知的时候，分别为表3和表4通知PUCCH资源。

[0094]　在本实施例中，DCI和PDSCH之间的间隔，可以是如下间隔之一：

[0095]　DCI的结束时域符号和PDSCH的开始时域符号之间的间隔；

[0096]　DCI的起始时域符号和PDSCH的开始时域符号之间的间隔；

[0097]　DCI所在的slot中的CORESET结束符号中的最晚的时域符号和PDSCH的开始时域符号之间的间隔；

[0098]　DCI所在的slot中的CORESET的最早时域符号和PDSCH的开始时域符号之间的间隔；

[0099]　DCI的结束时域符号和PDSCH在其占有的多个slot中的每个slot中的开始时域符号之间的间隔；

[0100]　DCI的起始时域符号和PDSCH在其占有的多个slot中的每个slot中的开始时域符号之间的间隔。

[0101]　上面是当DCI和PDSCH之间的间隔小于预定门限K时，TCI的指示域借用于PUCCH资源指示。类似地，也可以当DCI和PDSCH之间的间隔小于预定门限时，TCI的指示域借用于rate mating指示域，类似地高层信令在配置rate mating信息时，需要配置两套rate mating的参数，比如一套参数用于建立类似于表3所述的表格，另一个套参数用于建立表4所述的表格，或者一套参数只是这套参数中的全部entry用于表3的建立，约定的部分entry(比如前M个entry，或者后M个entry)用于表4的建立，只不过此时表格3和表4中的表格就应该是索引值和rate mating信息之间的对应关系，而且此时表格3的状态数和表格4的状态数也会改变，比如高层配置的rate-match-PDSCH-resource-set中包括2个resource，当DCI和PDSCH之间的传输间隔小于预定阈值时，参照表5得到rate mating信息，表5中总共有2^(1

$^{+3)}=16$个索引值，通过表1中的传输参数指示域8和传输参数指示域17联合指示；当DCI和PDSCH之间的间隔传输时间间隔大于或者等于预定阈值时，参照表6得到rate mating信息，表6中总共$2^{(1)}=2$个状态，通过表1中的传输参数指示域8指示。

[0102] 表5

[0103]

DCI中rate mating信息索引值	Rate mating信息
0	高层配置的rate mating信息1
1	高层配置的rate mating信息2
2	高层配置的rate mating信息3
3	高层配置的rate mating信息4
...	...
15	高层配置的rate mating信息16

[0104] 表6

[0105]

DCI 中 PUCCH 资源选择参数指示值	PUCCH 资源

[0106]

0	高层配置的 rate mating 信息 1
1	高层配置的 rate mating 信息 2

[0107] 类似地，当DCI和PDSCH之间的间隔小于预定门限K时，TCI指示域可以用于表1中除TCI传输参数之外的其他20个参数中任意一个或者多个传输参数。比如当DCI和PDSCH之间的间隔小于预定门限K时，TCI指示域的3比特中的其中前1个比特借用于rate mating信息的通知，后2个比特借用于ZP-CSI-RS信息的通知。或者通过约定规则或者信令信息确定当DCI和PDSCH之间的间隔小于预定门限时，TCI域指示的传输参数的类型，或者TCI域的每个比特指示的传输参数类型。比如基站信令指示，当DCI和PDSCH之间的间隔小于预定门限K时，TCI指示域的前1个比特用于rate mating信息的通知，TCI指示域后2个比特用于ZP-CSI-RS信息的通知，或者基站信令指示，当DCI和PDSCH之间的间隔小于预定门限K时，TCI域的3个比特都用于rate mating信息的通知；或者基站通过信令通知，当DCI和PDSCH之间的间隔小于预定门限K时，TCI域的前2个比特用于PDSCH频域资源的通知，TCI域后1个比特用于ZP-CSI-RS信息的通知。

[0108] 上述实施例中，当DCI和PDSCH之间的间隔小于K时，TCI指示域用于指示表1中的除TCI传输参数之外的其他类型的传输参数，也可以用于指示表1中没有的传输参数类型，比如用于指示CSI信息（其中CSI信息用于触发非周期CSI-RS和/或非周期CSI上报），这样当DCI和PDSCH之间的间隔小于K时，DCI中的TCI指示域借用于指示CSI触发信息，当DCI和PDSCH之间的间隔大于K时，TCI指示域用于指示TCI信息，此时DCI中就不能指示CSI信息。

[0109] 可选实施例2

[0110] 在本实施例中，根据物理层动态控制信令和第一信号的传输间隔与预定阈值之间的关系，确定如下信息至少之一：所述物理层动态控制信令的特定指示域指示的传输参数

类型，所述物理层动态控制信令中是否包括指示特定传输参数类型的指示信息。

[0111] 进一步地当所述关系为关系一时，所述物理层动态控制信令的特定指示域用于指示第一类型的传输参数；

[0112] 当所述关系为关系二时，所述物理层动态控制信令的特定指示域用于指示第二类型的传输参数；

[0113] 进一步地当所述关系为关系一时，所述物理层动态控制信令中包括指示特定传输参数类型的指示信息；

[0114] 当所述关系为关系二时，所述物理层动态控制信令中不包括指示特定传输参数类型的指示信息；

[0115] 进一步地，所述关系一为所述物理层动态控制信令和第一信号的传输间隔小于预定阈值，所述关系二为所述物理层动态控制信令和第一信号的传输间隔大于或者等于预定阈值；或者

[0116] 所述关系一为所述物理层动态控制信令和第一信号的传输间隔小于或者等于预定阈值，所述关系二为所述物理层动态控制信令和第一信号的传输间隔大于预定阈值。

[0117] 进一步地，所述传输参数可以是第一信号的传输参数，或者是第二信号的传输参数。

[0118] 具体地，当DCI和PDSCH(所述第一信号)之间的传输时间间隔小于K值时，表1中的编号为17的DCI中的指示域用于指示rate mating指示信息，当DCI和PDSCH之间的传输时间间隔大于或者等于K值时，表1中的编号为17的DCI中的指示域用于指示TCI信息。

[0119] 或者，当DCI和PDSCH(所述第一信号)之间的传输时间间隔小于K值时，表1中的编号为17的DCI中的指示域用于指示CSI请求信息，当DCI和PDSCH之间的传输时间间隔大于或者等于K值时，表1中的编号为17的DCI中的指示域用于指示TCI信息(即PDSCH的DMRS的QCL参数信息)。即当DCI和PDSCH之间的间隔小于K时，DL-Grant的DCI中包括CSI请求指示信息，当DCI和PDSCH之间的间隔大于或者等于K时，DL-Grant的DCI中不包括CSI请求指示信息。

[0120] 可选实施例3

[0121] 在上述可选实施例1和可选实施例2中，第一传输参数的值集合中包括的候选参数值的个数会根据第一关系而变化，比如当DCI和PDSCH之间的间隔小于K时，第一传输参数的值集合中包括X1个值，当DCI和PDSCH之间的大于K时，第一传输参数的值集合中包括X2个值。或者当DCI和PDSCH之间的间隔小于K时，DCI中控制信令指示第一传输参数的索引值参照的索引值和第一传输值之间的对应映射表格为表格一(比如如表3所示)，当DCI和PDSCH之间的大于K时，DCI中控制信令指示第一传输参数的索引值参照的索引值和第一传输值之间的对应映射表格为表格二(比如表4所示)。

[0122] 进一步地，DCI中是否存在TCI指示域也是per CORESET(Control resource set)配置的，配置CORESET1中的DCI中不存在TCI指示域，即CORESET1中的DCI不包括表1中编号为17的传输参数指示域，配置CORESET2中的DCI中存在TCI指示域，即CORESET2中的DCI包括表1中编号为17的传输参数指示域，且约定当DCI和PDSCH之间的传输间隔小于约定阈值(比如K)时，DCI中的TCI指示域用于指示rate mating信息，所以在CORESET2中传输的DCI中指示的rate mating信息所参照索引值和rate mating信息就有表5和表6两个表格，当DCI和PDSCH之间的间隔小于预定门限时，参照表格5，当DCI和PDSCH之间的间隔大于或者等于预

定门限时，参照表格6，CORESET1中的DCI中指示的rate mating信息所参照的索引值和rating信息也参照表6.或者CORESET1中的DCI中指示的rate mating信息所参照的索引值和rating信息也参照不同于表6的一张表，比如为表6-2，即此时rate mating信息所参照的表格有3，这样基站在通过高层信令通知rate mating信息时，就需要针对各个表格通知rate mating信息，或者高层通过一个信令通知表6和表5的信息，通过另一个信令通知表6-2的信息。

[0123] 即当DCI和PDSCH之间的传输间隔小于K时，DCI中的指示的rate mating信息的索引信息所参照的表格为表5，其他情况，DCI中的指示的rate mating信息的索引信息所参照的表为表6.

[0124] 上述实施方式中，是DCI中指示的rate mating信息所参照的表格有Y个，类似地，也可以是DCI中指示的其他传输参数类型所参照的表格有Y个。Y为大于1的数，比如上述实施方式中Y＝2或者Y＝3.

[0125] 可选实施例4

[0126] 在上述实施例中，根据第一信息确定第二信息，其中第二信息中包括如下信息至少之一：控制信令中通知第一传输参数所用的比特数N，控制信令中通知第一传输参数信息所参照的索引值和第一传输参数值之间的对应映射表格，控制信令中预定指示域通知的第一传输参数的类型，控制信令中通知第一传输参数所用的比特的位置信息。其中第一信息包括：所述控制信令和第一信号之间传输时间间隔与预定阈值之间的关系。

[0127] 本实施例中，所述第一信息还包括如下信息一～信息十中的至少一个信息。

[0128] 信息一：第二控制信令中包括的信息，比如基站给终端发送信令信息，所述信令信息中通知如下信息至少之一：是否TCI域可以借用于其他传输参数类型的通知，TCI域可借用于通知的传输参数类型，TCI域的哪些比特可借用于通知的传输参数类型，根据第二控制信令中通知的信息，用于确定第二信息；

[0129] 信息二：所述第一控制信令所在的CORESET关联的TCI-PresentInDCI参数用于配置这个CORESET中发送的DL-Grant的DCI中是否存在TCI指示域，即是否存在表1中编号为17的指示域，比如当CORESTE关联的TCI-PresentInDCI不使能，则这个CORESET中DCI中不存在TCI域，第一传输参数所用的比特数不会随着DCI和PDSCH之间的传输时间间隔是否小于预定阈值K而改变；

[0130] 信息三：信号所在的carrier frequencies(载频)是否小于预定阈值K1，比如当PDSCH在6GHz以下，则不会启动根据第一信息确定第二信息的机制；或者终端发送的可处理的频域范围，当终端的频域处理能力为FR1(即终端可处理的频域范围小于预定阈值，比如小于6GHz)，则不启动根据第一信息确定第二信息的机制。

[0131] 信息四：第一通信节点需要检测的CORESET集合中，是否至少存在一个配置了Spatial Rx parameter的CORESET；比如终端需要检测的CORESET集合中，不存在一个配置了Spatial Rx parameter的CORESET，则不启动根据第一信息确定第二信息的机制；

[0132] 信息五：与第一通信节点需要检测专有Search space关联的CORESET集合中，是否至少存在一个配置了Spatial Rx parameter的CORESET；比如与终端需要检测专有Search space关联的CORESET集合中，不存在一个配置了Spatial Rx parameter的CORESET，则不启动根据第一信息确定第二信息的机制；

[0133] 信息六:与所述信号距离最近的时间单元中最低CORESETID的CORESET是否配置Spatial Rx parameter的CORESET;比如与PDSCH/AP-CSI-RS距离最近的时间单元中最低CORESETID的CORESET没有配置Spatial Rx parameter的CORESET,则不启动根据第一信息确定第二信息的机制;

[0134] 信息七:与所述信号距离最近的时域符号中最低CORESETID的CORESET是否配置Spatial Rx parameter的CORESET;比如与PDSCH/AP-CSI-RS距离最近的时域符号中最低CORESETID的CORESET没有配置Spatial Rx parameter的CORESET,则不启动根据第一信息确定第二信息的机制;

[0135] 信息八:与所述信号关联的TCI state pool中,是否至少存在一个TCI state,所述TCI state中reference RS set对应的QCL parameter中包括Spatial Rx parameter;比如与PDSCH关联的RRC配置的TCI state pool中,不存在一个TCI state,所述TCI state中的一个DL-RS对应的QCL parameter中包括Spatial Rx parameter,则不启动根据第一信息确定第二信息的机制;

[0136] 信息九:与所述信号关联的激活的TCI state pool中,是否至少存在一个TCI state,所述TCI state中reference RS set对应的QCL parameter中包括Spatial Rx parameter;比如与PDSCH关联的MAC-CE激活TCI state pool或者DCI中的TCI域能指示的TCI state构成的TCI state pool中,不存在一个TCI state,所述TCI state中的一个DL-RS对应的QCL parameter中包括Spatial Rx parameter,则不启动根据第一信息确定第二信息的机制;

[0137] 信息十:第一通信节点上报的频域范围处理能力信息,比如终端上报其可处理的频域范围是FR1(即可处理的频域范围小于6GHz),则不启动根据第一信息确定第二信息的机制,当终端上报其可处理的频域范围为FR2(即可处理的频域范围包括大于或者等于6GHz).则启动根据第一信息确定第二信息的机制。

[0138] 可选实施例5

[0139] 在本实施例中,根据DCI和PDSCH之间的间隔与预定阈值K之间的关系,确定DCI中通知的TCI域所参照的表格。

[0140] 具体地,当DCI和PDSCH之间的间隔小于预定阈值K时,所述DCI中TCI所参照的表格为表格7,当DCI和PDSCH之间的间隔大于或者等于预定阈值K时,所述DCI中TCI所参照的表格为表格8.其中TCI state10~TCI state17和TCI state20~TCI state27是由不同的高层控制信令配置的,其中所述高层控制信令包括RRC信令和/或MAC-CE信令。

[0141] 可选地,当DCI和PDSCH之间的间隔小于K时,PDSCH的DMRS的Spatial Rx parameter参数根据约定规则得到(比如根据最近slot中的最低CORESETID的CORESET的Spatial Rx parameter的配置),PDSCH的DMRS的其他QCL参数信息通过DCI中TCI指示域并参照表7得到.或者PDSCH的全部QCL参数通过DCI中TC指示域指示的信息并参照表7获取,只是表7的配置有限制。当DCI和PDSCH之间的间隔大于或者等于K时,PDSCH的DMRS的全部QCL参数都根据DCI中TCI指示域指示的信息并参照表8获取。

[0142] 表7

[0143]

DCI中TCI域的索引值	TCI state值

0	TCI state10
1	TCI state11
2	TCI state12
3	TCI state13
4	TCI state14
5	TCI state15
6	TCI state16
7	TCI state17

[0144] 表8

[0145]

DCI中TCI域的索引值	TCI state值
0	TCI state20
1	TCI state21
2	TCI state22
3	TCI state23
4	TCI state24
5	TCI state25
6	TCI state26
7	TCI state27

[0146] 其中一个state用于建立Q个PDSCH的DMRS group和Q个DL-RS set之间的关联关系，其中Q为大于或者等于1的整数，如表9所示，一个TCI state-n中建立了(DMRS group1，DL-RS set1)和(DMRS group2，DL-RS set2)之间的关联，其中DL-RS set1包括{DL-RS1，DL-RS2}，DL-RS set2中包括DL-RS3，其中DMRS group1关于QCL-type1中的QCL参数和DL-RS1存在QCL关系，其中每个QCL-Type包括如下参数至少之一：Doppler shift(多普勒频移)，Doppler spread(多普勒扩展)，average delay(平均延迟)，delay spread，(延迟扩展)，average gain(平均增益)，Spatial Rx parameter(空域接收参数)。其中DL-RS(Down-link reference signal)可以为CSI-RS/SSB/DMRS of PBCH，其中DMRS group也可以称为QCL target reference signal，DL-RS也可以称为QCL reference signal。

[0147] 表9

[0148]

TCI state-n	DMRS group1	(DL-RS1， QCL-Type1)
		(DL-RS2， QCL-Type2)
	DMRS group2	(DL-RS3， QCL-Type1)

[0149] 进一步地，表7中各个TCI state中关联的QCL-Type中包括Spatial Rx parameter这个QCL参数构成的DL-RS集合有预定的约束条件，其中所述约束条件包括如下至少之一：这个DL-RS集合中只包括一个DL-RS；这个集合中的DL-RS两两之间关于Spatial Rx parameter参数是QCL的；这个集合中的DL-RS终端能同时接收，这个DL-RS集合是空集，这个

集合中的DL-RS属于一个分组，这个分组可以是基站分配的，也可以是终端上报。具体地，比如表7中8个state中关联的QCL-Type中包括Spatial Rx parameter的DL-RS包括{DL-RS100,DL-RS101,DL-RS102,DL-RS103,DL-RS104,DL-RS105,DL-RS106,DL-RS107}(即statei中DMRS group和DL-RS10i至少关于Spatial Rx parameter满足QCL关系，i＝0,1,...,7)，这个集合中的DL-RS两两之间关于Spatial Rx parameter是QCL的，或者这些DL-RS可以同时被终端接收，或者表7中8个state中关联的QCL-Type中包括Spatial Rx parameter的DL-RS都为DL-R100，或者这些DL-RS关联的QCL-Type中都不包括Spatial Rx parameter，约定此时的PDSCH的DMRS的Spatial Rx parameter参数根据约定规则得到，比如约定此时PDSCH的DMRS和最低CORESETID中的DMRS关于Spatial Rx parameter是QCL的。

[0150]　在本实施例中，当DCI和PDSCH之间的间隔小于预定阈值K时，DCI中包括的TCI指示域参照的表格为表7，当DCI和PDSCH之间的间隔大于或者等于预定阈值K时，DCI中的TCI指示域参照的表格为表8。因为表7中的TCI state中与Spatial Rx parameter关联的DL-RS的配置有限制，即这些TCI state关联的波束只有一个或者只有有限个。因为此时终端还没有解码出DCI，就要求终端在没有解码出DCI之前就知道PDSCH的Spatial Rx parameter，而在表8中就没有这样的限制，从而需要表7和表8两张表。

[0151]　表7的配置是高层信令配置的，为了实现不同时刻可以采用不同的波束，即使DCI和PDSCH之间的传输时间间隔小于K的时候，从而可以配置多个表7，每个表7配置其起作用的时域pattern，比如配置表7-1的周期和周期偏置，配置表7-2的周期和周期偏置。或者有两个表7，即表7-1和表7-2，配置表7-1的周期和周期偏置，其余的slot中参照表7-2，即当DCI落在表7-1所示的slot中时，这个DCI中通知的TCI域参照表7-1，当DCI落在其余slot中时，DCI中通知的TCI域参照表7-2。也可以是配置3个表7，比如为表7-1，表7-2，表7-3，并配置表7-1的周期和周期偏置，也配置表7-2所示的周期和周期偏置，表7-3不配置周期和周期偏置，当DCI落在表7-1所在的slot中时，DCI中的TCI指示域参照表7-1，当DCI落在表7-2所在的slot中时，DCI中的TCI指示域参照表7-2，当DCI落在其他slot中时，DCI中的TCI指示域参照表7-3。总之就是当DCI和PDSCH之间的间隔小于预定阈值时，根据DCI中指示的TCI指示信息，参照PDSCH所在的slot中对应TCI所参照的表格，得到PDSCH的QCL信息。如图5所示，配置表7-1～表7-3对应的时域pattern，当PDSCH落在slotn且PDSCH和DCI之间的间隔小于预定阈值K时，PDSCH的DMRS的QCL参数根据DCI中指示的TCI信息参照表7-1得到，当PDSCH落在slotn+1且PDSCH和DCI之间的间隔小于预定阈值K时，PDSCH的DMRS的QCL参数根据DCI中指示的TCI信息参照表7-2得到。当PDSCH落在slotn且PDSCH和DCI之间的间隔大于或者等于预定阈值K时，PDSCH的DMRS的QCL参数根据DCI中指示的TCI信息参照表8得到。

[0152]　类似地，根据DCI和AP-CSI-RS之间的间隔和预定阈值之间的关系，确定AP-CSI-RS的TCI参数对应的表格。

[0153]　在可选实施例中，所述TCI指示信息，用于指示DMRS group/CSI-RS port group和DL-RS set之间的QCL关系，即一个TCI索引信息对应一个state，一个state中包括Q个DMRS group和Q个DL-RS set之间对应关系，一个DL-RS set中包括一个或者多个DL-RS，每个DL-RS关联一个QCL参数集合，表示所述DMRS group/CSI-RS port group中的参考信号和与其关联的DL-RS set中的一个DL-RS关于所述QCL参数集合满足QCL(quasi-co-location准共址)关系。两个参考信号关于一个QCL参数满足准共址关系，表示一个参考信号的所述QCL参

数可以由两个参考信号的所述QCL参数获取，其中所述QCL参数包括如下参数至少之一：

[0154] Doppler shift(多普勒频移)，Doppler spread(多普勒扩展)，average delay(平均延迟)，delay spread，(延迟扩展)，average gain(平均增益)，Spatial Rx parameter(空域接收参数)。

[0155] 本可选实施例中，两个参考信号是QCL的表示这两个参考信号至少关于Spatial Rx parameter是QCL的，这两个参考信号关于其他QCL参数是否QCL没有限制。

[0156] 在可选实施例中，信道也可以是一种信号，即在所述信道上传输信号。比如在数据信道上传输数据信号。

[0157] 在可选实施例中，不同的CC(component carrier)可以通过不同的Serving cellID关联。

[0158] 在本实施例中，还提供了一种控制信令的接收方法，图9是根据本发明实施例的控制信令的发送方法流程图，如图9所示，该流程包括如下步骤：

[0159] 步骤S902，根据第一信息确定第二信息；

[0160] 步骤S904，根据上述第二信息接收第一控制信令；

[0161] 其中，上述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和上述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；上述第一信息包括：上述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

[0162] 可选地，在上述关系为第一关系时，上述N的取值包括N1；在上述关系为第二关系时，上述N的取值包括N2；其中，N1、N2为整数。

[0163] 其中，上述N1和上述N2之间的关系满足以下至少之一：上述N1大于上述N2；上述N1与上述N2的差值小于或者等于传输配置指示(Transmission configuration indication，简称为TCI)域所占的比特数；上述N1与上述N2的差值小于或者等于通知第二传输参数信息所需要的比特数。

[0164] 可选地，在上述关系为第一关系时，上述对应映射表格为第一对应映射表格；在上述关系为第二关系时，上述对应映射表格为第二对应映射表格；

[0165] 可选地，上述第一对应映射表格、上述第二对应映射表格、传输参数取值集合一以及传输参数取值集合二中的任一项通过以下方式至少之一确定：方式一、发送的信令信息所包括的内容；方式二、发送端和接收端预先约定的规则；其中，上述传输参数取值集合一对应上述第一对应映射表格中包括的上述第一传输参数的取值集合，上述传输参数取值集合二对应上述第二对应映射表格中包括的上述第一传输参数的取值集合。

[0166] 在一个可选地实施方式中，在上述第一传输参数的类型为TCI时，上述第一对应映射表格中各个状态中关联空间接收参数Spatial Rx parameter的下行链路参考信号(Down link reference signal，简称为DL-RS)构成的DL-RS集合中只包括一个DL-RS；在上述第一传输参数类型为TCI时，上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中DL-RS两两之间关于空间接收参数满足准共址(quasi co-location，简称为QCL)关系；

[0167] 在上述第一传输参数类型为TCI时，上述第一对应映射表格中各个状态中关联空

间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中的DL-RS能被第一通信节点同时接收；在上述第一传输参数类型为TCI时，上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合为空集；其中，上述第一通信节点为接收上述第一信号，和/或上述第一控制信令的通信节点。

[0168] 可选地，上述第一传输参数的类型为上述第一控制信令中包括的除TCI传输参数类型之外的一个或者多个传输参数类型；或者，上述第一传输参数类型为TCI传输参数。

[0169] 可选地，上述第一传输参数满足以下至少之一：上述第一传输参数为上述第一信号的传输参数；上述第一传输参数为第二信号的传输参数。

[0170] 可选地，上述第一信号或者上述第二信号包括以下信号至少之一：解调参考信号、测量参考信号、控制信道信号、数据信道信号；上述第一控制信令为物理层控制信令。

[0171] 在一个可选地实施方式中，上述第一信息还包括以下信息至少之一：第二控制信令中包括的信息；上述第一控制信令所在的控制资源集合(control resource set，简称为CORESET)对应的传输配置指示(transmission configuration indication，简称为TCI-PresentInDCI)是否使能信息；上述第一信号或者上述第二信号所在的载频与预定阈值G之间的关系；第一通信节点反馈的支持的频率范围能力；上述预设阈值K是否为0；第一通信节点需要检测的CORESET中是否至少存在一个配置了空间接收参数的CORESET；与上述第一通信节点需要检测专有搜索空间关联的CORESET集合中是否至少存在一个配置了空间接收参数的CORESET；与上述第一信号或者上述第二信号距离最近的时间单元中具有最低控制资源集合标识(control resource set identity，简称为CORESETID)的CORESET是否配置了空间接收参数的CORESET；与上述第一信号或者上述第二信号距离最近的时域符号中具有最低CORESETID的CORESET是否配置了空间接收参数的CORESET；与上述第一信号或者上述第二信号关联的TCI状态池中是否至少存在一个TCI状态，其中，上述TCI状态中与参考信号集合参考结合reference RS set对应的QCL参数中包括空间接收参数；与上述第一信号或者第二信号关联的激活TCI状态池中，是否至少存在一个TCI状态，上述TCI状态中于所述参考信号集合reference RS set对应的QCL参数中包括空间接收参数；其中，上述第一通信节点为接收上述第一信号，和/或上述第二信号的通信节点。

[0172] 可选地，在上述关系为第一关系时，上述第一控制信令中预定指示域所通知的上述第一传输参数的类型为第一类型传输参数；在上述关系为第二关系时，上述第二控制信令中预定指示域所通知的上述第一传输参数的类型为第二类型传输参数。

[0173] 可选地，在上述第一控制信令和上述第一信号之间的传输时间间隔小于上述预定阈值K时，上述关系为上述第一关系，在上述控制信令和上述第一信号之间的传输时间间隔大于或者等于上述预定阈值K时，上述关系为上述第二关系；或者，在上述控制信令和上述第一信号之间的传输时间间隔小于或者等于上述预定阈值K时，上述关系为上述第一关系，在上述控制信令和上述第一信号之间的传输时间间隔大于上述预定阈值K时，上述关系为上述第二关系；或者，在上述控制信令和上述第一信号之间的传输时间间隔大于或者等于上述预定阈值K时，上述第一关系为第一关系，在上述控制信令和上述第一信号之间的传输时间间隔小于上述预定阈值K时，上述关系为上述第二关系。

[0174] 通过以上的实施方式的描述，本领域的技术人员可以清楚地了解到根据上述实施例的方法可借助软件加必需的通用硬件平台的方式来实现，当然也可以通过硬件，但很多

情况下前者是更佳的实施方式。基于这样的理解，本发明的技术方案本质上或者说对现有技术做出贡献的部分可以以软件产品的形式体现出来，该计算机软件产品存储在一个存储介质(如ROM/RAM、磁碟、光盘)中，包括若干指令用以使得一台终端设备(可以是手机，计算机，服务器，或者网络设备等)执行本发明各个实施例所述的方法。

[0175] 实施例2

[0176] 在本实施例中提供了一种信息的确定方法，图10是根据本发明实施例的信息的确定方法流程图，如图10所示，该流程包括如下步骤：

[0177] 步骤S1002，根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，该第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在该第二信号，该第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，该第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，该第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，该第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。

[0178] 通过上述步骤S1002，也即通过信号和控制信道资源，或者信号和调度信号的控制信令之间的时间间隔与预定阈值之间的关系，确定两个信号之间的复用问题，或者两个信号的接收问题，解决了相关技术中终端检测控制信令存在延迟，以及同一时刻打出的射频波束有限所导致的无法正确接收信号的问题。

[0179] 可选地，上述步骤的执行主体可以为基站等，但不限于此。

[0180] 可选地，上述第一控制信令和/或第二控制信令的格式可以结合上述实施例1中所描述的方法进行确定。

[0181] 可选地，所述第一控制信令为调度所述第一信号的物理层动态控制信令，所述第二控制信令为调度所述第二信号的物理层动态控制信令

[0182] 在一个可选地实施方式中，上述特定CORESET满足以下特征至少之一：上述CORESET是距离上述第一信号最近的时域符号中具有最低控制资源集合标识CORESET ID的CORESET；上述CORESET是距离上述第一信号最近的时间单元中具有最低CORESET ID的CORESET；在上述CORESET中终端需要检测调度下行信号和/或信道的下行控制信息DCI；在上述CORESET中不包括调度上述第一信号的控制信令信息；在上述CORESET中包括调度上述第二信号的控制信令信息；上述CORESET至少与一个专有搜索空间关联；上述CORESET是距离上述第一信号和/或上述第二信号最近的时间单元中的所有载波单元CC具有最低CORESETID的CORESET；上述CORESET是距离上述第一信号和/或上述第二信号最近的时间单元中的预定CC中具有最低CORESETID的CORESET；上述CORESET是距离上述第一信号和/或上述第二信号最近的时间单元中的预定CC组中具有最低CORESETID的CORESET；上述CORESET是一个时间单元中预定M个时域符号中的CORESET，其中，M小于或者等于上述时间单元中包括的时域符号个数。

[0183] 可选地，在上述第一信号和上述CORESET之间的时间间隔小于上述预定阈值X1时，上述第一信号的QCL参数根据上述CORESET的QCL参数获取；在上述第一信号和上述CORESET之间的间隔大于或者等于上述预定阈值X1时，上述第一信号的QCL参数通过上述第一信号

的配置信息中配置的QCL参数获取。
[0184] 可选地，在上述第一信号和上述CORESET之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数优先级高于上述第二信号的QCL参数；在上述第一信号和上述CORESET之间的间隔大于或者等于上述预定阈值X1时，上述第一信号的QCL参数优先级低于上述第二信号的QCL参数。
[0185] 可选地，在上述第一信号和上述CORESET之间的间隔小于上述预定阈值X1时，上述第一信号和上述第二信号之间不允许采用频分复用的方式；在上述第一信号和上述CORESET之间的间隔大于或者等于上述预定阈值X1时，上述第一信号和上述第二信号允许采用频分复用的方式。
[0186] 可选地，上述第一信号和/或上述第二信号包括以下信号至少之一：下行测量参考信号、下行同步信号、下行解调参考信号、下行数据信道信号、下行控制信道信号。
[0187] 可选地，上述预定阈值X1与预定阈值X2相等；和/或上述第二信号的QCL参数根据调度上述第二信号的控制信息和上述第二信号之间的间隔与上述预定阈值X2之间的关系确定。
[0188] 可选地，上述第一信号满足如下特征至少之一：上述第一信号为物理层动态控制信令调度的下行信号；上述第一信号为下行物理控制信道信号；调度上述第一信号的控制信令和上述第一信号之间的间隔小于上述预定阈值X1。
[0189] 可选地，上述第二信号满足以下特征至少之一：调度上述第二信号的控制信令在上述第一信号所在的时域符号之前；调度上述第二信号的控制信令和上述第一信号所在的时域符号之间的间隔大于或者等于上述预定阈值X3；调度上述第二信号的控制信令和上述第二信号所在的起始时域符号之间的间隔大于或者等于上述预定阈值X3；上述第二信号是物理层动态控制信令调度的下行信号；上述第二信号为周期下行测量参考信号；其中X3为实数。
[0190] 可选地，在上述CORESET之后预定时间窗中存在上述第二信号时，上述第一信号的QCL参数根据上述第二信号的QCL参数确定；在上述CORESET之后预定时间窗中不存在上述第二信号时，上述第一信号的QCL参数不根据上述第二信号的QCL参数确定；和/或在上述CORESET之后预定时间窗中存在上述第二信号，上述第一信号和调度上述第一信号的控制信令之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数不根据上述CORESET的QCL参数获取；在上述CORESET之后预定时间窗中不存在上述第二信号，上述第一信号和调度上述第一信号的控制信令之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数根据CORESET的QCL参数获取。
[0191] 可选地，上述第一信号和上述第二信号之间满足以下特征至少之一：上述第二信号的空间接收参数和上述第一信号的空间接收参数不同；上述第二信号的空间接收参数对应的空间滤波器和上述第一信号的空间接收参数对应的空间滤波器在第一通信节点不能同时打出；上述第二信号和上述第一信号属于不同的CC；上述第一信号所在的时域位置和上述第二信号所在的时域位置之间的交集为非空集合；上述第一信号和上述第二信号在相同的时域位置上；上述第二信号的优先级高于上述第一信号的优先级。
[0192] 可选地，在上述第二信息为上述第一信号的准共址QCL参数时，上述根据第一信息确定第二信息包括：根据上述第一信息确定如下信息至少之一：上述第一信号和上述第二

信号的QCL参数之间的优先级；上述第一信号的配置信息中配置的QCL参数和特定CORESET的QCL参数之间的优先级；当上述第一信号和调度上述第一信号的控制信令之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数是否根据特定CORESET的QCL参数获取。

[0193] 可选地，在上述第二信息为第二信号所在的时域位置上第一信号的接收方式时，上述根据第一信息确定第二信息包括根据上述第一信息确定如下信息至少之一：是否在上述第二信号所在的时域位置上接收上述第一信号；是否在上述第二信号所在的时域位置上检测控制信道；在上述第二信号所在的时域位置上，上述第一信号的QCL参数和上述第二信号的QCL参数之间的优先级；上述第一信号和上述第二信号之间能否频分复用；上述第一信号可在的时域位置是否包括第二信号所在的时域位置。

[0194] 可选地，在上述第二信息为第二信号所在的时域位置上第一信号的发送方式时，上述根据第一信息确定第二信息包括根据上述第一信息确定如下信息至少之一：是否在上述第二信号所在的时域位置上发送上述第一信号；是否在上述第二信号所在的时域位置上发送控制信道；在上述第二信号所在的时域位置上，上述第一信号的QCL参数和上述第二信号的QCL参数之间的优先级；上述第一信号和上述第二信号之间能否频分复用；上述第一信号可在的时域位置是否包括第二信号所在的时域位置。

[0195] 可选地，上述第二信号所在的时域位置包括如下时域位置之一：上述第二信号所在的时域符号；上述第二信号所在的时间单位。

[0196] 可选地，上述方法还包括：不接收满足以下特征的配置：当调度上述第一信号的上述第一控制信令和上述第一信号之间的间隔大于或者等于上述预定阈值X1，调度上述第二信号的上述第二控制信令和上述第二信号之间的间隔大于或者等于上述预定阈值X2时，上述第一信号和上述第二信号关于空间接收参数不满足QCL关系；当调度上述第一信号的上述第一控制信令和上述第一信号之间的间隔小于上述预定阈值X1，调度上述第二信号的上述第二控制信令和上述第二信号之间的间隔大于或者等于上述预定阈值X2时，上述第一信号的QCL参数根据上述第二信号的QCL参数确定；当调度上述第一信号的上述第一控制信令和上述第一信号之间的间隔小于上述预定阈值X1，调度上述第二信号的上述第二控制信令和上述第二信号之间的间隔小于上述预定阈值X2时，上述第一信号的QCL参数和上述第二信号的QCL参数的优先级根据约定规则或者信令信息获取。

[0197] 可选地，上述第一信息还包括以下信息至少之一：上述特定CORESET中包括的控制信令中是否包括传输配置指示TCI指示域；上述第一信号和/或上述第二信号所在的载频与预定阈值G之间的关系；上述预设阈值X1和/或上述预定阈值X2是否为0；特定CORESET中是否至少存在一个配置了空间接收参数的CORESET；上述第一通信节点需要检测的CORESET集合中是否至少存在一个配置了空间接收参数的CORESET；与上述第一信号或者上述第二信号关联的TCI状态池中是否至少存在一个TCI状态，其中，上述TCI状态中与参考信号集合对应的QCL参数中包括空间接收参数；与上述第一信号或者第二信号关联的激活TCI状态池中，是否至少存在一个TCI状态，上述TCI状态中与上述参考信号集合对应的QCL参数中包括空间接收参数；其中，上述第一通信节点为接收上述第一信号的通信节点。

[0198] 可选地，在上述第一信息为第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系时，上述根据第一信息确定第二信息包括如下方式至少之一：上述第一信号和上述第二信号关于空间接收参数满足QCL关系时，上述第一信号可在的

时域符号包括上述第二信号所在的时域符号；上述第一信号和上述第二信号关于空间接收参数不满足QCL关系时，上述第一信号可在的时域符号不包括上述第二信号所在的时域符号；在上述第一空间接收参数对应的空间滤波器和上述第二空间接收参数对应的空间滤波器第一通信节点能同时产生时，上述第一信号可在的时域符号包括上述第二信号所在的时域符号；在上述第一空间接收参数对应的空间滤波器和上述第二空间接收参数对应的空间滤波器第一通信节点不能同时产生时，上述第一信号可在的时域符号不包括上述第二信号所在的时域符号。

[0199]　需要说明的是，上述第一信号可在的时域符号不包括上述第二信号所在的时域符号可以为在第二信号所在的时域符号位置上，不发送和/或不接收所述第一信号做速率匹配。

[0200]　可选地，在上述第一信息为上述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，上述第二信息为第一信号的准共址QCL参数时，上述根据第一信息确定第二信息包括以下至少之一：上述第一信号在一个时间单元的不同时域符号上，上述QCL参数保持不变；上述第一信号在不同时间单元上，上述QCL参数可以不同；上述第一信号B1套QCL参数和A个时间单元之间存在对应关系；在上述第一信号所在的A个时间单元中的每个时间单元中的上述第一信号的QCL参数根据距离该时间单元最近的时间单元中具有预定特定的CORESET的QCL参数获取；在上述第一信号所在的A个时间单元中根据每个时间单元中上述第一信号和上述第一控制信令之间的时间间隔与上述预定阈值X1之间的关系，确定该时间单元中上述第一信号的QCL参数；其中，上述第一信号占有A个时间单元中，A为大于1的自然数，其中B1为小于或者等于A的非负整数。

[0201]　需要说明的是，上述时间单元可以是一个slot，也可以是一个子帧，或者其他时间单元。

[0202]　可选地，在上述第一信息为上述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，上述第二信息为第一信号的准共址QCL参数时，上述根据第一信息确定第二信息包括以下至少之一：根据A个时间单元中最前面的一个时间单元中上述第一信号和上述第一控制信令之间的时间间隔与上述预定阈值X1之间的关系，确定上述第一信号的QCL参数，上述第一信号在上述A个时间单元中的QCL参数保持不变；在上述第一信号所在的A1个时间单元中的每个时间单元中的上述第一信号的QCL参数根据距离该时间单元最近的时间单元中具有预定特定的CORESET的QCL参数获取，其中上述A1个时间单元中的最后一个时间单元中的上述第一信号和上述第一控制信令之间的间隔小于上述预定阈值X1；在上述第一信号所在的A2个时间单元中上述第一信号的QCL参数保持不变；上述第一信号B2套QCL参数和上述A2个时间单元之间存在对应关系；在上述第一信号所在的A2个时间单元中上述第一信号的QCL参数保持不变，在上述第一信号在上述A2个时间单元中的QCL参数根据上述第一控制信令通知的信息确定，其中上述A2个时间单元中最前面的时间单元中的上述第一信号和上述第一控制信令之间的间隔大于或者等于上述预定阈值X1；其中，上述第一信号占有A个时间单元中，A为大于1的自然数，A1，A2为小于或者等于上述A值的非负整数，B2为小于或者等于A2的非负整数。

[0203]　下面结合可选实施例，对本实施例进行举例说明。

[0204]　可选实施例6

[0205] 在本实施例中，基站和终端约定，同一时域符号上的多个下行信号之间满足QCL关系，即终端不希望基站配置在同一个时域符号中的多个下行信号不满足QCL关系，或者同一时域符号上的多个下行信号两两之间满足QCL关系

[0206] 其中所述多个下行信号包括如下信号中的至少两个信号：PDSCH数据信号，CORESET，下行测量参考信号，多个CC的下行信号。比如终端不希望收到不满足如下配置的下行信号在一个时域符号上，多个下行信号之间不满足QCL关系；或者在一个时域符号上多个下行信号和最低CORESETID的DMRS不满足QCL关系.

[0207] 如图6a所示，终端希望同一时刻配置的属于不同CC(component carrier)的两个PDSCH的DMRS需要满足QCL关系。如图6b所示，终端希望同一时刻配置的CC1上的PDSCH/DMRS和CC2上的CORESET的DMRS之间要满足QCL关系。如图6c所示，终端希望同一时刻配置的属于不用CC的两个CORESET的DMRS之间需要满足QCL关系。如图6d所示，终端希望同一时刻配置的属于CC1上的PDSCH/DMRS和CC2上的CORESET的DMRS之间需要满足QCL关系。

[0208] 图6a～6d中是属于不同CC的多个下行信号之间需要满足QCL关系，图7a～7d中是属于相同CC的多个下行信号之间需要满足QCL关系。图7e是一个CC中的两个CSI-RS之间需要满足QCL关系。类似地，需要要求相同时域符号上来自不同CC的CSI-RS至少关于Spatial Rx parameter之间是QCL的。

[0209] 进一步地，所述最低CORESETID满足如下特征至少之一：所述最低CORESETID是距离所述时域符号最近的时域符号中的最低CORESETID；所述最低CORESETID是距离所述时域符号最近的slot中的最低CORESETID；所述CORESET和所述时域符号之间的距离小于预定阈值K.

[0210] 在本实施例中，不同的CC可以和不同的Serving cellID对应。

[0211] 可选实施例7

[0212] 本可选实施例中，根据第一信号和特定的CORESET之间的间隔与预定阈值之间的关系，确定如下信息至少之一：第一信号的QCL参数，同一时域符号上第一信号和第二信号的QCL参数之间的优先级，第一信号的QCL参数和所述特定CORESET的QCL参数之间的优先级，同一时域符号上第一信号和第二信号之间能否频分复用。

[0213] 进一步地，所述特定CORESET满足如下特征至少之一：所述CORESET是距离所述下行信号最近的时域符号中的具有最低CORESETID的CORESET；所述CORESET是距离所述下行信号最近的slot中的具有最低CORESETID的CORESET；在所述CORESET中终端需要检测调度下行信号和/或信道的DCI；在所述CORESET中不包括调度所述第一信号的控制信令信息；在所述CORESET中包括调度所述第二信号的控制信令信息；所述CORESET至少与一个专有搜索空间(Search space)关联。

[0214] 进一步地，当所述第一信号和所述CORESET之间的间隔小于预定阈值时，所述第一信号的QCL参数根据所述CORESER的QCL参数获取；当下行参考信号和最低CORESETID之间的间隔大于或者等于预定阈值时，所述第一信号的QCL参数通过下行信号配置信息中配置的QCL参数获取。

[0215] 进一步地，当所述第一信号和所述CORESET之间的间隔小于预定阈值时，第一信号的QCL参数优先级高于第二信号的QCL参数；当所述第一信号和所述CORESET之间的间隔大于或者等于预定阈值时，第一信号的QCL参数优先级低于第二信号的QCL参数。

[0216] 进一步地，当所述第一信号和所述CORESET之间的间隔小于预定阈值时，第一信号和第二信号之间不能频分复用；当所述第一信号和所述CORESET之间的间隔大于或者等于预定阈值时，所述第一信号和所述第二信号可以频分复用。

[0217] 其中所述QCL参数包括如下参数至少之一：Doppler shift(多普勒频移)，Doppler spread(多普勒扩展)，average delay(平均延迟)，delay spread，(延迟扩展)，average gain(平均增益)，Spatial Rx parameter(空域接收参数)。

[0218] 进一步地，所述第一信号包括如下信号至少之一：下行测量参考信号，下行同步信号，下行解调参考信号，下行数据信道信号，下行控制信道信号。

[0219] 进一步地，所述第二信号包括如下信号至少之一：下行测量参考信号，下行同步信号，下行解调参考信号，下行数据信道信号，下行控制信道信号。

[0220] 进一步地，所述预定阈值与第二预定阈值相等，其中所述第二信号的QCL参数根据调度第二信号的控制信息和所述第二信号之间的间隔与所述第二预定阈值之间的关系，确定第二信号的QCL参数。

[0221] 具体地，现在NR规定当DCI和PDSCH之间的间隔小于预定阈值K时，采用最近slot中的最低CORESETID的Spatial Rx parameter接收PDSCH，因为在终端缓存PDSCH的时候，DCI还没有解出来，需要采用已知的波束缓存PDSCH。PDSCH可以存在于DCI之后K时间窗中的任意位置，此时在DCI之后K时间窗中的PDSCH终端都需要采用最低CORESETID中的波束缓存PDSCH，但是实际可能不存在PDSCH，但是终端还是需要缓存这些PDSCH。问题是如果在这个时间窗中存在周期CSI-RS而且周期CSI-RS的Spatial Rx parameter和终端需要缓存的PDSCH的Spatial Rx parameter不同，就需要确定两者之间的优先级，方式一是基站和终端约定在这个窗口中的下行信号和/或信道的Spatial Rx parameter都以最低CORESETID的CORESET的Spatial Rx parameter为准，下行信号和/或信道的其他QCL参数也以最低CORESETID为准，或者其他QCL参数根据下行信号或者信道的配置信息得到，比如根据周期CSI-RS的配置信息中QCL参数配置信息得到。

[0222] 方式二：基站和终端约定当周期CSI-RS和最近slot中的最低CORESETID的CORESET之间的距离小于预定阈值K时，周期CSI-RS的至少Spatial Rx parameter这个QCL参数优于同时域符号的PDSCH的Spatial Rx parameter参数，当周期CSI-RS和最近slot中的最低CORESETID的CORESET之间的距离大于或者等于预定阈值K，同一时域符号上的PDSCH的Spatial Rx parameter参数优于同时域符号的CSI-RS的Spatial Rx parameter参数.

[0223] 如图2所示，距离slotn上周期CSI-RS最近的slot中的具有最低CORESETID的CORESET为slotn上的CORESET0，在slotn上PDSCH和CSI-RS在相同时域符号上时，以CSI-RS的波束接收CSI-RS和PDSCH，即此时PDSCH的Spatial Rx parameter参数优先级低于周期CSI-RS的Spatial Rx parameter参数。此时对于slotn中没有周期CSI-RS的符号上，一种方式是采用周期CSI-RS的Spatial Rx parameter接收，从而减少终端在slotn上的波束切换次数，或者终端和基站约定在slotn没有CSI-RS的时域符号上，采用距离PDSCH最低CORESET的波束接收，如图3所示。

[0224] 距离slotn+2上的周期CSI-RS最近的slot中的最低CORESETID还是slotn中的CORESET0(在slotn+1，slotn+2上终端都不需要检测CORESET)，此时slotn+2上的周期CSI-RS域CORESET0之间的距离大于所述预定阈值，则slotn+2上如果PDSCH和CSI-RS在相同时域

符号上时，则采用PDSCH的波束接收PDSCH和CSI-RS，即此时PDSCH的Spatial Rx parameter参数优先级高于周期CSI-RS的Spatial Rx parameter参数。或者在slotn+2上当相同时域符号上的PDSCH和CSI-RS的接收波束冲突时，放弃测量CSI-RS。因为在slotn上终端需要缓存CORESET0调度的PDSCH时，DCI还没有解出来，可能没有PDSCH，则此时就优先接收周期CSI-RS，在slotn+2上的终端需要缓存的PDSCH对应的DCI，终端已经解出来了，那此时的PDSCH是终端确定基站调度了的。

[0225] 可选实施例8

[0226] 在本实施例中，根据第一信息，确定第二信息，其中第二信息包括如下信息至少之一：第一信号的QCL参数，是否在第一信号上检测控制信道，是否接收第一信号，第一信号可在的时域符号位置。其中第一信息包括如下信息至少之一：特定CORESET之后预定时间窗中是否存在第二信号。

[0227] 进一步地，所述特定CORESET满足如下特征至少之一：所述CORESET是距离所述第二信号最近的时域符号中的具有最低CORESETID的CORESET；所述特定CORESET是距离所述第二信号最近的slot中的具有最低CORESETID的CORESET；在所述CORESET中终端需要检测调度下行信号和/或信道的DCI；所述CORESET是距离所述第一信号最近的时域符号中的具有最低CORESETID的CORESET；所述特定CORESET是距离所述第一信号最近的slot中的具有最低CORESETID的CORESET。

[0228] 进一步地，所述第一信号包括如下信号至少之一：非周期下行测量参考信号，物理层动态控制信令调度的下行数据信道信号，物理层动态控制信令调度的下行信号，下行物理控制信道信号。

[0229] 进一步地，所述第二信号满足如下特征至少之一：所述第二信号是之前调度的信号；所述第二信号为周期下行测量参考信号；所述第二信号为非周期下行测量参考信号，其中调度非周期测量参考信号的DCI和所述非周期测量参考信号之间的间隔大于或者等于预定阈值；所述第二信号为半持续PDSCH，其中激活SPS-PDSCH的DCI和SPS-PDSCH之间的间隔大于或者等于预定阈值；所述第二信号为动态调度的PDSCH，其中动态调度PDSCH的DCI和PDSCH之间的间隔大于或者等于预定阈值。

[0230] 进一步地，当所述特定CORESET之后预定时间窗中存在所述第二信号时，所述第一信号的QCL参数根据第二信号的QCL参数得到；当所述特定CORESET之后预定时间窗中不存在所述第二信号时，第一信号的QCL参数获取参数中不包括所述第二信号的QCL参数；

[0231] 进一步地，在所述第二信号所在的时域符号上，和第二通信节点约定不会存在第一信号。

[0232] 进一步地，在所述第二信号所在的时域符号上，和第二通信节点不在第一信号上检测控制信道；

[0233] 进一步地，所述第二信号的Spatial Rx parameter和第一信号的Spatial Rx parameter不同，或者所述第二信号的Spatial Rx parameter对应的空间滤波器和第一信号的Spatial Rx parameter对应的空间滤波器第一通信节点不能同时打出。

[0234] 进一步地，所述第二信号和第一信号属于不同的CC；

[0235] 具体地，如图1a所示，在slotn中基站给终端调度了PDSCH1，其中调度PDSCH1的DCI(此DCI在图1a中的CORESET1中)和PDSCH1的距离大于预定阈值K，从而在slotn中终端确定

地知道slotn中基站已经调度了PDSCH1，从而PDSCH1的QCL参数就可以通过调度PDSCH1的DCI中指示的信息获取。在slotn中终端还需要继续检测CORESET0和/或CORESET2，CORESET0或者CORESET2中的DCI可能会给终端调度PDSCH2，优选地PDSCH2和PDSCH1在不同的CC中，由于在接收潜在的PDSCH2的时候，调度的PDSCH2的DCI终端还没有解出来，按照规定需要潜在的PDSCH2需要采用slotn中的所有CC中的最低CORESETID的波束接收PDSCH2，比如需要采用CORESET0的波束接收PDSCH2，当动态指示的PDSCH1的接收波束(通过DCI中指示的Spatial Rx parameter信息)和CORESET0的波束不同时，就需要确定PDSCH1和PDSCH2的Spatial parameter的优先级。由于PDSCH1是确定调用的，PDSCH2不一定存在，优先地采用PDSCH1的波束接收潜在的PDSCH1和PDSCH2.

[0236] 如图1b，在slotn中基站给终端调度了非周期CSI-RS(Channel-state information reference signal测量参考信号)，其中调度非周期CSI-RS的DCI和非周期测量参考信号的间距大于预定阈值K，slotn中终端还需要检测CORESET0，CORESET0有可能在slotn中给终端调度PDSCH，则在slotn中的PDSCH和CSI-RS同时域符号时，需要确定PDSCH和CSI-RS的QCL参数的优先级，同理，由于非周期测量参考信号是确定已经调度的，从而终端至少在CSI-RS所在的时域符号上采用非周期测量参考信号接收CSI-RS和潜在的PDSCH，slotn中不存在非周期测量参考信号的时域符号上，可以采用slotn中最低CORESETID的CORESET的QCL参数获取潜在PDSCH的QCL参数，或者规定在slotn中潜在PDSCH所在的时域符号中都采用非周期CSI-RS的接收波束接收PDSCH。

[0237] 从图1a，1b可以看出，即使PDSCH和调度PDSCH的DCI之间的距离小于预定阈值K，PDSCH的QCL参数不一定采用PDSCH最近的具有最低CORESETID的CORESET的QCL参数获取，还要看在PDSCH所在的时域符号上是否存在第二信号，当存在第二信号时，至少第一信号的Spatial Rx parameter根据第二信号的Spatial Rx parameter确定，当不存在第二信号时，才根据距离PDSCH最近的具有最低CORESETID的CORESET的QCL参数获取PDSCH的QCL参数，其中所述QCL参数至少包括Spatial Rx parameter.

[0238] 图1c所示，当PDSCH和调度PDSCH的DCI之间的间距小于预定阈值K时，PDSCH的至少Spatial Rx parameter根据距离PDSCH最近的时域符号中的最低CORESETID的Spatial Rx parameter参数获取(即根据CORESET1的Spatial Rx parameter参数获取PDSCH的Spatial Rx parameter参数)，而不是根据距离PDSCH最近的slot中具有最低CORESETID的CORESET的Spatial Rx parameter参数获取，即不是根据CORESET0的Spatial Rx parameter获取PDSCH的Spatial Rx parameter。

[0239] 如图1d所示，当PDSCH和调度PDSCH的DCI之间的间距小于预定阈值K时，PDSCH需要采用距离PDSCH最近的slot中的CORESET的接收波束接收PDSCH，而潜在的PDSCH可以存在于slot中的任意时域符号上，这样在CORESET1所在的时域符号上，就需要同时接收潜在的PDSCH和CORESET1，当CORESET1的接收波束和CORESET0的接收波束不同，或者这两个接收波束终端不能同时打出时，就需要规定这两者之间的优先级，一种方式是规定在CORESET1上的潜在PDSCH和CORESET1至少关于Spatial Rx parameter是QCL的。另一种方式是规定在CORESET1上PDSCH不存在，其中PDSCH和调度PDSCH的DCI之间的间隔小于预定阈值K。

[0240] 如图1e所示，当一个slot中终端在多个时域符号上检测CORESET，而且需要缓存潜在的PDSCH，其中潜在的PDSCH表示PDSCH和调度PDSCH的DCI之间的间隔小于预定阈值K，此

时PDSCH的QCL参数不是根据距离PDSCH最近的slot中具有最低CORESETID的CORESET的QCL参数获取(如图1e中的PDSCH的QCL参数不是根据CORESET0的QCL参数获取),而是根据根据距离PDSCH最近的slot中前3个时域符号中的具有最低CORESETID的CORESET的QCL参数获取。具有最低CORESETID的CORESET的QCL参数获取(如图1e中的PDSCH的QCL参数根据CORESET1的QCL参数获取)。

[0241] 如图1f所示,当slotn中已经确定基站给终端调度了PDSCH,即此时调度PDSCH的DCI和PDSCH之间的间隔大于预定阈值K,而在slotn上基站还给终端半静态配置需要检测CORESET.此时一种方式是规定,终端在PDSCH所在的时域符号上,当CORESET和PDSCH之间Spatial Rx parameter之间不同时,终端不需要在这个时域符号上接收和检测CORESET,或者终端和基站规定,此时的PDSCH的DMRS与和PDSCH相同时域符号上的CORESET至少关于Spatial Rx parameter参数是QCL的。或者终端和基站约定,在PDSCH和CORESET相同时域符号上且两者的Spatial Rx parameter对应的接收波束不同时,以CORESET的Spatial Rx parameter对应的接收波束接收PDSCH和CORESET.

[0242] 可选实施例9

[0243] 在本实施例中,讲述当PDSCH占有多个slot时,PDSCH的QCL参数如何获取。

[0244] 首先一个问题是,PDSCH和调度PDSCH的DCI之间的距离如何获取,包括两种获取方式:

[0245] 时间间隔获取方式一,根据PDSCH占有的A个slot中的最前面的一个slot中PDSCH的起始符号位置和DCI之间的一个时间间隔和预定阈值X1(比如为K值,当然本申请也不排除X1和K不相同的情况),得到PDSCH的QCL参数的获取方式,比如所述时间间隔小于预定阈值X1,则PDSCH的QCL参数根据距离PDSCH的最近的slot中的特定CORESET(比如是所述slot中具有最低CORESETID的CORESET)的QCL参数获取PDSCH的QCL参数,如果所述时间间隔大于或者等于预定阈值X1,则PDSCH的QCL参数DCI中指示的信息获取,如图4b所示;

[0246] 时间间隔获取方式二,根据PDSCH占有的A个slot中的每个slot中PDSCH的起始符号位置和DCI之间的A个时间间隔和预定阈值X1(比如为K值,当然本申请也不排除X1和K不相同的情况),得到每个slot中的PDSCH的QCL参数的获取方式,比如前A1个slot中的PDSCH和DCI之间的间隔小于预定阈值X1,则A1个slot中的PDSCH的QCL参数根据距离PDSCH的最近的slot中的特定CORESET(比如是所述slot中具有最低CORESETID的CORESET)的QCL参数获取PDSCH的QCL参数,后A2个slot中PDSCH和DCI之间的间隔大于或者等于预定阈值X1,则PDSCH的QCL参数DCI中指示的信息获取,如图4a所示.

[0247] 另一个问题是,所述根据距离PDSCH最近的slot中的具有预定特征的CORESET的QCL参数获取,有如下两种理解方式:

[0248] QCL获取方式一:根据距离PDSCH占有的A个slot中最前面的slot中最近的slot中的具有最低CORESETID的CORESET的QCL参数获取A个slot中PDSCH的QCL参数,PDSCH在A个slot中的QCL参数获取方式不变,或者称为PDSCH在A个slot中的QCL参数保持不变;

[0249] QCL获取方式二:根据PDSCH占有的A个slot中每个slot中距离该slot最近的slot中的具有最低CORESETID的CORESET的QCL参数获取该slot中PDSCH的QCL参数,PDSCH在A个slot中的QCL参数获取方式可以不同,或者称为PDSCH在A个slot中的QCL参数可以改变;

[0250] 其中时间间隔获取方式一和二,可以和QCL参数获取方式一和二任意搭配。

[0251] 具体地，当采用时间间隔获取方式一和QCL获取方式一时，如图4c所示，根据PDSCH占有的3个slot中最前面的slot和DCI之间的时间间隔小于预定阈值K，则PDSCH在3个slot中的QCL参数都根据距离最前面的slot最近的slot中具有最低CORESETID的CORESET的QCL参数(即slotn中CORESET0的QCL参数)获取PDSCH的QCL参数，PDSCH在3个slot中的QCL参数保持不变。

[0252] 当采用时间间隔获取方式一和QCL获取方式二时，如图4b所示，根据PDSCH占有的3个slot中最前面的slot和DCI之间的时间间隔小于预定阈值K，则PDSCH在3个slot中的QCL参数根据距离每个slot最近的slot中具有最低CORESETID的CORESET的QCL参数获取PDSCH的QCL参数，PDSCH在3个slot中的QCL参数可以不同，也可以相同。

[0253] 当采用时间间隔获取方式二和QCL获取方式一时，如图4d所示，根据PDSCH占有的3个slot中每个slot和DCI之间的时间间隔和预定阈值K之间的关系，得到3个slot中每个slot的QCL参数是根据CORESET获取还是根据DCI指示的信息获取，当PDSCH的多个slot和DCI之间的间隔都小于阈值K，则PDSCH在这多个slot(即图4d中slotn，slotn+1)中QCL参数保持不变，根据距离这多个slot中的最前面的slot(即slotn)最近的slot中具有最低CORESETID的CORESET的QCL参数获取PDSCH的QCL参数，slotn+2中的PDSCH和DCI之间的间隔大于K，则slotn+2中的PDSCH的QCL参数根据DCI指示的信息获取。

[0254] 当采用时间间隔获取方式二和QCL获取方式二时，如图4a所示，根据PDSCH占有的3个slot中每个slot和DCI之间的时间间隔和预定阈值K之间的关系，得到3个slot中每个slot的QCL参数是根据CORESET获取还是根据DCI指示的信息获取，当PDSCH的多个slot和DCI之间的间隔都小于阈值K，则PDSCH在这多个slot(即图4d中slotn，slotn+1)中的每个slot中的PDSCH的QCL参数，根据距离这个slot中最近的slot中具有最低CORESETID的CORESET的QCL参数获取PDSCH的QCL参数，slotn+2中的PDSCH和DCI之间的间隔大于K，则slotn+2中的PDSCH的QCL参数根据DCI指示的信息获取，这个PDSCH在3个slot中的每个slot中判断其和调度CORESET0之间的间隔，当间隔小于K时，采用距离这个slot最近的slot中最近的slot中的最低CORESETID的CORESET的QCL参数获取PDSCH的QCL参数。当间隔大于K时，采用DCI中指示的QCL参数获取PDSCH的QCL参数。如图4a所示，slotn上采用slotn中的CORESET0的波束接收PDSCH，在slotn+1上采用slotn+1的CORESET1的波束接收PDSCH，slotn+2上采用slotn中的CORESET0中发送的DCI指示的QCL参数确定slotn+2上的接收波束。这是因为在K个时域符号中终端还没有解调出DCI，还要缓存PDSCH，而slotn的CORESET0和slotn+1的CORESET1都有可能给终端调度数据，终端在没有检出来DCI之前在slotn+1上需要缓存CORESET0和/或CORESET1给他调度的PDSCH，当终端的接收能力有限，比如只能打出一个接收波束时，在DCI和PDSCH小于预定阈值的K范围内的每个slot中PDSCH，采用距离这个slot中的PDSCH最近的slot最近的slot中的最低CORESETID的CORESET获取QCL参数。

[0255] 特别地当PDSCH和DCI之间的间隔大于1时，是A2个slot对应一套QCL参数(如图4e所示)，还是A2个slot各自对应不同套的QCL参数(如图4f所示)，具体是哪种方式进一步基站和终端约定，或者基站通过信令信息通知。

[0256] 具体时间间隔的获取方式和QCL参数的获取方式是采用哪种组合，可以终端和基站约定，也可以基站通过信令信息通知时哪种组合。

[0257] 如图4a～4d中，K是26个时域符号，slotn上的CORESET0调度的PDSCH跨越3个slot，

即{slotn,slotn+1,slotn+2},。

[0258] 在图4f中,当PDSCH和DCI之间的间隔大于预定阈值K的两个slot中,DCI会为不同的slot通知不同的QCL参数,从而DCI中需要为每个slot配置对应的QCL参数,当然本实施例也不排除,基站在DCI中为多个slot配置其中一个slot的QCL参数(比如配置slotn+2中的QCL参数,即配置最前面的一个slot中QCL参数),其他slot中的QCL参数通过高层信令配置,或者其他slot中的QCL参数根据DCI配置的QCL参数得到,比如多个slot中的采用轮询的方式,比如DCI和/或高层信令通知的QCL参数只有两套,而PDSCH占有4个slot,则这两套在这4个slot中轮询。图4a～4f中,不同的QCL参数对应不同的波束。其中高层信令可以是RRC信令也可以是MAC-CE命令。该高层信令可以是通知DCI中的候选TCIstate的高层信令,比如当DCI通知slotn+2的TCI为TCI state2(DCI中通知TCI域包括3个比特,对应激活的8个TCI state),则PDSCH在slotn+3中的TCI state对应TCI state3。

[0259] 在本可选实施例中一个PDSCH在占有多个slot中可以是数据重复发送,也可以在多个slot中发送不同的数据。

[0260] 可选实施例10

[0261] 在本实施中,DCI中通知的TCI域中的一个state对应多个关系,不同关系对应PDSCH占有的不同时间单元或者不同时间单元集合,每个关系对应PDSCH占有的一个时间单元,或者一个时间单元集合,一个关系中包括Z个DMRS group和Z个RS Set之间的关系,Z个DMRS group和Z个RS Set之间一一对应,DMRS group和相对应的RS Set在所述对应的时间单元或者时间单元集合上,关于一种QCL参数集合满足QCL关系。

[0262] 可选实施例11

[0263] 在本实施例中,当PDSCH/AP-CSI-RS的QCL参数根据距离PDSCH/AP-CSI-RS最近的slot中的最低CORESETID的CORESET的QCL参数获取时,进一步明确上述CORESET满足如下特征之一:

[0264] 上述具有最低CORESETID的CORESET为上述时间单元中所有CC中包括的终端需要检测的所有CORESET中的具有最低CORESETID的CORESET;

[0265] 上述具有最低CORESETID的CORESET为上述时间单元中对应PCell中包括的终端需要检测的所有CORESET中的具有最低CORESETID的CORESET;

[0266] 上述具有最低CORESETID的CORESET为上述时间单元中对应PDSCH所在的serving cell中包括的终端需要检测的所有CORESET中的具有最低CORESETID的CORESET;

[0267] 上述具有最低CORESETID的CORESET为上述时间单元中对应调度PDSCH的DCI所在的serving cell中包括的终端需要检测的所有CORESET中的具有最低CORESETID的CORESET;

[0268] 上述具有最低CORESETID的CORESET为上述时间单元中预定CC(比如最低CCID的CC)所在的serving cell中包括的终端需要检测的所有CORESET中的具有最低CORESETID的CORESET;

[0269] 上述具有最低CORESETID的CORESET为上述时间单元中预定CC组中包括的终端需要检测的所有CORESET中的具有最低CORESETID的CORESET。

[0270] 可选实施例12

[0271] 在本实施例中,一个CORESET的QCL参数和第一通信节点是否检测波束恢复响应信

号之间有关联。

[0272] 具体地，基站给终端配置了一个OCRESET，在终端没有检测波束恢复响应信号的时候，这个CORESET的QCL参数基站通过信令告知终端，当终端需要检测波束恢复响应信号的时候(比如终端给基站发送了波束恢复请求信号之后4个slot，终端在这个CORESET上检测基站的波束恢复响应信号，当超过预定时间窗，还没有成功检测到基站发的波束恢复响应信号，终端停止在这个CORESET上检测波束恢复请求信号)，这个CORESET的QCL参数根据终端发送的波束恢复请求信号中终端发现的波束获取。如图8a所示，在T1时间段中，CORESET1的QCL参数通过基站通知的信令信息获取，在T2时间段中终端开始在CORESET1上检测基站发送的波束恢复请求响应信号，CORESET1的QCL参数根据终端发送的波束恢复请求信号中包括的参考信号指示信息q_{new}得到，其中q_{new}表示终端在一个参考信号集合中选择的参考信号指示信息(也即表示终端新选择的波束)，在T3时间段，CORESET1的QCL参数通过基站发送的信令信息获得，其中T1时间段和T3时间段中，基站给终端发送的关于CORESET1的QCL参数的信令信息可以是不同的信令信息，即基站可以在T2时间段通过信令信息更新CORESET1的QCL参数。其中终端发送的波束恢复请求信号中终端发现的新波束通过终端发送的参考信号指示信息得到，其中参考信号指示信息表示终端在一个参考信号集合中选择的参考信号。其中所述参考信号包括测量参考信号和/或同步参考信号。

[0273] 可选实施例13

[0274] 在本实施例中，调度非周期测量参考信号的物理层动态控制信令可以在非周期测量参考信号之后。

[0275] 可选地，所述非周期测量参考信号和所述物理动态控制信令在同一个时间单元中。

[0276] 如图8b调度非周期测量参考信号的DCI所在的起始时域符号在非周期测量参考信号之后，图8c所示，调度非周期测量参考信号的DCI所在的部分时域符号在非周期测量参考信号之后，即比如DCI在3个时域符号上，CSI-RS在DCI所在的第一个时域符号上。

[0277] 在可选实施例中，所述TCI指示信息，用于指示DMRS group/CSI-RS port group和DL-RS set之间的QCL关系，即一个TCI索引信息对应一个state，一个state中包括Q个DMRS group和Q个DL-RS set之间对应关系，一个DL-RS set中包括一个或者多个DL-RS，每个DL-RS关联一个QCL参数集合，表示所述DMRS group/CSI-RS port group中的参考信号和与其关联的DL-RS set中的一个DL-RS关于所述QCL参数集合满足QCL(quasi-co-location准共址)关系。两个参考信号关于一个QCL参数满足准共址关系，表示一个参考信号的所述QCL参数可以由两个参考信号的所述QCL参数获取，其中所述QCL参数包括如下参数至少之一：

[0278] Doppler shift(多普勒频移)，Doppler spread(多普勒扩展)，average delay(平均延迟)，delay spread，(延迟扩展)，average gain(平均增益)，Spatial Rx parameter(空域接收参数)。

[0279] 本可选实施例中，两个参考信号是QCL的表示这两个参考信号至少关于Spatial Rx parameter是QCL的，这两个参考信号关于其他QCL参数是否QCL没有限制。

[0280] 在可选实施例中，信道也可以是一种信号，即在所述信道上传输信号。比如在数据信道上传输数据信号。

[0281] 在可选实施例中，不同的CC(component carrier)可以通过不同的Serving cellID关联。

[0282] 可选实施例14

[0283] 在本可选实施例中，终端不希望收到满足如下特征的配置，相同时间符号上的PDSCH和CSI-RS关于接收空间参数不满足QCL关系。

[0284] 可选地，上述PDSCH和调度PDSCH的控制信令之间的间隔小于预定阈值K。

[0285] 通过以上的实施方式的描述，本领域的技术人员可以清楚地了解到根据上述实施例的方法可借助软件加必需的通用硬件平台的方式来实现，当然也可以通过硬件，但很多情况下前者是更佳的实施方式。基于这样的理解，本发明的技术方案本质上或者说对现有技术做出贡献的部分可以以软件产品的形式体现出来，该计算机软件产品存储在一个存储介质(如ROM/RAM、磁碟、光盘)中，包括若干指令用以使得一台终端设备(可以是手机，计算机，服务器，或者网络设备等)执行本发明各个实施例所述的方法。

[0286] 实施例3

[0287] 在本实施例中还提供了一种控制信令的发送装置，该装置用于实现上述实施例及优选实施方式，已经进行过说明的不再赘述。如以下所使用的，术语“模块”可以实现预定功能的软件和/或硬件的组合。尽管以下实施例所描述的装置较佳地以软件来实现，但是硬件，或者软件和硬件的组合的实现也是可能并被构想的。

[0288] 图11是根据本发明实施例的控制信令的发送装置的结构框图，应用于第一通信节点，如图11所示，该装置包括：

[0289] 1)第一确定模块112，用于根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和该第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；该第一信息包括：该第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；

[0290] 2)第一发送模块114，用于发送该第一控制信令。

[0291] 通过图11所示装置，根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和该第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；该第一信息包括：该第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；发送该第一控制信令。也就是说，通过第二信息确定控制信令的格式，然后发送新的控制信令，解决了相关技术中，现有控制信令中部分资源被空置所造成的资源利用率较低的问题，达到了提高控制信令资源利用率的技术效果。

[0292] 可选地，在上述关系为第一关系时，上述N的取值包括N1；在上述关系为第二关系时，上述N的取值包括N2；其中，N1、N2为整数。

[0293] 其中，上述N1和上述N2之间的关系满足以下至少之一：上述N1大于上述N2；上述N1与上述N2的差值小于或者等于传输配置指示(Transmission configuration indication，简称为TCI)域所占的比特数；上述N1与上述N2的差值小于或者等于通知第二传输参数信息所需要的比特数。

[0294] 可选地,在上述关系为第一关系时,上述对应映射表格为第一对应映射表格;在上述关系为第二关系时,上述对应映射表格为第二对应映射表格;

[0295] 可选地,上述第一对应映射表格、上述第二对应映射表格、传输参数取值集合一以及传输参数取值集合二中的任一项通过以下方式至少之一确定:方式一、发送的信令信息所包括的内容;方式二、发送端和接收端预先约定的规则;其中,上述传输参数取值集合一对应上述第一对应映射表格中包括的上述第一传输参数的取值集合,上述传输参数取值集合二对应上述第二对应映射表格中包括的上述第一传输参数的取值集合。

[0296] 在一个可选地实施方式中,在上述第一传输参数的类型为TCI时,上述第一对应映射表格中各个状态中关联空间接收参数Spatial Rx parameter的下行链路参考信号(Down link reference signal,简称为DL-RS)构成的DL-RS集合中只包括一个DL-RS;在上述第一传输参数类型为TCI时,上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中DL-RS两两之间关于空间接收参数满足准共址(quasi co-location,简称为QCL)关系;

[0297] 在上述第一传输参数类型为TCI时,上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合中的DL-RS能被第一通信节点同时接收;在上述第一传输参数类型为TCI时,上述第一对应映射表格中各个状态中关联空间接收参数的下行链路参考信号DL-RS构成的DL-RS集合为空集;其中,上述第一通信节点为接收上述第一信号,和/或上述第一控制信令的通信节点。

[0298] 可选地,上述第一传输参数的类型为上述第一控制信令中包括的除TCI传输参数类型之外的一个或者多个传输参数类型;或者,上述第一传输参数类型为TCI传输参数。

[0299] 可选地,上述第一传输参数满足以下至少之一:上述第一传输参数为上述第一信号的传输参数;上述第一传输参数为第二信号的传输参数。

[0300] 可选地,上述第一信号或者上述第二信号包括以下信号至少之一:解调参考信号、测量参考信号、控制信道信号、数据信道信号;上述第一控制信令为物理层控制信令。

[0301] 在一个可选地实施方式中,上述第一信息还包括以下信息至少之一:第二控制信令中包括的信息;上述第一控制信令所在的控制资源集合(control resource set,简称为CORESET)对应的传输配置指示(transmission configuration indication,简称为TCI-PresentInDCI)是否使能信息;上述第一信号或者上述第二信号所在的载频与预定阈值G之间的关系;第一通信节点反馈的支持的频率范围能为;上述预设阈值K是否为0;第一通信节点需要检测的CORESET中是否至少存在一个配置了空间接收参数的CORESET;与上述第一通信节点需要检测专有搜索空间关联的CORESET集合中是否至少存在一个配置了空间接收参数的CORESET;与上述第一信号或者上述第二信号距离最近的时间单元中具有最低控制资源集合标识(control resource set identity,简称为CORESETID)的CORESET是否配置了空间接收参数的CORESET;与上述第一信号或者上述第二信号距离最近的时域符号中具有最低CORESETID的CORESET是否配置了空间接收参数的CORESET;与上述第一信号或者上述第二信号关联的TCI状态池中是否至少存在一个TCI状态,其中,上述TCI状态中与参考信号集合参考结合reference RS set对应的QCL参数中包括空间接收参数;与上述第一信号或者第二信号关联的激活TCI状态池中,是否至少存在一个TCI状态,上述TCI状态中于所述参考信号集合reference RS set对应的QCL参数中包括空间接收参数;其中,上述第一通信节

点为接收上述第一信号，和/或上述第二信号的通信节点。

[0302] 可选地，在上述关系为第一关系时，上述第一控制信令中预定指示域所通知的上述第一传输参数的类型为第一类型传输参数；在上述关系为第二关系时，上述第二控制信令中预定指示域所通知的上述第一传输参数的类型为第二类型传输参数。

[0303] 可选地，在上述第一控制信令和上述第一信号之间的传输时间间隔小于上述预定阈值K时，上述关系为上述第一关系，在上述控制信令和上述第一信号之间的传输时间间隔大于或者等于上述预定阈值K时，上述关系为上述第二关系；或者，在上述控制信令和上述第一信号之间的传输时间间隔小于或者等于上述预定阈值K时，上述关系为上述第一关系，在上述控制信令和上述第一信号之间的传输时间间隔大于上述预定阈值K时，上述关系为上述第二关系；或者，在上述控制信令和上述第一信号之间的传输时间间隔大于或者等于上述预定阈值K时，上述第一关系为第一关系，在上述控制信令和上述第一信号之间的传输时间间隔小于上述预定阈值K时，上述关系为上述第二关系。

[0304] 在本实施例中还提供了一种控制信令的接收装置，图12是根据本发明实施例的控制信令的接收装置的结构框图，应用于第二通信节点，如图12所示，该装置包括：

[0305] 1）第二确定模块122，用于根据第一信息确定第二信息；

[0306] 2）接收模块124，用于根据上述第二信息接收第一控制信令；

[0307] 其中，上述第二信息为根据第一信息确定的信息；其中，上述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和上述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；上述第一信息包括：上述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

[0308] 需要说明的是，上述各个模块是可以通过软件或硬件来实现的，对于后者，可以通过以下方式实现，但不限于此：上述模块均位于同一处理器中；或者，上述各个模块以任意组合的形式分别位于不同的处理器中。

[0309] 实施例4

[0310] 在本实施例中还提供了一种信息的确定装置，该装置用于实现上述实施例及优选实施方式，已经进行过说明的不再赘述。如以下所使用的，术语“模块”可以实现预定功能的软件和/或硬件的组合。尽管以下实施例所描述的装置较佳地以软件来实现，但是硬件，或者软件和硬件的组合的实现也是可能并被构想的。

[0311] 图13是根据本发明实施例的信息的确定装置的结构框图，应用于第一通信节点，如图13所示，该装置包括：

[0312] 1）第三确定模块132，用于根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，该第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在该第二信号，该第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，该第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，该第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，该第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信

号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数。

[0313] 通过图13所示装置，也即通过信号和控制信道资源，或者信号和调度信号的控制信令之间的时间间隔与预定阈值之间的关系，确定两个信号之间的复用问题，或者两个信号的接收问题，解决了相关技术中终端检测控制信令存在延迟，以及同一时刻打出的射频波束有限所导致的无法正确接收信号的问题。

[0314] 在一个可选地实施方式中，上述特定CORESET满足以下特征至少之一：上述CORESET是距离上述第一信号最近的时域符号中具有最低控制资源集合标识CORESET ID的CORESET；上述CORESET是距离上述第一信号最近的时间单元中具有最低CORESET ID的CORESET；在上述CORESET中终端需要检测调度下行信号和/或信道的下行控制信息DCI；在上述CORESET中不包括调度上述第一信号的控制信令信息；在上述CORESET中包括调度上述第二信号的控制信令信息；上述CORESET至少与一个专有搜索空间关联；上述CORESET是距离上述第一信号和/或上述第二信号最近的时间单元中的所有载波单元CC具有最低CORESETID的CORESET；上述CORESET是距离上述第一信号和/或上述第二信号最近的时间单元中的预定CC中具有最低CORESETID的CORESET；上述CORESET是距离上述第一信号和/或上述第二信号最近的时间单元中的预定CC组中具有最低CORESETID的CORESET；上述CORESET是一个时间单元中预定M个时域符号中的CORESET，其中，M小于或者等于上述时间单元中包括的时域符号个数。

[0315] 可选地，在上述第一信号和上述CORESET之间的时间间隔小于上述预定阈值X1时，上述第一信号的QCL参数根据上述CORESET的QCL参数获取；在上述第一信号和上述CORESET之间的间隔大于或者等于上述预定阈值X1时，上述第一信号的QCL参数通过上述第一信号的配置信息中配置的QCL参数获取。

[0316] 可选地，在上述第一信号和上述CORESET之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数优先级高于上述第二信号的QCL参数；在上述第一信号和上述CORESET之间的间隔大于或者等于上述预定阈值X1时，上述第一信号的QCL参数优先级低于上述第二信号的QCL参数。

[0317] 可选地，在上述第一信号和上述CORESET之间的间隔小于上述预定阈值X1时，上述第一信号和上述第二信号之间不允许采用频分复用的方式；在上述第一信号和上述CORESET之间的间隔大于或者等于上述预定阈值X1时，上述第一信号和上述第二信号允许采用频分复用的方式。

[0318] 可选地，上述第一信号和/或上述第二信号包括以下信号至少之一：下行测量参考信号、下行同步信号、下行解调参考信号、下行数据信道信号、下行控制信道信号。

[0319] 可选地，上述预定阈值X1与预定阈值X2相等；和/或上述第二信号的QCL参数根据调度上述第二信号的控制信息和上述第二信号之间的间隔与上述预定阈值X2之间的关系确定。

[0320] 可选地，上述第一信号满足如下特征至少之一：上述第一信号为物理层动态控制信令调度的下行信号；上述第一信号为下行物理控制信道信号；调度上述第一信号的控制信令和上述第一信号之间的间隔小于上述预定阈值X1。

[0321] 可选地，上述第二信号满足以下特征至少之一：调度上述第二信号的控制信令在

上述第一信号所在的时域符号之前；调度上述第二信号的控制信令和上述第一信号所在的时域符号之间的间隔大于或者等于上述预定阈值X3；调度上述第二信号的控制信令和上述第二信号所在的起始时域符号之间的间隔大于或者等于上述预定阈值X3；上述第二信号是物理层动态控制信令调度的下行信号；上述第二信号为周期下行测量参考信号；其中X3为实数。

[0322] 可选地，在上述CORESET之后预定时间窗中存在上述第二信号时，上述第一信号的QCL参数根据上述第二信号的QCL参数确定；在上述CORESET之后预定时间窗中不存在上述第二信号时，上述第一信号的QCL参数不根据上述第二信号的QCL参数确定；和/或在上述CORESET之后预定时间窗中存在上述第二信号，上述第一信号和调度上述第一信号的控制信令之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数不根据上述CORESET的QCL参数获取；在上述CORESET之后预定时间窗中不存在上述第二信号，上述第一信号和调度上述第一信号的控制信令之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数根据CORESET的QCL参数获取。

[0323] 可选地，上述第一信号和上述第二信号之间满足以下特征至少之一：上述第二信号的空间接收参数和上述第一信号的空间接收参数不同；上述第二信号的空间接收参数对应的空间滤波器和上述第一信号的空间接收参数对应的空间滤波器在第一通信节点不能同时打出；上述第二信号和上述第一信号属于不同的CC；上述第一信号所在的时域位置和上述第二信号所在的时域位置之间的交集为非空集合；上述第一信号和上述第二信号在相同的时域位置上；上述第二信号的优先级高于上述第一信号的优先级。

[0324] 可选地，在上述第二信息为上述第一信号的准共址QCL参数时，上述根据第一信息确定第二信息包括：根据上述第一信息确定如下信息至少之一：上述第一信号和上述第二信号的QCL参数之间的优先级；上述第一信号的配置信息中配置的QCL参数和特定CORESET的QCL参数之间的优先级；当上述第一信号和调度上述第一信号的控制信令之间的间隔小于上述预定阈值X1时，上述第一信号的QCL参数是否根据特定CORESET的QCL参数获取。

[0325] 可选地，在上述第二信息为第二信号所在的时域位置上第一信号的接收方式时，上述根据第一信息确定第二信息包括根据上述第一信息确定如下信息至少之一：是否在上述第二信号所在的时域位置上接收上述第一信号；是否在上述第二信号所在的时域位置上检测控制信道；在上述第二信号所在的时域位置上，上述第一信号的QCL参数和上述第二信号的QCL参数之间的优先级；上述第一信号和上述第二信号之间能否频分复用；上述第一信号可在的时域位置是否包括第二信号所在的时域位置。

[0326] 可选地，在上述第二信息为第二信号所在的时域位置上第一信号的发送方式时，上述根据第一信息确定第二信息包括根据上述第一信息确定如下信息至少之一：是否在上述第二信号所在的时域位置上发送上述第一信号；是否在上述第二信号所在的时域位置上发送控制信道；在上述第二信号所在的时域位置上，上述第一信号的QCL参数和上述第二信号的QCL参数之间的优先级；上述第一信号和上述第二信号之间能否频分复用；上述第一信号可在的时域位置是否包括第二信号所在的时域位置。

[0327] 可选地，上述第二信号所在的时域位置包括如下时域位置之一：上述第二信号所在的时域符号；上述第二信号所在的时间单位。

[0328] 可选地，上述方法还包括：不接收满足以下特征的配置：当调度上述第一信号的上

述第一控制信令和上述第一信号之间的间隔大于或者等于上述预定阈值X1，调度上述第二信号的上述第二控制信令和上述第二信号之间的间隔大于或者等于上述预定阈值X2时，上述第一信号和上述第二信号关于空间接收参数不满足QCL关系；当调度上述第一信号的上述第一控制信令和上述第一信号之间的间隔小于上述预定阈值X1，调度上述第二信号的上述第二控制信令和上述第二信号之间的间隔大于或者等于上述预定阈值X2时，上述第一信号的QCL参数根据上述第二信号的QCL参数确定；当调度上述第一信号的上述第一控制信令和上述第一信号之间的间隔小于上述预定阈值X1，调度上述第二信号的上述第二控制信令和上述第二信号之间的间隔小于上述预定阈值X2时，上述第一信号的QCL参数和上述第二信号的QCL参数的优先级根据约定规则或者信令信息获取。

[0329] 可选地，上述第一信息还包括以下信息至少之一：上述特定CORESET中包括的控制信令中是否包括传输配置指示TCI指示域；上述第一信号和/或上述第二信号所在的载频与预定阈值G之间的关系；上述预设阈值X1和/或上述预定阈值X2是否为0；特定CORESET中是否至少存在一个配置了空间接收参数的CORESET；上述第一通信节点需要检测的CORESET集合中是否至少存在一个配置了空间接收参数的CORESET；与上述第一信号或者上述第二信号关联的TCI状态池中是否至少存在一个TCI状态，其中，上述TCI状态中与参考信号集合对应的QCL参数中包括空间接收参数；与上述第一信号或者第二信号关联的激活TCI状态池中，是否至少存在一个TCI状态，上述TCI状态中与上述参考信号集合对应的QCL参数中包括空间接收参数；其中，上述第一通信节点为接收上述第一信号的通信节点。

[0330] 可选地，在上述第一信息为第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系时，上述根据第一信息确定第二信息包括如下方式至少之一：上述第一信号和上述第二信号关于空间接收参数满足QCL关系时，上述第一信号可在的时域符号包括上述第二信号所在的时域符号；上述第一信号和上述第二信号关于空间接收参数不满足QCL关系时，上述第一信号可在的时域符号不包括上述第二信号所在的时域符号；在上述第一空间接收参数对应的空间滤波器和上述第二空间接收参数对应的空间滤波器第一通信节点能同时产生时，上述第一信号可在的时域符号包括上述第二信号所在的时域符号；在上述第一空间接收参数对应的空间滤波器和上述第二空间接收参数对应的空间滤波器第一通信节点不能同时产生时，上述第一信号可在的时域符号不包括上述第二信号所在的时域符号。

[0331] 需要说明的是，上述第一信号可在的时域符号不包括上述第二信号所在的时域符号可以为在第二信号所在的时域符号位置上，不发送和/或不接收所述第一信号做速率匹配。

[0332] 可选地，在上述第一信息为上述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，上述第二信息为第一信号的准共址QCL参数时，上述根据第一信息确定第二信息包括以下至少之一：上述第一信号在一个时间单元的不同时域符号上，上述QCL参数保持不变；上述第一信号在不同时间单元上，上述QCL参数可以不同；上述第一信号B1套QCL参数和A个时间单元之间存在对应关系；在上述第一信号所在的A个时间单元中的每个时间单元中的上述第一信号的QCL参数根据距离该时间单元最近的时间单元中具有预定特定的CORESET的QCL参数获取；在上述第一信号所在的A个时间单元中根据每个时间单元中上述第一信号和上述第一控制信令之间的时间间隔与上述预定阈值X1之间的关系，确定该

时间单元中上述第一信号的QCL参数；其中，上述第一信号占有A个时间单元中，A为大于1的自然数，其中B1为小于或者等于A的非负整数。

[0333] 需要说明的是，上述时间单元可以是一个slot，也可以是一个子帧，或者其他时间单元。

[0334] 可选地，在上述第一信息为上述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，上述第二信息为第一信号的准共址QCL参数时，上述根据第一信息确定第二信息包括以下至少之一：根据A个时间单元中最前面的一个时间单元中上述第一信号和上述第一控制信令之间的时间间隔与上述预定阈值X1之间的关系，确定上述第一信号的QCL参数，上述第一信号在上述A个时间单元中的QCL参数保持不变；在上述第一信号所在的A1个时间单元中的每个时间单元中的上述第一信号的QCL参数根据距离该时间单元最近的时间单元中具有预定特定的CORESET的QCL参数获取，其中上述A1个时间单元中的最后一个时间单元中的上述第一信号和上述第一控制信令之间的间隔小于上述预定阈值X1；在上述第一信号所在的A2个时间单元中上述第一信号的QCL参数保持不变；上述第一信号B2套QCL参数和上述A2个时间单元之间存在对应关系；在上述第一信号所在的A2个时间单元中上述第一信号的QCL参数保持不变，在上述第一信号在上述A2个时间单元中的QCL参数根据上述第一控制信令通知的信息确定，其中上述A2个时间单元中最前面的时间单元中的上述第一信号和上述第一控制信令之间的间隔大于或者等于上述预定阈值X1；其中，上述第一信号占有A个时间单元中，A为大于1的自然数，A1，A2为小于或者等于上述A值的非负整数，B2为小于或者等于A2的非负整数。

[0335] 需要说明的是，上述各个模块是可以通过软件或硬件来实现的，对于后者，可以通过以下方式实现，但不限于此：上述模块均位于同一处理器中；或者，上述各个模块以任意组合的形式分别位于不同的处理器中。

[0336] 实施例5

[0337] 本发明的实施例还提供了一种存储介质，该存储介质中存储有计算机程序，其中，该计算机程序被设置为运行时执行上述任一项方法实施例中的步骤。

[0338] 可选地，在本实施例中，上述存储介质可以被设置为存储用于执行以下步骤的计算机程序：

[0339] S1，根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；

[0340] S2，发送所述第一控制信令。

[0341] 可选地，存储介质还被设置为存储用于执行以下步骤的计算机程序：

[0342] S1，根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间

的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数；

[0343] 可选地，存储介质还被设置为存储用于执行以下步骤的计算机程序：

[0344] S1，根据第一信息确定第二信息；

[0345] S2，根据所述第二信息接收第一控制信令；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

[0346] 可选地，在本实施例中，上述存储介质可以包括但不限于：U盘、只读存储器(Read-Only Memory，简称为ROM)、随机存取存储器(Random Access Memory，简称为RAM)、移动硬盘、磁碟或者光盘等各种可以存储计算机程序的介质。

[0347] 本发明的实施例还提供了一种电子装置，包括存储器和处理器，该存储器中存储有计算机程序，该处理器被设置为运行计算机程序以执行上述任一项方法实施例中的步骤。

[0348] 可选地，上述电子装置还可以包括传输设备以及输入输出设备，其中，该传输设备和上述处理器连接，该输入输出设备和上述处理器连接。

[0349] 可选地，在本实施例中，上述处理器可以被设置为通过计算机程序执行以下步骤：

[0350] S1，根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数；

[0351] S2，发送所述第一控制信令。

[0352] 可选地，上述处理器还被设置为存储用于执行以下步骤的计算机程序：

[0353] S1，根据第一信息确定第二信息；其中，所述第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，所述第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在所述第二信号，所述第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，所述第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，所述第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，所述第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数；

[0354] 可选地，上述电子装置还被设置为存储用于执行以下步骤的计算机程序：

[0355] S1，根据第一信息确定第二信息；

[0356] S2，根据所述第二信息接收第一控制信令；其中，所述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和所述第一传输参数的取值之间的对应映射表格、第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；所述第一信息包括：所述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数。

[0357] 可选地，本实施例中的具体示例可以参考上述实施例及可选实施方式中所描述的示例，本实施例在此不再赘述。

[0358] 显然，本领域的技术人员应该明白，上述的本发明的各模块或各步骤可以用通用的计算装置来实现，它们可以集中在单个的计算装置上，或者分布在多个计算装置所组成的网络上，可选地，它们可以用计算装置可执行的程序代码来实现，从而，可以将它们存储在存储装置中由计算装置来执行，并且在某些情况下，可以以不同于此处的顺序执行所示出或描述的步骤，或者将它们分别制作成各个集成电路模块，或者将它们中的多个模块或步骤制作成单个集成电路模块来实现。这样，本发明不限制于任何特定的硬件和软件结合。

[0359] 以上所述仅为本发明的优选实施例而已，并不用于限制本发明，对于本领域的技术人员来说，本发明可以有各种更改和变化。凡在本发明的原则之内，所作的任何修改、等同替换、改进等，均应包含在本发明的保护范围之内。

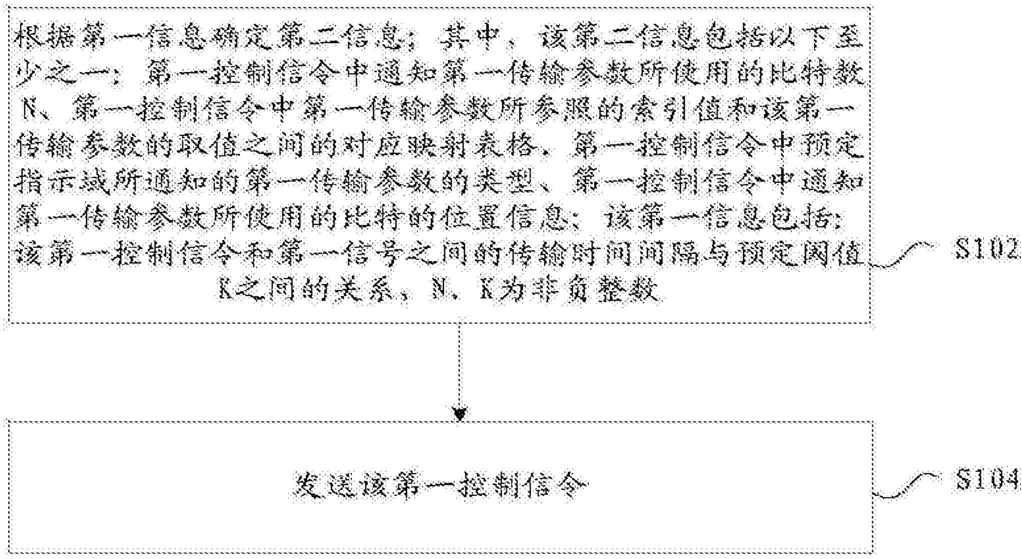

根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和该第一传输参数的取值之间的对应映射表格，第一控制信令中预定指示域所通知的第一传输参数的类型、第一控制信令中通知第一传输参数所使用的比特的位置信息；该第一信息包括：该第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数
S102
发送该第一控制信令
S104

图1

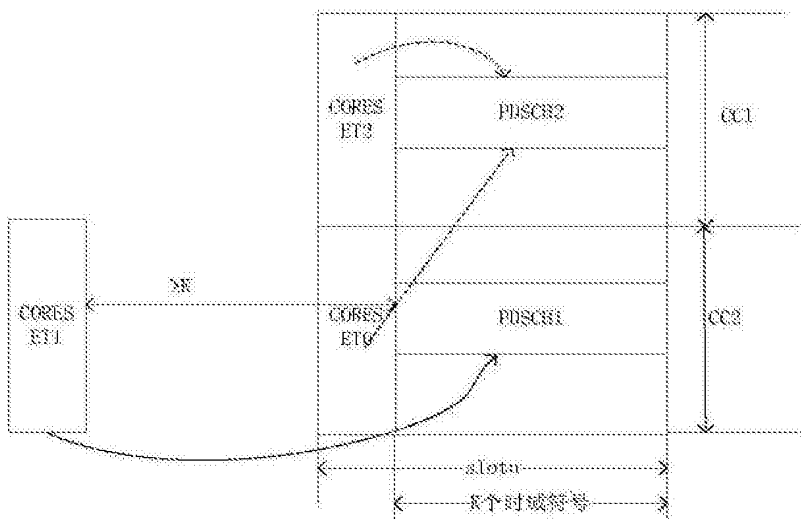

CORES
ET2
PDSCH2
CC1
CORES
ET1
CORES
ET0
PDSCH1
CC2
slotn
K个时域符号

图1a

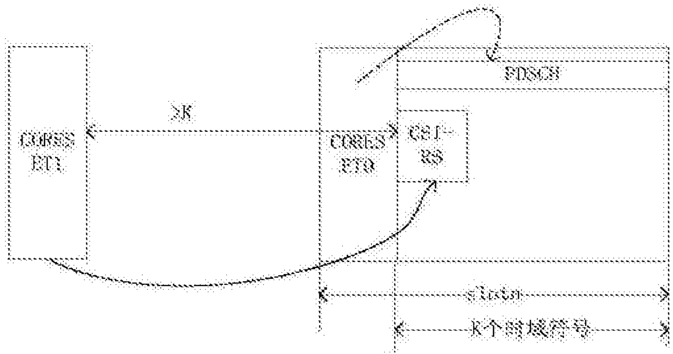

PDSCH
>K
CORESET1
CORESET0
CSI-RS
K个时域符号

图1b

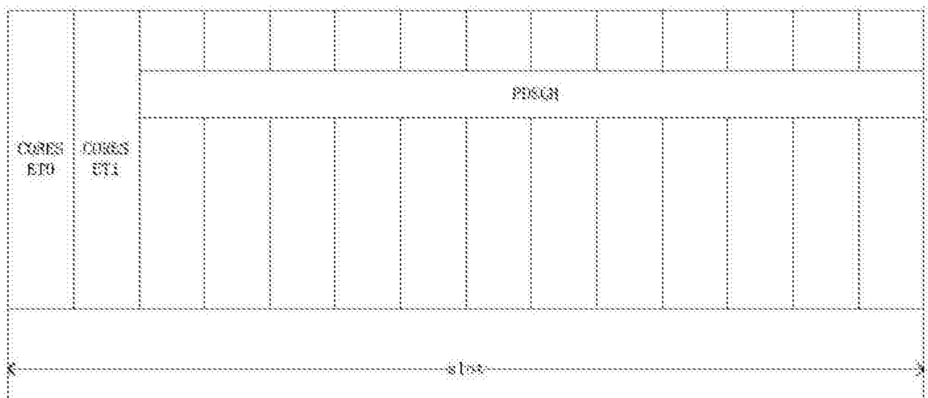

PDSCH
CORESET0
CORESET1

图1c

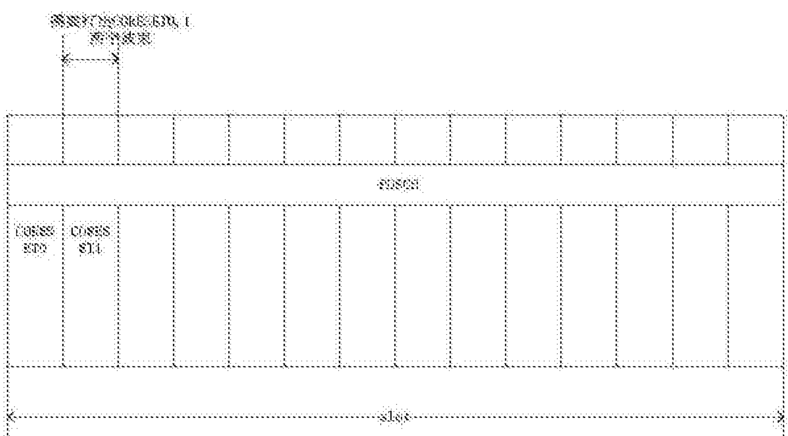

PDSCH
CORESET0
CORESET1

图1d

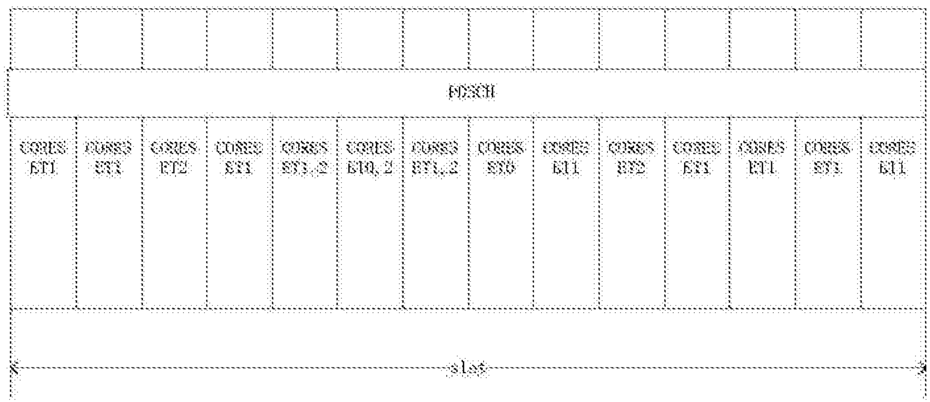

PDSCH
slot

图1e

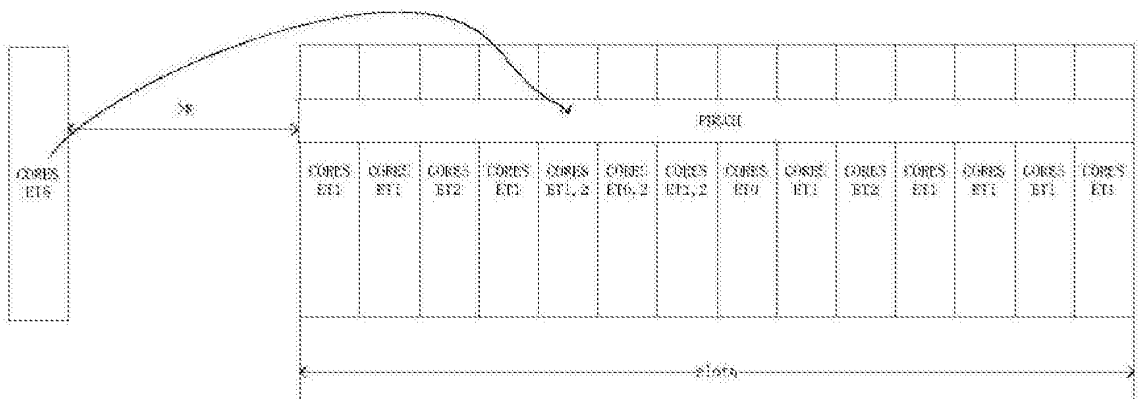

PDSCH
slots

图1f

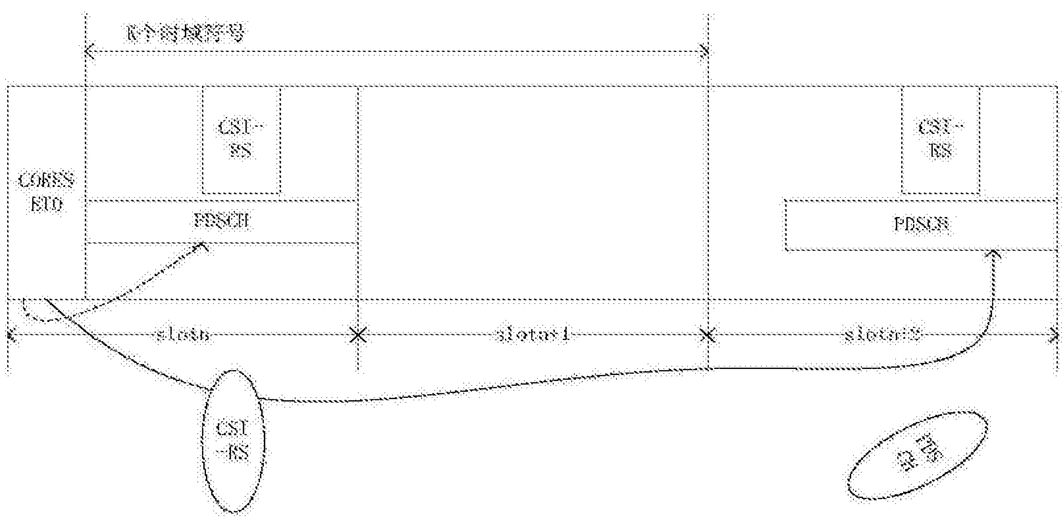

K个时域符号
CORESET0
CSI-RS
PDSCH
CSI-RS
PDSCH
slotn
slotn+1
slotn+2
CSI-RS

图2

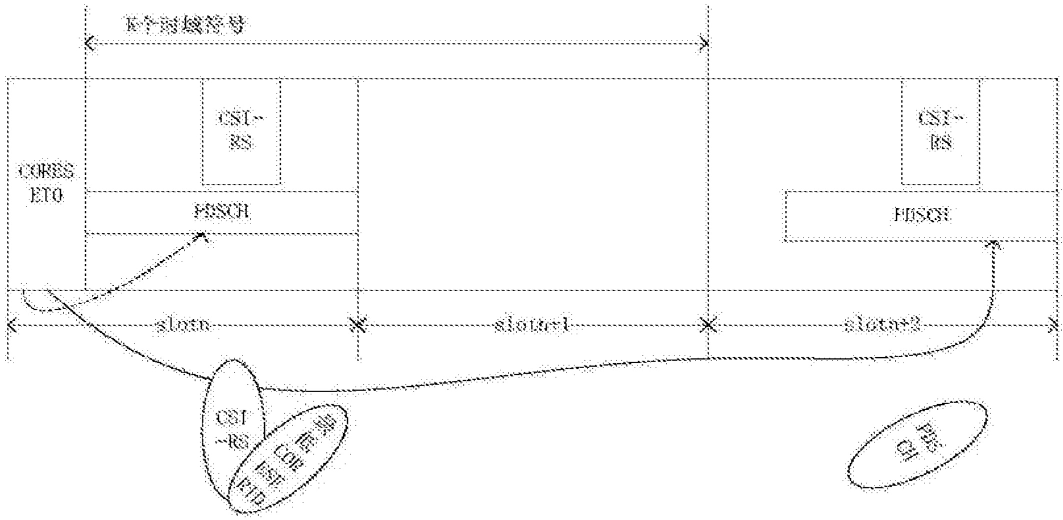

K个时域符号
CORESET0
CSI-RS
PDSCH
CSI-RS
PDSCH
slotn
slotn+1
slotn+2

图3

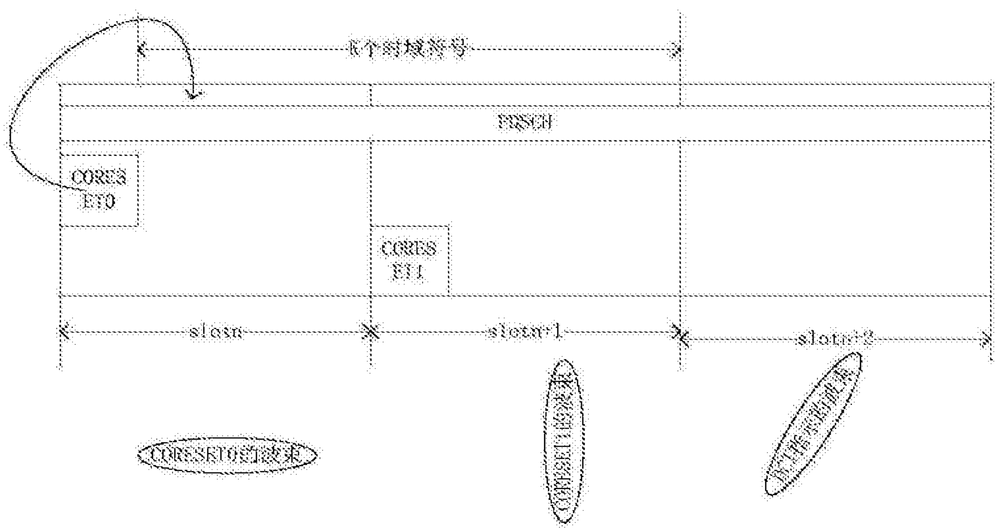

K个时域符号
PDSCH
CORESET0
CORESET1
slotn
slotn+1
slotn+2
CORESET0的波束
CORESET1的波束

图4a

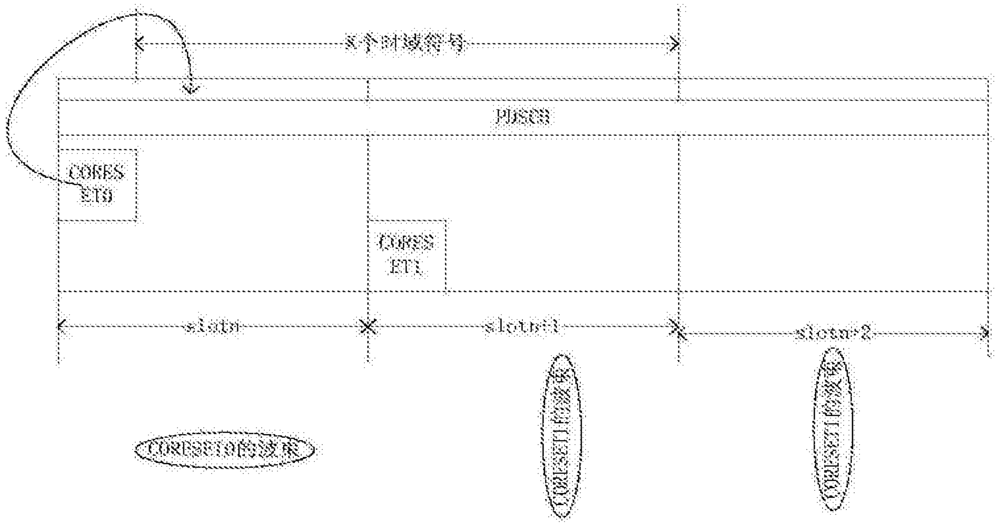

8个时域符号
PDSCH
CORES
ET0
CORES
ET1
slotn
slotn+1
slotn+2
CORESET0的波束
CORESET1的波束
CORESET1的波束

图4b

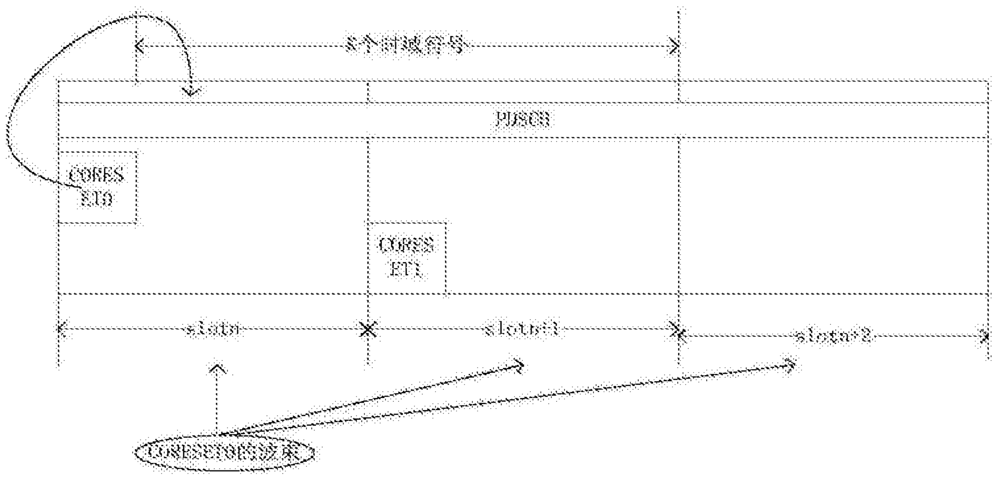

8个时域符号
PDSCH
CORES
ET0
CORES
ET1
slotn
slotn+1
slotn+2
CORESET0的波束

图4c

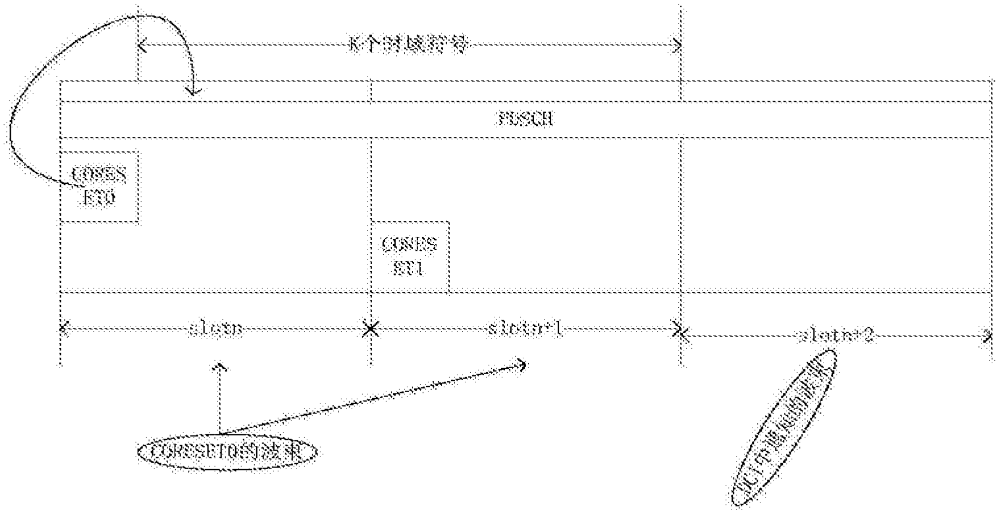

K个时域符号
PDSCH
CORES
ET0
CORES
ET1
slotn
slotn+1
slotn+2
CORESET0的波束

图4d

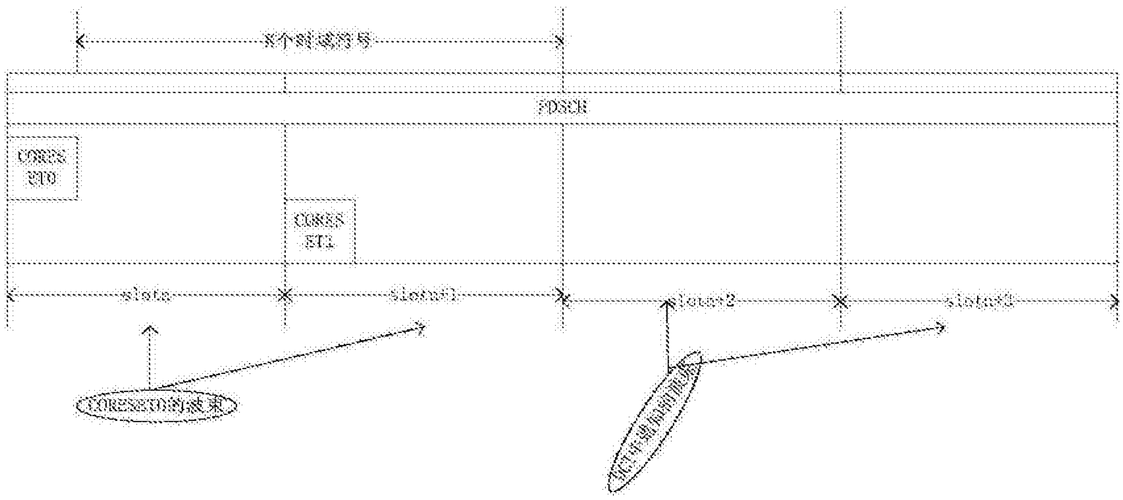

K个时域符号
PDSCH
CORES
ET0
CORES
ET1
slotn
slotn+1
slotn+2
slotn+3
CORESET0的波束

图4e

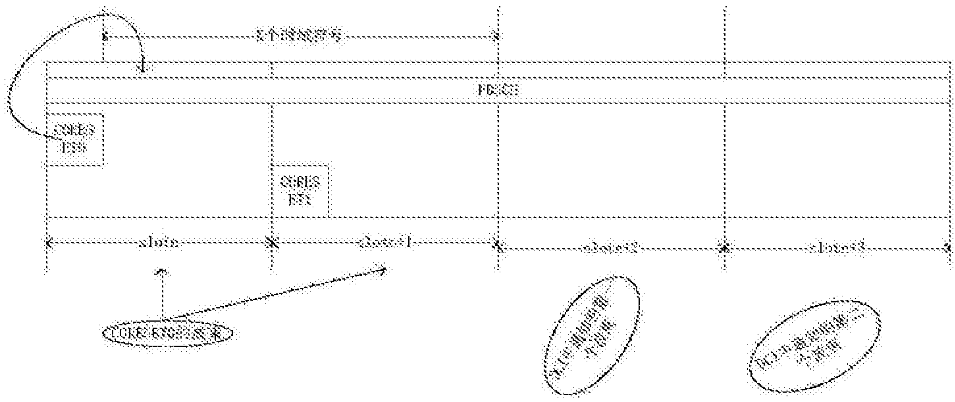


图4f

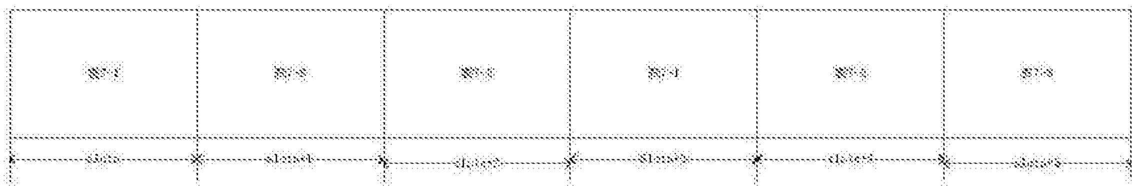


图5

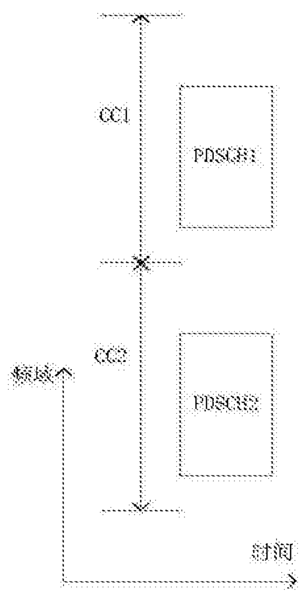


图6a

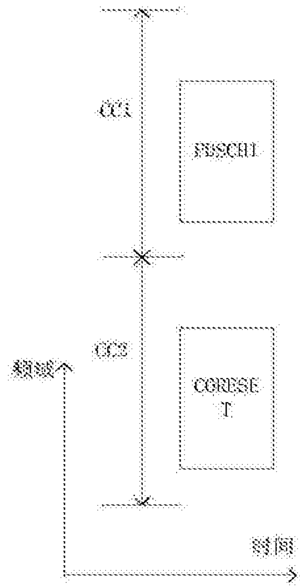


图6b

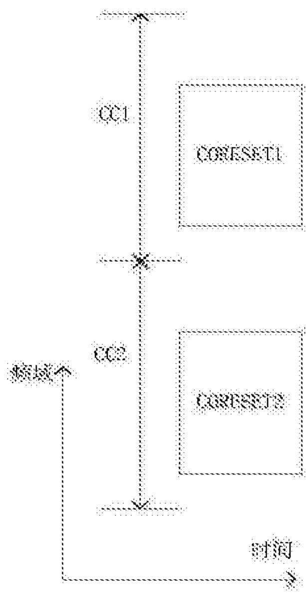


图6c

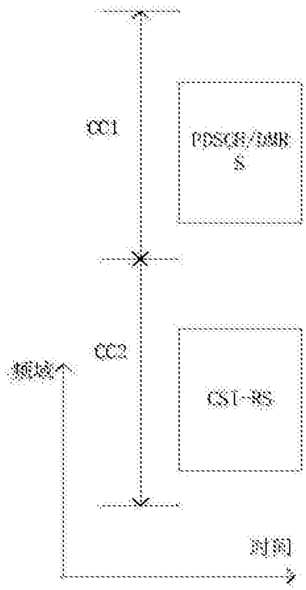

CC1
PDSCH/DMRS
CC2
CSI-RS
频域
时间

图6d

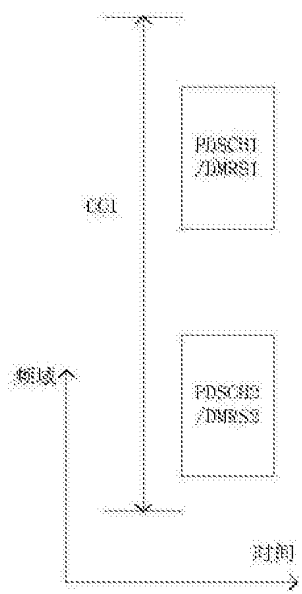

PDSCH1
/DMRS1
CC1
PDSCH2
/DMRS2
频域
时间

图7a

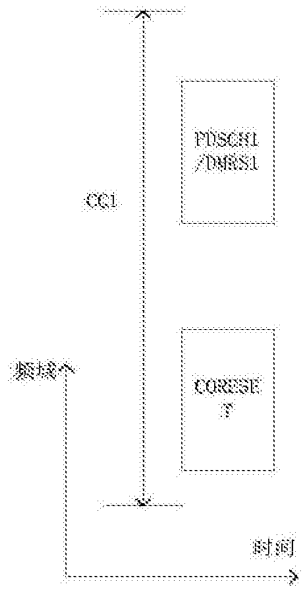


图7b

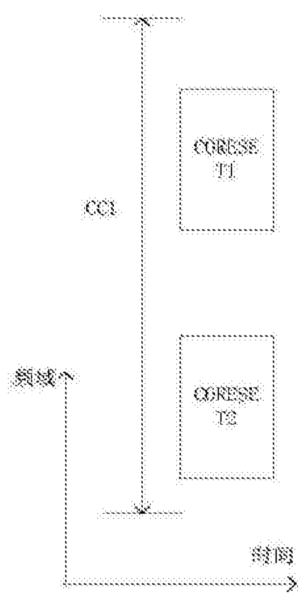


图7c

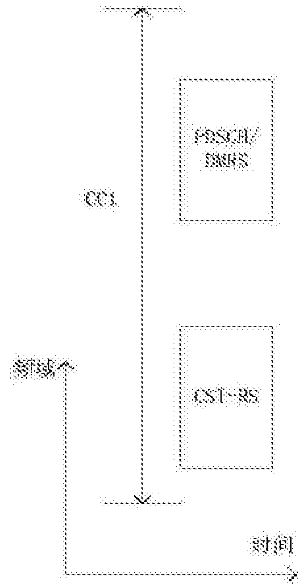


图7d

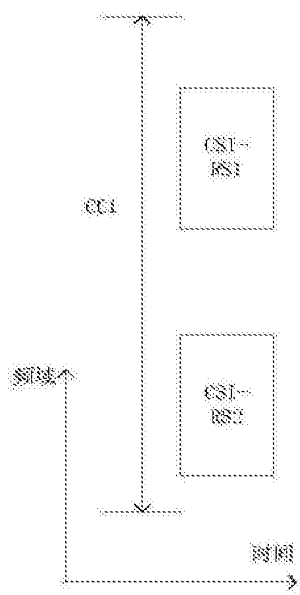


图7e

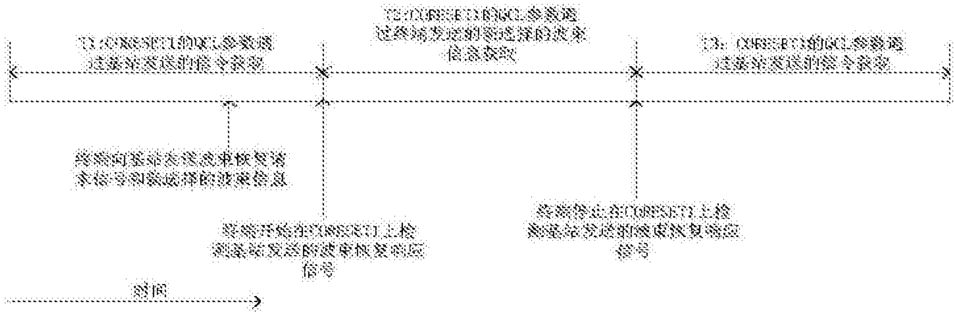


图8a

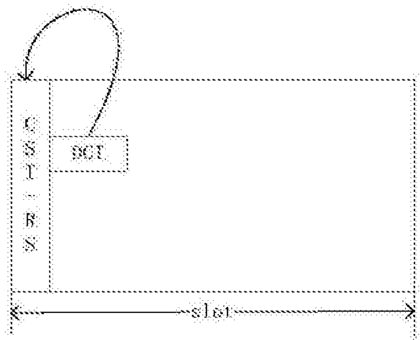


图8b

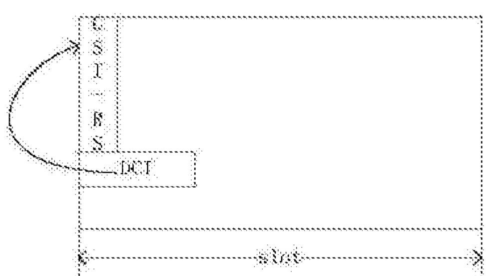


图8c

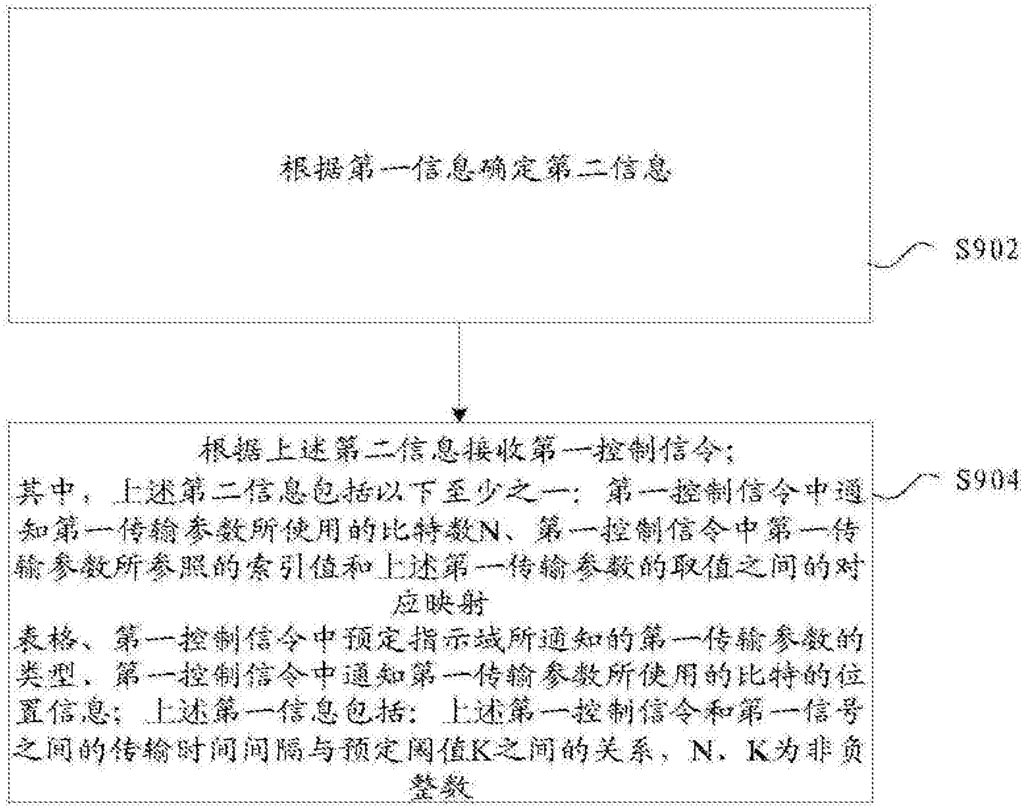

根据第一信息确定第二信息
S902
根据上述第二信息接收第一控制信令；
其中，上述第二信息包括以下至少之一：第一控制信令中通知第一传输参数所使用的比特数N、第一控制信令中第一传输参数所参照的索引值和上述第一传输参数的取值之间的对应映射
表格、第一控制信令中预定指示域所通知的第一传输参数的类型，第一控制信令中通知第一传输参数所使用的比特的位置信息；上述第一信息包括：上述第一控制信令和第一信号之间的传输时间间隔与预定阈值K之间的关系，N、K为非负整数
S904

图9

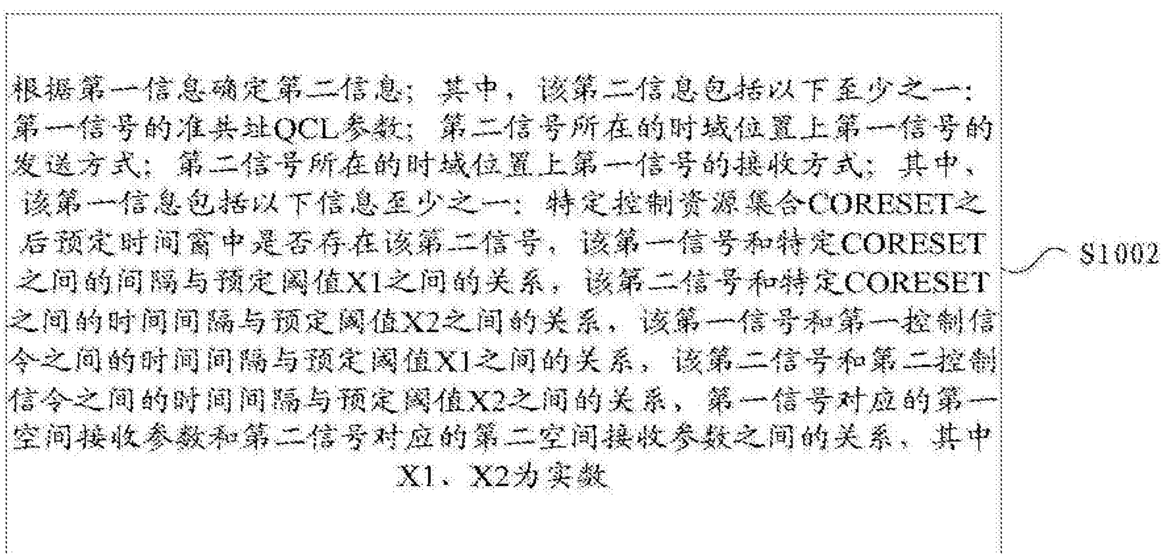

根据第一信息确定第二信息；其中，该第二信息包括以下至少之一：第一信号的准共址QCL参数；第二信号所在的时域位置上第一信号的发送方式；第二信号所在的时域位置上第一信号的接收方式；其中，该第一信息包括以下信息至少之一：特定控制资源集合CORESET之后预定时间窗中是否存在该第二信号，该第一信号和特定CORESET之间的间隔与预定阈值X1之间的关系，该第二信号和特定CORESET之间的时间间隔与预定阈值X2之间的关系，该第一信号和第一控制信令之间的时间间隔与预定阈值X1之间的关系，该第二信号和第二控制信令之间的时间间隔与预定阈值X2之间的关系，第一信号对应的第一空间接收参数和第二信号对应的第二空间接收参数之间的关系，其中X1、X2为实数
S1002

图10

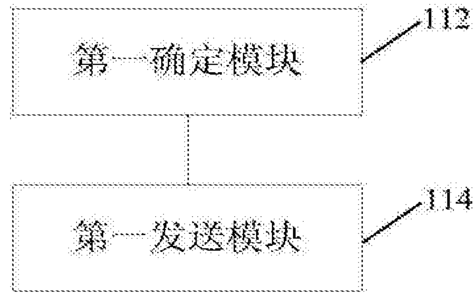


图11

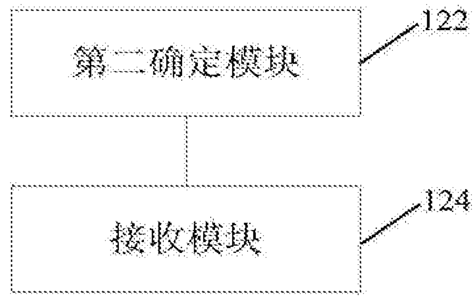


图12

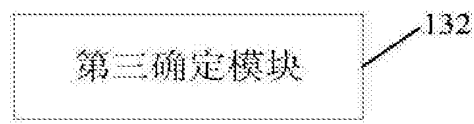


图13

Electronic Acknowledgement Receipt

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International Application Number:	
Confirmation Number:	6936
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First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
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1	Foreign Reference	US7824120041502IDS-OT.pdf	4242441 10911b8d7b6ec59c4934c71294815e8edb745522	no	28

Warnings:

Information:					
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Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	US78241__IDS.pdf	532749 6a26c1f816b31f6fd09bb3239be0b0f730474a40	no	4
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Information:					
4	Foreign Reference	US7824120041503IDS-OT.pdf	10725439 6bf80af10373adff63e800696ab298f358de7249	no	69
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Information:					
			Total Files Size (in bytes):	24324834	

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
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English Translation of Abstract of China Patent Application No. CN108092754A

Title

A kind of reference signal channel characteristics collocation method and device and communication equipment

Abstract

The present invention, which provides a kind of reference signal channel characteristics collocation method and device and communication equipment, the above method, to be included：Determine first kind signaling；The first kind signaling carries first kind set, and the first kind set includes multiple index elements；First kind signaling is sent to the second communication node.Pass through technical scheme, method based on QCL hypothesis or strong constraint instruction, instruction uplink reference signals to distinguish obtain for wave beam training or channel state information, enable adaptation to the scene of the movement of user and the variation of channel, reduce wave beam instruction expense, add the flexibility of system.

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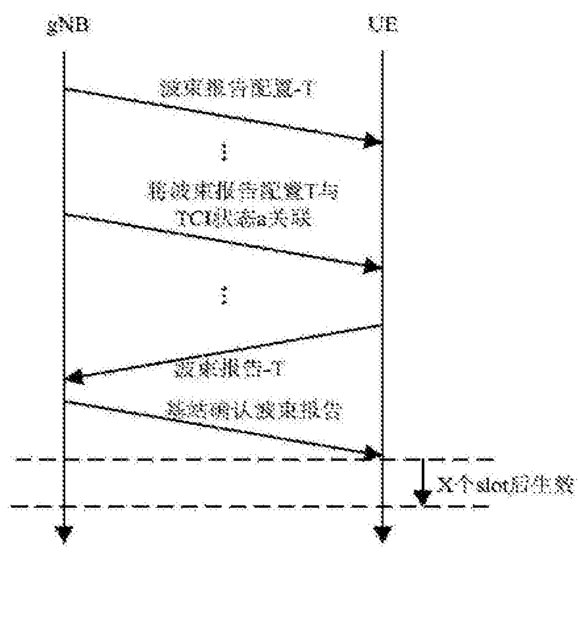
权利要求书7页 说明书16页 附图3页

(54)发明名称

一种参考信号信道特征配置方法和装置、及通信设备

(57)摘要

本发明提供一种参考信号信道特征配置方法和装置，及通信设备，上述方法包括：确定第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；向第二通信节点发送第一类信令。通过本发明的技术方案，基于QCL假设或者强约束指示的方法，来区分的指示上行参考信号用于波束训练或者信道状态信息获取，从而能够适应用户的移动和信道的变化的场景，减少了波束指示开销，增加了系统的灵活性。



1.一种参考信号信道特征配置方法，应用于第一通信节点，其特征在于，所述方法包括：

确定第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；

向第二通信节点发送第一类信令。

2.根据权利要求1所述的方法，其特征在于，

所述索引元素包括如下信息中的一个或组合：

索引元素序号、参考信号类型索引、参考信号资源配置索引、参考信号资源集合索引、参考信号资源索引、参考信号端口索引、资源块索引、资源块突发索引、资源块突发集合索引、测量限制窗口索引、时域窗索引、报告配置索引、波束分组索引、测量约束、配置约束、时间约束、触发信息、以及参考信号分组索引。

3.根据权利要求2所述的方法，其特征在于，

所述参考信号包括如下之一或组合：同步信号块SS block、信道状态信息参考信号CSI-RS、信道探测参考信号SRS、物理随机接入信道信号PRACH、解调参考信号DMRS。

4.根据权利要求1所述的方法，其特征在于，

第一类信令中携带的第一类集合的个数为M个；

其中，其中第i个集合内部包含Ni个索引元素；M和Ni均是大于或等于1的整数。

5.根据权利要求4所述的方法，其特征在于，

每一个第一类集合中包括的索引元素的数目均为1个。

6.根据权利要求4所述的方法，其特征在于，

所述的第一类集合，为传输控制指示状态transmission configuration indication state，或备选的传输控制指示状态candidate transmission configuration indication state，或上行传输控制指示状态。

7.根据权利要求1所述的方法，其特征在于，在向第二通信节点发送第一类信令之后，所述方法还包括：

重新配置第一类集合；

将新配置的第一类集合携带在第一类信令中发送给第二通信节点；或，将重新配置第一类集合的相关重配信息发送给第二通信节点；

所述重新配置第一类集合包括如下操作的至少一项：

向所述第一类集合中添加新的第一类集合；

删除所述第一类集合中的指定集合；

更新所述第一类集合中指定集合内的指定元素；

删除所述第一类集合中指定集合内的指定元素；

添加所述第一类集合中指定集合内的元素。

8.根据权利要求1～7所述的方法，其特征在于，在向第二通信节点发送第一类信令之后，所述方法还包括：

确定第二类信令，所述第二类信令携带有第二类集合指示信息，用于指示第二通信节点在第一类集合的基础上获取第二类集合；

向第二通信节点发送第二类信令；

所述第二类集合指示信息用于指示如下内容中的至少一个：

激活第一类集合中的部分集合，通过激活的第一类集合构成第二类集合；

组合第一类集合中的部分或全部集合，构成第二类集合；

组合第一类集合中集合内的元素，构成第二类集合。

9.根据权利要求8所述的方法，其特征在于，

获取的第二类集合的个数为S，第i个第二类集合内包含ki个索引元素；

其中，S和ki均是大于或等于1的整数。

10.根据权利要求8所述的方法，其特征在于，

所述的方法还包括：

使用比特地图，指示第一类集合中的集合或者元素来构成第二类集合。

11.根据权利要求8所述的方法，其特征在于，

第一类集合中的集合或者集合中的元素，与比特地图中的每个比特相对应；

若比特位置为特定数值时，表示激活，组合或者选择所述比特位置关联集合，或者激活，组合或者选择所述比特位置关联集合中的元素。

12.根据权利要求11所述的方法，其特征在于，

通过比特地图选择出的集合或者元素，按照比特地图中顺序依次编码，用于指示第二类集合中的集合或者集合中的元素。

13.根据权利要求11所述的方法，其特征在于，

第二类集合中X1个集合被显式指示，而L-X1个集合使用比特地图进行指示；

其中，X1和L是大于等于1的整数；L为第二类信令中携带的第二类集合的个数，X1为小于L的整数。

14.根据权利要求8所述的方法，其特征在于，所述方法还包括：

确定第三类信令，所述第三类信令携带有第三类指示信息，用于指示第二通信节点在第一类集合或第二类集合的范围中指定其中的一个集合；

向第二通信节点发送第三类信令；

所述第三类指示信息用于指示如下内容中的至少一个：

内容1、指示所关联的下行解调参考信号的信道特性假设；

内容2、指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

内容3、指示所关联的物理上行控制信道PUCCH，或者指示所关联的物理上行控制信道PUCCH的所关联的层layer；

内容4、指示所关联的物理上行共享信道PUSCH，或者指示所关联的物理上行共享信道PUSCH的所关联的layer；

内容5、指示所关联的信道状态信息参考信号CSI-RS的信道特性假设；

内容6、指示所关联的信道探测参考信号SRS的信道特性假设；

内容7、指示所关联的干扰测量参考信号IMR的信道特性假设。

15.根据权利要求1所述的方法，其特征在于，所述方法还包括：

确定第三类集合；

向第二通信节点发送第三类集合；

其中，第三类集合包括T个集合，其中第i个集合包含Ri个上行参考信号索引元素；T和Ri是大于等于1的整数。

16.根据权利要求1所述的方法，其特征在于，所述方法还包括：

确定第四类信令，所述第四类信令携带有第四类集合指示信息，用于指示第二通信节点在第一类集合、或第二类集合、或者第三类集合的范围中指定其中的一个集合；

向第二通信节点发送第四类信令；

所述第四类指示信息用于指示如下内容中的至少一个：

指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

指示所关联的信道探测参考信号SRS，或者指示所关联的信道探测参考信号SRS的信道特性假设。

17.根据权利要求16所述的方法，其特征在于，所述第四类信令的信道特征假设，是基于相同的空间滤波器，或者基于相同的天线端口假设，或者基于以下所有参数集合之一或组合：

多普勒扩展，多普勒平移，时延拓展，平均时延，平均增益和空间参数；

或者，多普勒扩展，多普勒平移，时延拓展，平均时延和空间参数。

18.根据权利要求16所述的方法，其特征在于，

所述上行参考信号包括如下信号之一：信道探测参考信号SRS、物理随机接入信道信号PRACH、上行解调参考信号UL DMRS。

19.根据权利要求16所述的方法，其特征在于，

所述的上行解调参考信号，为物理上行控制信道PUCCH所关联的上行解调参考信号，或物理上行共享信道PUSCH所关联的上行解调参考信号。

20.根据权利要求16所述的方法，其特征在于，

所述的第四类信令的信道特征假设的约束条件，强于所述第三类信令的信道特征假设的约束条件。

21、根据权利要求16所述的方法，其特征在于，

在E>=2^{Nd}时，从E个SRS资源集合中选择2^{Nd}-1个SRS资源，与DCI指示字段关联，用于非周期SRS资源触发；在E<2^{Nd}时，将E个SRS资源，直接与DCI指示字段关联，用于非周期SRS资源触发；

其中E、Nd和Wi为大于等于1的正整数。

22.根据权利要求21所述的方法，其特征在于，

使用比特地图，将E个SRS资源集合中选择2^{Nd}-1个SRS资源集合。

23.根据权利要求21所述的方法，其特征在于，

所述第三类集合下的每一个集合内的索引元素的数目可以都仅为1个。

24.根据权利要求14所述的方法，其特征在于，

所述CSI-RS、SRS或者IMR为非周期参考信号，并且所述参考信号资源或者资源集合大于等于2^{G}时

将Y个所述参考信号资源或者资源集合池中选择2^{G}-1个资源或者资源集合；

再将所选择的2^{G}-1个资源或者资源集合中的每一个集合，与所述第三类信令指定的第

二类集合中的集合，或者与所述第三类信令指定的第一类集合中的集合，进行关联，用于指示所选择的资源或者资源集合的信道特征假设。

25.根据权利要求14所述方法，其特征在于，

所述的信道特征假设，包括如下之一或者组合：准共址，多普勒扩展，多普勒平移，时延拓展，平均时延，平均增益，空间接收参数，空间关系和空间参数。

26.根据权利要求8所述的方法，其特征在于，

根据准则，所述的第二类集合中的约定集合，用于指示所关联的物理上行控制信道(PUCCH)，或者用于指示所关联的物理上行控制信道(PUCCH)的解调参考信号的信道特性假设。

27.根据权利要求26所述的方法，其特征在于，

所述的准则是指如下至少之一：

准则1、最低序号的集合；

准则2、最高序号的集合；

准则3、第一通信节点配置序号，则确定所述序号下的集合。

28.根据权利要求1所述的方法，其特征在于，所述方法还包括：

生成第五类信令，将第二类集合中的一个集合，和/或第一类集合中的一个集合，与第二通信节点的波束报告中关联，根据波束报告结果更新所指示的集合或者集合中的元素。

29.根据权利要求28所述的方法，其特征在于，第一通信节点在接收到所述的波束报告后，向第二通信节点发送确认信令。

30.根据权利要求29所述的方法，其特征在于，更新生效时间，为所述确认信令发送后的X个slot，其中X是大于等于1的整数。

31.根据权利要求30所述的方法，其特征在于，

对与所述的第一类或者第二类集合中的一个集合或元素相关联的下行参考信号的信道特征假设进行更新；

或者，激活与第一类或者第二类集合中的一个集合或元素相关联相的下行参考信号。

32.根据权利要求31所述的方法，其特征在于，所述的下行参考信号包括如下至少之一：

CSI-RS，用于时频追踪的CSI-RS，或者TRS。

33.根据权利要求28所述的方法，其特征在于，向第二通信节点发送的确认信息需要特征有如下至少之一：

承载确认信令的DCI，调度PDSCH；

UE不希望承载确认信令的DCI不关联或者不调度PDSCH。

34.根据权利要求1所述的方法，其特征在于，第一通信节点指示第二通信节点根据一组port index的指示测量上报CSI，其中UE对port index指示的理解满足特性要求。

35.根据权利要求34所述的方法，其特征在于，所述的特性要求包括层间嵌套的特性。

36.根据权利要求35所述的方法，其特征在于，所述的层间嵌套特性为：

用于测量rank i的port组是rank j的port组的一个子集，i<j，

其中i和j为大于等于1的整数。

37.一种参考信号信道特征配置方法，应用于第二通信节点，其特征在于，所述方法包

括：

接收第一通信节点发送的第一类信令；

获取所述第一类信令中携带的第一类集合，所述第一类集合包括多个索引元素。

38.根据权利要求37所述的方法，其特征在于，所述方法还包括：

接收第一通信节点发送的第二类信令；所述第二类信令携带有第二类集合指示信息，用于指示第二通信节点在第一类集合的基础上获取第二类集合；

根据接收的第二类信令中携带的第二类集合指示信息，在第一类集合的基础上获取第二类集合；

所述根据接收的第二类信令中携带的第二类集合指示信息，在第一类集合的基础上获取第二类集合包括如下方式的至少一种：

激活第一类集合中的部分集合，通过激活的第一类集合构成第二类集合；

组合第一类集合中的部分或全部集合，构成第二类集合；

组合第一类集合中集合内的元素，构成第二类集合。

39.根据权利要求37或38所述的方法，其特征在于，

接收第一通信节点发送的链路重配置请求信令的确认响应；

在接收所述确认响应之后，执行如下方式的至少一种：

将第一类集合下约定的集合，或者第二类集合下约定的集合，更新为第一通信节点发送链路重配置请求信令所指示的下行参考信号所对应的参考信号索引；

确定接收的PDSCH的DMRS与下行参考信号满足信道特征假设；其中，所述下行参考信号为第一通信节点发送链路重配置请求信令所指示的下行参考信号；

确定要发送的PUCCH与上行参考信号满足信道特征假设；其中，所述上行参考信号为第一通信节点发送链路重配置请求信令所指示的上行参考信号；

确定要发送的PUCCH与请求信令所使用的PUCCH的信道特征假设相同；其中，请求信令所使用的PUCCH为第一通信节点发送链路重配置请求信令所使用的PUCCH。

40.一种参考信号信道特征配置装置，设置在通信设备上，其特征在于，所述装置包括：

信令确定单元，用于确定第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；

信令发送单元，用于向第二通信节点发送第一类信令。

41.根据权利要求40所述的装置，其特征在于，所述信令确定单元还用于：在向第二通信节点发送第一类信令之后，

重新配置第一类集合；

将新配置的第一类集合携带在第一类信令中发送给第二通信节点；或，将重新配置第一类集合的相关重配信息发送给第二通信节点；

所述重新配置第一类集合包括如下操作的至少一项：

向所述第一类集合中添加新的第一类集合；

删除所述第一类集合中的指定集合；

更新所述第一类集合中指定集合内的指定元素；

删除所述第一类集合中指定集合内的指定元素；

添加所述第一类集合中指定集合内的元素。

42.根据权利要求40所述的装置，其特征在于，

所述信令确定单元还用于在向第二通信节点发送第一类信令之后，确定第二类信令，所述第二类信令携带有第二类集合指示信息，用于指示第二通信节点在第一类集合的基础上获取第二类集合；

所述信令发送单元还用于向第二通信节点发送第二类信令；

所述第二类集合指示信息用于指示如下内容中的至少一个：

激活第一类集合中的部分集合，激活的第一类集合构成第二类集合；

组合第一类集合中的部分或全部集合，构成第二类集合；

组合第一类集合中集合内的元素，构成第二类集合。

43.根据权利要求40～41中任一项所述的装置，其特征在于，

所述信令确定单元还用于确定第三类信令，所述第三类信令携带有第三类指示信息，用于指示第二通信节点在第一类集合或第二类集合的范围中指定其中的一个集合；

所述信令发送单元还用于向第二通信节点发送第三类信令；

所述第三类指示信息用于指示如下内容中的至少一个：

内容1、指示所关联的下行解调参考信号的信道特性假设；

内容2、指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

内容3、指示所关联的物理上行控制信道PUCCH，或者指示所关联的物理上行控制信道PUCCH的所关联的层layer；

内容4、指示所关联的物理上行共享信道PUSCH，或者指示所关联的物理上行共享信道PUSCH的所关联的layer；

内容5、指示所关联的信道状态信息参考信号CSI-RS的信道特性假设；

内容6、指示所关联的信道探测参考信号SRS的信道特性假设；

内容7、指示所关联的干扰测量参考信号IMR的信道特性假设。

44.根据权利要求40所述的装置，其特征在于，所述装置还包括：

所述信令确定单元还用于确定第四类信令，所述第四类信令携带有第四类集合指示信息，用于指示第二通信节点在第一类集合、或第二类集合、或者第三类集合的范围中指定其中的一个集合；

所述信令发送单元还用于向第二通信节点发送第四类信令；

所述第四类指示信息用于指示如下内容中的至少一个；

指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

指示所关联的信道探测参考信号SRS，或者指示所关联的信道探测参考信号SRS的信道特性假设。

45.根据权利要求40所述的装置，其特征在于，

所述信令确定单元还用于生成第五类信令，将第二类集合中的一个集合，和/或第一类集合中的一个集合，与第二通信节点的波束报告中关联，根据波束报告结果更新所指示的集合或者集合中的元素。

46.一种终端，包括存储器、处理器及存储在所述存储器上并可在所述处理器上运行的

计算机程序，其特征在于，所述处理器执行所述计算机程序时实现如权利要求1至39中任一权项所述的方法的处理。

一种参考信号信道特征配置方法和装置、及通信设备

技术领域

[0001] 本发明涉及通信领域，尤指一种参考信号信道特征配置方法和装置、及通信设备。

背景技术

[0002] 超宽带宽的高频段，即毫米波通信，成为未来移动通信发展的重要方向，吸引了全球的学术界和产业界的目光。特别是，在当下日益拥塞的频谱资源和物理网大量接入时，毫米波的优势变得越来越有吸引力，在很多标准组织，例如IEEE、3GPP都开始展开相应的标准化工作。例如，在3GPP标准组，高频段通信凭借着其大带宽的显著优势将会成为5G New Radio Access Technology(New RAT)的重要创新点。

[0003] 然而，高频段通信也面临着链路衰减的挑战，具体而言，包括传播路径损失大、空气吸收(尤其是氧气)吸收更大、雨衰影响较重等。面对这些挑战，高频段通信系统可以利用高频段波长较短和易于天线集成等特点，通过多天线阵列和波束赋形方案来获取高天线增益和对抗信号传输损耗，进而以确保链路余量和提升通信鲁棒性。

[0004] 在天线权重(也称为，预编码、波束)训练过程中，高频段发端发送训练导频，接端接收信道并执行信道估计。然后，高频段接收端需要向训练发端反馈信道状态信息，便于实现收发端从可选的收发端天线权重对中，找到可以用于多路数据传输所需要的多组收发端天线权重对，提升整体的频谱效率。

发明内容

[0005] 为了解决上述问题，本发明提出了一种参考信号信道特征配置方法和装置、及通信设备，能够改善大幅度增大波束指示开销的问题。

[0006] 为了解决上述技术问题，本发明提出了一种参考信号信道特征配置方法，应用于第一通信节点，所述方法包括：

[0007] 确定第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；

[0008] 向第二通信节点发送第一类信令。

[0009] 为了解决上述技术问题，本发明还提出了一种参考信号信道特征配置方法，应用于第二通信节点，所述方法包括：

[0010] 接收第一通信节点发送的第一类信令；

[0011] 获取所述第一类信令中携带的第一类集合，所述第一类集合包括多个索引元素。

[0012] 为了解决上述技术问题，本发明还提出了一种参考信号信道特征配置装置，设置在通信设备上，所述装置包括：

[0013] 信令确定单元，用于确定第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；

[0014] 信令发送单元，用于向第二通信节点发送第一类信令。

[0015] 为了解决上述技术问题，本发明还提出了一种终端，包括存储器、处理器及存储在

所述存储器上并可在所述处理器上运行的计算机程序，所述处理器执行上述任一方法的处理

[0016] 与现有技术相比，本发明提供的技术方案包括：确定第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；向第二通信节点发送第一类信令。通过本发明的方案，基于QCL假设或者强约束指示的方法，来区分的指示上行参考信号用于波束训练或者信道状态信息获取，从而能够适应用户的移动和信道的变化的场景，减少了波束指示开销，增加了系统的灵活性。

附图说明

[0017] 下面对本发明实施例中的附图进行说明，实施例中的附图是用于对本发明的进一步理解，与说明书一起用于解释本发明，并不构成对本发明保护范围的限制。

[0018] 图1为本发明实施例提供的面向PDSCH和PDCCH的波束指示示意图；

[0019] 图2为本发明实施例提供的面向非周期的CSI-RS的波束指示示意图。

[0020] 图3为本发明实施例提供的对于非周期的SRS的信道状态信息的配置示意图。

[0021] 图4为本发明实施例提供的对于与波束报告关联的波束指示示意图。

[0022] 图5为本发明实施例提供的端口指示以实现CSI上报的示意图。

具体实施方式

[0023] 为了便于本领域技术人员的理解，下面结合附图对本发明作进一步的描述，并不能用来限制本发明的保护范围。需要说明的是，在不冲突的情况下，本申请中的实施例及实施例中的各种方式可以相互组合。

[0024] 在介绍本发明实施例提供的方法和装置之前，首先对一些相关的概念进行说明，本发明实施例中，所述的参考信号至少包括如下之一：

[0025] 1) 小区参考信号(CRS)

[0026] 2) 信道状态信息参考信号(CSI-RS)

[0027] 3) 波束管理的信道状态信息参考信号

[0028] 4) 信道状态信息干扰测量信号(CSI-IM)

[0029] 5) 解调参考信号(DMRS)

[0030] 6) 下行解调参考信号

[0031] 7) 上行解调参考信号

[0032] 8) 信道探测参考信号(SRS)

[0033] 9) 相位追踪参考信号(PT-RS)

[0034] 10) 移动相关参考信号(MRS)

[0035] 11) 波束参考信号(BRS)

[0036] 12) 波束细化参考信号(BRRS)

[0037] 13) 随机接入信道信号(RACH)

[0038] 14) 同步信号(SS)

[0039] 15) 同步信号块(SS block)

[0040] 16) 主同步信号(PSS)

[0041] 17)副同步信号(SSS)

[0042] 所述信道特征，即包括物理传播信道特征，例如水平发送方位角，垂直发送方位角，水平接收方位角，垂直接收方位角等，也包括射频和基带电路的特征，例如天线阵子特征(element pattern)，天线摆放，以及基带时偏，频偏和相位噪声等；

[0043] 所述波束可以为一种资源(例如发端预编码，收端预编码、天线端口，天线权重矢量，天线权重矩阵等)，波束符号可以被替换为资源索引，因为波束可以与一些时频码资源进行传输上的绑定。波束也可以为一种传输(发送/接收)方式；所述的传输方式可以包括空分复用、频域/时域分集等。

[0044] 所述的接收波束指示是指，发送端可以通过当前参考信号和天线端口与UE反馈报告的参考信号(或基准参考信号)和天线端口的准共址(QCL)假设来进行指示。

[0045] 所述的接收波束是指，无需指示的接收端的波束，或者发送端可以通过当前参考信号和天线端口与UE反馈报告的参考信号(或基准参考信号)和天线端口的准共址(QCL)指示下的接收端的波束资源；

[0046] 进一步的，在波束指示中，原参考信号是指之前曾经测量的参考信号，作为参考源；而目标参考信号，是指该信道特征需要指示的参考信号，用于确定所关联参考信号的信道特征加载。

[0047] 所述的准共址(QCL)涉及的参数至少包括，多普勒扩展，多普勒平移，时延拓展，平均时延，平均增益，空间参数，空间关系和空间接收参数；

[0048] 链路重配置请求也称为，波束恢复请求。

[0049] 本发明提出了一种参考信号信道特征配置方法，所述方法包括：

[0050] 步骤100，基站配置M个第一类集合，其中第i个集合内部包含Ni个索引元素；

[0051] 步骤200，基站向UE发送信令，其中携带有配置的M个第一类集合；

[0052] 其中，配置的M个第一类集合中，其中第i个集合内部包含Ni个索引元素，并且将配置信息告知给UE端。其中，M和Ni是大于等于1的整数。在仅考虑单beam的情况下，第一类集合下的每一个集合内的索引元素的数目可以都仅为1个。所述的第一类集合，可以称为传输控制指示(transmission configuration indication)，或者备选的传输控制指示(candidate transmission configuration indication)，或者上行的传输控制指示。

[0053] 例如，在每个集合下索引元素都为1时，我们有第一类集合，即备选的传输控制指示状态，如表1所示。

[0054]

状态序号	参考信号索引
0	CRI-1
1	CRI-8
…	…
N-1	SS block-8

[0055] 表1、备选的传输控制指示状态实例一

[0056] 在一般案例下，配选的传输控制指示状态，如表2所示。其中，每个状态可以关联大于等于1个参考信号索引。

[0057]

状态序号	参考信号索引
0	CRI-7
	CRI-8
1	CRI-8

[0058]

	SS block-11
…	…
N-1	CRI-6
	SS block-12

[0059] 表2备选的传输控制指示状态实例二

[0060] 其中，所述的索引可以包括如下至少之一或者组合：索引元素序号、参考信号类型索引、参考信号资源配置索引、参考信号资源集合索引、参考信号资源索引、参考信号端口索引、资源块索引、资源块突发索引、资源块突发集合索引、测量限制窗口索引、时域窗索引、报告配置索引、波束分组索引、测量约束、配置约束、时间约束、触发信息、参考信号分组索引。

[0061] 其中，参考信号包括如下之一或组合：同步信号块SS block、信道状态信息参考信号CSI-RS、信道探测参考信号SRS、物理随机接入信道信号PRACH、解调参考信号DMRS。

[0062] 对于非周期参考信号，例如aperiodic CSI-RS时，指示该aperiodic CSI-RS需要额外配置触发信息。对于非周期的CSI-RS而言，系统端可能会多次触发aperiodic CSI-RS，而触发信息可以用于区分是具体的aperiodic CSI-RS指示。进一步的，存在一种索引行为是触发索引，而aperiodic CSI-RS指示模式是触发索引+CRI。

[0063] 进一步，支持重配置所述第一类集合包括至少如下之一：向所述第一类集合中添加集合；删除所述第一类集合中指定集合；更新所述第一类集合中指定集合内的元素；删除所述第一类集合中指定集合内的元素；添加所述第一类集合中指定集合内的元素。进一步的，重配置所述的第一类集合可以通过RRC信令或者MAC-CE信令实现。进一步，重配置可通过一个独立的信令实现，而不仅是第一类信令。

[0064] 在所述的第一类集合基础上，支持对于第一类集合的筛选，进而构成第二类集合。进一步的，生成第二类信令，包括如下操作至少之一或者组合：

[0065] (1)、激活第一类集合中的集合，构成第二类集合；

[0066] (2)、组合第一类集合中的集合，构成第二类集合；

[0067] (3)、组合第一类集合中集合内的元素，构成第二类集合；

[0068] 向第二通信节点发送第二类信令。其中，第二类集合，共包括S个集合，第i个所述集合内部包含k_i个索引元素。S和k_i是大于等于1的整数。进一步的，方法包括使用比特地图，

指示第一类集合中的集合或者元素来构成第二类集合。第一类集合中的集合或者集合中的元素，与比特地图中的每个比特相对应。所述的比特地图(bitmap)是指，通过一组二进制系列中的1和0元素以及元素的位置来指示所关联的信息是否有效或是否激活。

[0069] 若比特位置为特定数值时，表示激活，组合或者选择所关联集合，或者激活，组合或者选择所关联集合中的元素。通过比特地图选择出的集合或者元素，按照比特地图中顺序依次编码，用于指示第二类集合中的集合或者集合中的元素。

[0070] 例如，第一类集合下一共有16个集合，则激活第一类集合中(8个集合)的信令，可以分别显式指示：例如1,3,5,6,7,8,15,16；或者，通过bitmap来进行指示。进一步的，通过16-bit来分别对应于需要第一类集合中的每一个集合，然后1代表激活该集合，否者0表示不激活，例如16' b1010111100000011。因此，仅需要16个bit就可以有效的指示和激活其中任意集合。进一步，存在一个门限k，当需要激活的集合数目大于或者大于等于k时，使用bitmap的方法；否者使用显式指示的方法。其中k为大于等于1的正整数。进一步的，$k=\lceil T/\lceil \log(T)\rceil\rceil$，其中T表示为第一类集合中集合的个数。

[0071] 进一步的，该显式以及bitmap的方法可以扩展到对于集合中元素的指示，以及集合和集合元素的联合激活中来。

[0072] 在本发明的另一个实施例中，第二类集合中的X1个集合被显式指示，而M-X1个集合使用比特地图进行指示，其中，X1是大于等于1的整数。具体而言，第二类集合使用两种不同的指示办法来进行指示。比特地图可以有效节省花销，但是，比特地图并不能提供有效的顺序信息。而，从第一类集合中选择中，第二类集合中其中特定位置的集合和其他集合的默认配置不一致。

[0073] 进一步，根据准则(包括，最低序号的集合；最高序号的集合；第一通信节点预先指定或者配置的序号，则所述序号下的集合；)，则所述的第二类集合中的约定集合，用于指示所关联的物理上行控制信道(PUCCH)，或者用于指示所关联的物理上行控制信道(PUCCH)的解调参考信号的信道特性假设。

[0074] 例如，第一类集合下一共有16个集合，则激活第一类集合中(8个集合)的信令，可以通过一个显式信令加一个bitmap来进行指示。具体而言，例如激活1,3,5,6,7,8,15,16而其中6作为第二类集合中的第一个集合，则信令格式为{显式指示，比特地图}＝{6,16' b1010101100000011}。进一步的，比特地图将不指示显式指示的集合，则信令格式为{显式指示，比特地图(跳过显式指示比特)}＝{6,15' b101011100000011}。具体而言，我们将获得如下的第二类集合：

[0075]

第二类集合序号	所对应的第一类集合索引
1	第一类集合—集合6
2	第一类集合—集合1
3	第一类集合—集合3
4	第一类集合—集合5
5	第一类集合—集合8
6	第一类集合—集合8
7	第一类集合—集合15

8	第一类集合—集合16

[0076] 下面的实施例结合DL control,data channel,UL control and data channel的场景进行说明。

[0077] 根据第一类和第二类集合构成的可选集合，通过第三类信令来进行指示。进一步的，第三类信令，可能是MAC-CE信令或者DCI信令。进一步地，指示第二类集合中的一个集合，和/或指示第一类集合中的一个集合，用于如下至少之一或者组合：

[0078] (a)指示所关联的下行解调参考信号的信道特性假设；

[0079] (b)指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

[0080] (c)指示所关联的物理上行控制信道(PUCCH)，或者指示所关联的物理上行控制信道(PUCCH)的所关联的层(layer)

[0081] (d)指示所关联的物理上行共享信道(PUSCH)，或者指示所关联的物理上行共享信道(PUSCH)的所关联的层(layer)

[0082] (e)指示所关联的信道状态信息参考信号(CSI-RS)的信道特性假设；

[0083] (f)指示所关联的信道探测参考信号(SRS)的信道特性假设；

[0084] (g)指示所关联的干扰测量参考信号(IMR)的信道特性假设；

[0085] 向第二通信节点发送第三类信令。

[0086] 图1为本发明实施例提供的一种波束指示方法的示意图，应用于面向PDSCH和PDCCH的波束指示的场景下。首先，基站配置M个第一类集合，即配置一个包含M个配选的传输配置指示(TCI)状态集合，其中，其中每一个集合关联到非周期、半持续以及周期的CSI-RS和SSB，也就是说，每个集合管理到非周期、半持续以及周期的CSI-RS和SSB中的一个或组合，M个第一类集合携带在第一类信令中，第一类信令通过RRC发送给UE。其中，配选的TCI状态集合，也可以关联到非半持续以及周期的SRS资源。

[0087] 对于PDCCH而言，可以通过MAC-CE进行指示，而对于PDSCH而言，如果M>2^{Na}时，启用MAC-CE信令进行下选择，从M个配选TCI状态中，选择2^{Na}个TCI状态，并且建立2^{Na}和Na个比特的DCI指示字段进行关联，即第二类信令。

[0088] 最后，对于PDSCH，通过DCI进行波束指示，完成第三类信令的传输。

[0089] 其中，存在将PDCCH和PDSCH进行联合指示的方法，因为均涉及MAC-CE信令，而MAC-CE信令可以共享，其中被激活的第一个配选的TCI状态可以作为PDCCH的指示波束。

[0090] 需要说明的，对于PDSCH和PDCCH的波束指示，是通过对于其所关联的DMRS信号的QCL指示所实现的。即由TCI来携带参考的RS索引信息，而在最后的指示阶段，关联到所对应的PDSCH的DMRS信号上来。

[0091] 图2为本发明面向非周期的CSI-RS的波束指示实施例。首先，与PDCCH和PDSCH共享一个相同的备选TCI状态集合。首先，除了通过RRC信令配置的配选TCI状态外，RRC信令配置L个非周期的CSI-RS资源集合。然后，如果L大于等于2^{Nb}时，激活其中的$2^{Nb}-1$个状态，其中分别关联到对应的CSI-RS资源集合上来，其中每一个资源集合包含K_i个CSI-RS资源。进一步的，可以通过比特地图的方法，从L个非周期的CSI-RS资源集合上激活$2^{Nb}-1$个非周期CSI-RS资源。进一步的，比特地图中非零元素的个数可以隐式指示Nb的尺寸大小。其后，通过MAC-CE信令，将candidate TCI states和非周期的CSI-RS资源关联起来，用于支持最后的$2^{Nb}-1$

的非周期CSI-RS资源集合的DCI触发。

[0092] 另外，如果将第二类集合中的一个集合和/或指示第一类集合中的一个集合与上行参考信号索引联合编码，指示联合编码中的一个元素，或者，指示上行参考信号索引，用于如下至少之一或者组合：

[0093] (a)指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

[0094] (b)指示所关联的信道探测参考信号(SRS)的信道特性假设；

[0095] 然后，向第二通信节点发送携带上述信息的第四类信令；

[0096] 进一步的，所述的第四类信令的信道特征假设的约束条件，强于第三类信令的信道特征假设的约束条件。第四类信令的信道特征假设，是基于相同的空间滤波器，或者基于以下所有参数集合之一：多普勒扩展，多普勒平移，时延拓展，平均时延，平均增益和空间参数；或者，多普勒扩展，多普勒平移，时延拓展，平均时延和空间参数。而，第三类信令仅基于空间参数或者空间关系。

[0097] 进一步的，所述的上行参考信号，包括如下之一：信道探测参考信号SRS、物理随机接入信道信号PRACH、上行解调参考信号UL DMRS。

[0098] 具体而言，第三类信令，仅限制了基本的空间特征，例如上行参考信号和下行参考信号波束之间的相关度足够(而非完全相同的空间滤波器)，而第四类信令，是明确要求限制目标上行参考信号需要完全与原上行参考信号的发送模式一致，包括完全一致的空间滤波器。

[0099] 下面的实施例结合面向非周期的SRS的场景进行说明。

[0100] 如果指示所关联的(即目标参考信号)SRS为非周期SRS时，如果E>=2^{Nd}时，第一通信节点需要从E个SRS资源集合中选择$2^{Nd}-1$个SRS资源，与DCI指示字段关联，用于非周期SRS资源触发；如果E<2^{Nd}时，E个SRS资源，直接与DCI指示字段关联，用于非周期SRS资源触发。所述非周期SRS，是由E个SRS资源集合构成，其中第i个SRS资源集合下包含W_i个SRS资源，其中E、Nd和W_i为大于等于1的正整数。

[0101] 具体而言，可以使用比特地图，将E个SRS资源集合中选择$2^{Nd}-1$个SRS资源集合。

[0102] 图3为本发明对于非周期的SRS的信道状态信息的配置实施例。首先，RRC信令配置L_d个非周期的SRS资源集合，然后通过MAC-CE信令来进行对于其中$2^{Nd}-1$个状态进行激活，其中每个SRS资源集合中包含K_1个SRS资源。然后，通过配选的TCI状态或者上行UL-TCI状态来与SRS进行关联。这里，支持两种关联方法，第一种关联方法，通过QCL或者空间关联的方法进行规范，在这种情况下，仅对上行发送波束进行较粗的约束；第二种关联方法，通过SRI或CRI进行直接约束，在这种情况下，要求目标参考信号需要完全服从指示参考信号的滤波器或者完整的信道特征要求。最后，通过DCI信令，对于aperiodic SRS资源进行触发和指示。

[0103] 需要强调的是，仅当L_d大于等于Nd时，才需要使用MAC-CE信令进行下选择，否则可以省略该信令。但是，对于将目标参考信号和源参考信号(即备选的TCI)进行关联时，可以通过MAC-CE信令进行关联。

[0104] 其中备选的UL-TCI状态，可以被称为第三类集合，而第三类集合包括T个集合，其中第i个集合包含R_i个上行参考信号索引元素，其中T和R_i是大于等于1的整数。在仅考虑一个beam的条件下，所述第三类集合下的每一个集合内的索引元素的数目可以都仅为1个。

[0105] 总之,对于CSI-RS、SRS或者IMR为非周期参考信号,并且所述参考信号资源或者资源集合大于等于2^6时,可以通过比特地图,将Y个所述参考信号资源或者资源集合池中选择2^6-1个资源或者资源集合;然后,再将所选择的2^6-1个资源或者资源集合中的每一个集合,与所述第三类信令指定的第二类集合中的集合,或者与所述第三类信令指定的第一类集合中的集合,进行关联。

[0106] 下面的实施例结合如何解决一部分与beam reporting绑定的关系的场景进行说明。

[0107] 针对第一类和第二类集合或者集合中的元素,允许其与波束报告关联,根据波束报告的结果来更新指示集合或者集合中的元素。而后,第一通信节点在接收到所述的波束报告后,向第二通信节点发送确认信令,用于指示更新生效,其中更新生效时间,为所述确认信令发送后的X个slot,其中X是大于等于1的整数。

[0108] 与所述的第一类或者第二类集合中的一个集合或元素相关联的下行参考信号的信道特征假设进行更新;或者,激活与第一类或者第二类集合中的一个集合或元素相关联相的下行参考信号。这里,下行参考信号包括如下至少之一:CSI-RS,用于时频追踪的CSI-RS,或者TRS。

[0109] 图4为本发明对于与波束报告关联的波束指示实施例。首先,基站向UE配置了波束报告配置-T,并且将波束报告配置T与TCI状态a关联。进一步的,波束报告的配置,可以通过测量配置进而实现。在UE进行波束报告后,基站需要向UE发送确认信令。只有在确认信令生效后,才表明TCI状态a会和波束报告中的结果关联,例如最佳RSRP的beam。考虑UE的响应的花销,该关联只有在X个slot后生效,例如X的大小为4个slot。其中X的值,可以根据UE的能力进行确定。即,在X个slot后,如果基站进一步指示TCI-a,则与该报告关联的参考信号,将会成为原参考信号,用于波束指示。

[0110] 需要说明的是,因为UE上报存在一定的失败的可能,如果没有基站的确认信令,很可能出现双方的误判。例如,UE认为该信息已经被告知给基站,但是基站并没有收到。因此,基站的确认信令,即响应信息,将会显著提升TCI状态更新(即关联的原参考信号)的稳定性和可靠性。进一步的,承载确认信令的DCI,调度PDSCH;或者,UE不希望承载确认信令的DCI不关联或者不调度PDSCH。

[0111] 下面的实施例结合port index指示方法的场景进行说明。

[0112] 图5为本发明端口指示以实现CSI上报的实施例。基站指示终端根据一组port index的指示测量上报CSI,其中UE对port index指示的理解满足一定的特性,例如层间嵌套的特性,例如定义这样的规则:UE用于测量rank i的port组是rank j的port组的一个子集,i<j,如图5所述,这样信令只需要通知rank 8的端口顺序就可以了。

[0113] 具体而言,第一通信节点(基站)指示第二通信节点(UE)根据一组port index的指示测量上报CSI,其中UE对port index指示的理解满足特性要求。特征在于,所述的特性要求包括层间嵌套的特性。进一步的,所述的层间嵌套特性为用于测量rank i的port组是rank j的port组的一个子集,i<j,其中i和j为大于等于1的整数。

[0114] 综上所述,基于本发明实施例提供的技术方案,建立多层的波束指示架构和使用比特地图的方法,通过创建索引集合,激活部分索引集合(和指示特定的索引集合),实现对于下行数据信道、下行控制信道、下行参考信号、上行控制信道、上行数据信道和上行参考

信号的波束指示。其中,对于上行参考信号指示上,提出了两种不同约束强度的指示方法,即基于QCL假设或者强约束指示的方法,来区分的指示上行参考信号用于波束训练或者信道状态信息获取。

[0115] 基于与上述实施例相同或相似的构思,本发明实施例还提供一种参考信号信道特征配置方法,应用于第二通信节点,所述方法包括:

[0116] 第二通信节点接收第一通信节点发送的第一类信令;所述第一类信令携带有第一类集合,所述第一类集合包括多个索引元素;

[0117] 第二通信节点获取第一类信令携带的第一类集合。

[0118] 其中,所述索引元素包括如下信息中的一个或组合:

[0119] 索引元素序号、参考信号类型索引、参考信号资源配置索引、参考信号资源集合索引、参考信号资源索引、参考信号端口索引、资源块索引、资源块突发索引、资源块突发集合索引、测量限制窗口索引、时域窗索引、报告配置索引、波束分组索引、测量约束、配置约束、时间约束、触发信息、以及参考信号分组索引。

[0120] 所述参考信号包括如下之一或组合:同步信号块SS block、信道状态信息参考信号CSI-RS、信道探测参考信号SRS、物理随机接入信道信号PRACH、解调参考信号DMRS。

[0121] 第一类信令中携带的第一类集合的个数为M个;

[0122] 其中,其中第i个集合内部包含Ni个索引元素;M和Ni均是大于或等于1的整数。优选地,每一个第一类集合中包括的索引元素的数目均为1个。

[0123] 所述的第一类集合,为传输控制指示状态transmission configuration indication state,或备选的传输控制指示状态candidate transmission configuration indication state,或上行传输控制指示状态。

[0124] 其中,所述方法还包括:

[0125] 第二通信节点接收第一通信节点发送的用于指示重新配置第一类集合的相关重配信息;

[0126] 第二通信节点根据接收的重新配置第一类集合的相关重配信息,重新配置第一类集合;其中,所述重新配置第一类集包括如下操作的至少一项:

[0127] 向所述第一类集合中添加新的第一类集合;

[0128] 删除所述第一类集合中的指定集合;

[0129] 更新所述第一类集合中指定集合内的指定元素;

[0130] 删除所述第一类集合中指定集合内的指定元素;

[0131] 添加所述第一类集合中指定集合内的元素。

[0132] 本发明实施例中,所述方法还包括:

[0133] 第二通信节点接收第一通信节点发送的第二类信令;所述第二类信令携带有第二类集合指示信息,用于指示第二通信节点在第一类集合的基础上获取第二类集合;

[0134] 第二通信节点根据接收的第二类信令中携带的第二类集合指示信息,在第一类集合的基础上获取第二类集合;

[0135] 所述根据接收的第二类信令中携带的第二类集合指示信息,在第一类集合的基础上获取第二类集合包括如下方式的至少一种:

[0136] 激活第一类集合中的部分集合,通过激活的第一类集合构成第二类集合;

[0137] 组合第一类集合中的部分或全部集合，构成第二类集合；

[0138] 组合第一类集合中集合内的元素，构成第二类集合。

[0139] 其中，获取的第二类集合的个数为S，第i个第二类集合内包含ki个索引元素；其中，S和ki均是大于或等于1的整数；

[0140] 本发明实施例中，所述的方法还包括：

[0141] 第二通信节点接收第一通信节点发送的比特地图；

[0142] 第二通信节点根据接收的比特地图携带的指示信息，获取第二类集合，其中，比特地图携带的指示信息用于指示第一类集合中的集合或者元素来构成第二类集合。

[0143] 其中，第一类集合中的集合或者集合中的元素，与比特地图中的每个比特相对应；

[0144] 若比特位置为特定数值时，激活对应的集合或元素，组合或者选择所述比特位置来关联集合，或者激活，组合或者选择所述比特位置关联集合中的元素。

[0145] 其中，通过比特地图选择出的集合或者元素，按照比特地图中顺序依次编码，用于指示第二类集合中的集合或者集合中的元素。

[0146] 其中，第二类集合中X1个集合被显式指示，而L-X1个集合使用比特地图进行指示。

[0147] 其中，X1和L是大于等于1的整数；L为第二类信令中携带的第二类集合的个数，X1为小于L的整数。

[0148] 本发明实施例中，所述方法还包括：

[0149] 第二通信节点接收第一通信节点发送的第三类信令；所述第三类信令携带有第三类指示信息，用于指示第二通信节点在第一类集合或第二类集合的范围中指定其中的一个集合；

[0150] 第二通信节点根据第三类指示信息，确定第一类集合或第二类集合的范围中的一个集合指示如下内容中的至少一个：

[0151] 内容1、指示所关联的下行解调参考信号的信道特性假设；

[0152] 内容2、指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

[0153] 内容3、指示所关联的物理上行控制信道PUCCH，或者指示所关联的物理上行控制信道PUCCH的所关联的层layer；

[0154] 内容4、指示所关联的物理上行共享信道PUSCH，或者指示所关联的物理上行共享信道PUSCH的所关联的layer；

[0155] 内容5、指示所关联的信道状态信息参考信号CSI-RS的信道特性假设；

[0156] 内容6、指示所关联的信道探测参考信号SRS的信道特性假设；

[0157] 内容7、指示所关联的干扰测量参考信号IMR的信道特性假设。

[0158] 本发明实施例中，所述方法还包括：

[0159] 第二通信节点接收第一通信节点发送的第三类集合；

[0160] 其中，第三类集合包括T个集合，其中第i个集合包含Ri个上行参考信号索引元素；T和Ri是大于等于1的整数。

[0161] 本发明实施例中，所述方法还包括：

[0162] 第二通信节点接收第一通信节点发送的第四类信令，所述第四类信令携带有第四类集合指示信息，用于指示第二通信节点在第一类集合、或第二类集合、或者第三类集合的

范围中指定其中的一个集合；

[0163] 第二通信节点根据第三类指示信息，确定第一类集合、或第二类集合、或者第三类集合的一个集合指示如下内容中的至少一个：

[0164] 指示所关联的上行解调参考信号；

[0165] 指示所关联的上行解调参考信号的信道特性假设；

[0166] 指示所关联的信道探测参考信号SRS；

[0167] 指示所关联的信道探测参考信号SRS的信道特性假设。

[0168] 其中，所述第四类信令的信道特征假设，是基于相同的空间滤波器，或者基于相同的天线端口假设，或者基于以下所有参数集合之一或组合：

[0169] 多普勒扩展，多普勒平移，时延拓展，平均时延，平均增益和空间参数；

[0170] 或者，多普勒扩展，多普勒平移，时延拓展，平均时延和空间参数。

[0171] 其中，所述上行参考信号包括如下信号之一：信道探测参考信号SRS、物理随机接入信道信号PRACH、上行解调参考信号UL DMRS。

[0172] 其中，所述的上行解调参考信号，为物理上行控制信道PUCCH所关联的上行解调参考信号，或物理上行共享信道PUSCH所关联的上行解调参考信号。

[0173] 其中，所述的第四类信令的信道特征假设的约束条件，强于所述第三类信令的信道特征假设的约束条件。

[0174] 所述方法还包括：

[0175] 第二通信节点接收第一通信节点发送的第五类信令，第五类信令用于指示将第二类集合中的一个集合，和/或第一类集合中的一个集合，与第二通信节点的波束报告中关联，根据波束报告结果更新所指示的集合或者集合中的元素；

[0176] 第二通信节点根据接收到的第五类信令，将第二类集合中的一个集合，和/或第一类集合中的一个集合，与本节点的波束报告关联，以及，根据波束报告结果更新所指示的集合或者集合中的元素。

[0177] 所述方法还包括：

[0178] 第二通信节点向第一通信节点发送波束报告；

[0179] 第二通信节点接收第一通信节点发送的关于上述波束报告的确认信令；

[0180] 本发明实施例中，第一通信节点更新生效时间，为所述确认信令发送后的X个slot，其中X是大于等于1的整数。

[0181] 所述方法还包括：

[0182] 第二通信节点向第一通信节点发送链路重配置请求信令；

[0183] 第二通信节点接收第一通信节点发送的链路重配置请求信令的确认响应；

[0184] 第二通信节点在接收所述确认响应之后，执行如下方式的至少一种：

[0185] 将第一类集合下约定的集合，或者第二类集合下约定的集合，更新为第一通信节点发送链路重配置请求信令所指示的下行参考信号所对应的参考信号索引；或，

[0186] 确定接收的PDSCH的DMRS与下行参考信号满足信道特征假设；其中，所述下行参考信号为第一通信节点发送链路重配置请求信令所指示的下行参考信号；

[0187] 确定要发送的PUCCH与上行参考信号满足信道特征假设；其中，所述上行参考信号为第一通信节点发送链路重配置请求信令所指示的上行参考信号；

[0188]　确定要发送的PUCCH与请求信令所使用的PUCCH的信道特征假设相同；其中，请求信令所使用的PUCCH为第一通信节点发送链路重配置请求信令所使用的PUCCH。

[0189]　其中，链路重配置请求信令也称为：波束恢复请求信令。

[0190]　优选地，本发明实施例中，第一通信节点为基站，第二通信节点为UE。

[0191]　基于与上述实施例相同或相似的构思，本发明实施例还提供一种参考信号信道特征配置装置，设置在通信设备上，优选地所述通信设备为基站，所述装置包括：

[0192]　信令确定单元，用于确定第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；

[0193]　信令发送单元，用于向第二通信节点发送第一类信令。

[0194]　本发明实施例中，所述索引元素包括如下信息中的一个或组合：

[0195]　索引元素序号、参考信号类型索引、参考信号资源配置索引、参考信号资源集合索引、参考信号资源索引、参考信号端口索引、资源块索引、资源块突发索引、资源块突发集合索引、测量限制窗口索引、时域窗索引、报告配置索引、波束分组索引、测量约束、配置约束、时间约束、触发信息、以及参考信号分组索引。

[0196]　本发明实施例中，所述参考信号包括如下之一或组合：同步信号块SSblock、信道状态信息参考信号CSI-RS、信道探测参考信号SRS、物理随机接入信道信号PRACH、解调参考信号DMRS。

[0197]　本发明实施例中，所述第一类信令中携带的第一类集合的个数为M个；

[0198]　其中，其中第i个集合内部包含Ni个索引元素；M和Ni均是大于或等于1的整数。

[0199]　本发明实施例中，每一个第一类集合中包括的索引元素的数目均为1个。

[0200]　本发明实施例中，所述的第一类集合，为传输控制指示状态transmission configuration indication state，或备选的传输控制指示状态candidate transmission configuration indication state，或上行传输控制指示状态。

[0201]　本发明实施例中，所述信令确定单元还用于：在向第二通信节点发送第一类信令之后，

[0202]　重新配置第一类集合；

[0203]　将新配置的第一类集合携带在第一类信令中发送给第二通信节点；或，将重新配置第一类集合的相关重配信息发送给第二通信节点；

[0204]　所述重新配置第一类集合包括如下操作的至少一项：

[0205]　向所述第一类集合中添加新的第一类集合；

[0206]　删除所述第一类集合中的指定集合；

[0207]　更新所述第一类集合中指定集合内的指定元素；

[0208]　删除所述第一类集合中指定集合内的指定元素；

[0209]　添加所述第一类集合中指定集合内的元素。

[0210]　本发明实施例中，所述信令确定单元还用于在向第二通信节点发送第一类信令之后，确定第二类信令，所述第二类信令携带有第二类集合指示信息，用于指示第二通信节点在第一类集合的基础上获取第二类集合；

[0211]　所述信令发送单元还用于向第二通信节点发送第二类信令；

[0212]　所述第二类集合指示信息用于指示如下内容中的至少一个：

[0213]　激活第一类集合中的部分集合，激活的第一类集合构成第二类集合；

[0214]　组合第一类集合中的部分或全部集合，构成第二类集合；

[0215]　组合第一类集合中集合内的元素，构成第二类集合。

[0216]　本发明实施例中，获取的第二类集合的个数为S，第i个第二类集合内包含ki个索引元素；

[0217]　其中，S和ki均是大于或等于1的整数；

[0218]　本发明实施例中，所述信令确定单元还用于使用比特地图，指示第一类集合中的集合或者元素来构成第二类集合。

[0219]　本发明实施例中，第一类集合中的集合或者集合中的元素，与比特地图中的每个比特相对应；

[0220]　若比特位置为特定数值时，表示激活，组合或者选择所述比特位置关联集合，或者激活，组合或者选择所述比特位置关联集合中的元素。

[0221]　本发明实施例中，通过比特地图选择出的集合或者元素，按照比特地图中顺序依次编码，用于指示第二类集合中的集合或者集合中的元素。

[0222]　本发明实施例中，第二类集合中X1个集合被显式指示，而L-X1个集合使用比特地图进行指示。

[0223]　其中，X1和L是大于等于1的整数；L为第二类信令中携带的第二类集合的个数，X1为小于L的整数。

[0224]　本发明实施例中，所述信令确定单元还用于确定第三类信令，所述第三类信令携带有第三类指示信息，用于指示第二通信节点在第一类集合或第二类集合的范围中指定其中的一个集合；

[0225]　所述信令发送单元还用于向第二通信节点发送第三类信令；

[0226]　所述第三类指示信息用于指示如下内容中的至少一个：

[0227]　内容1、指示所关联的下行解调参考信号的信道特性假设；

[0228]　内容2、指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

[0229]　内容3、指示所关联的物理上行控制信道PUCCH，或者指示所关联的物理上行控制信道PUCCH的所关联的层layer；

[0230]　内容4、指示所关联的物理上行共享信道PUSCH，或者指示所关联的物理上行共享信道PUSCH的所关联的layer；

[0231]　内容5、指示所关联的信道状态信息参考信号CSI-RS的信道特性假设；

[0232]　内容6、指示所关联的信道探测参考信号SRS的信道特性假设；

[0233]　内容7、指示所关联的干扰测量参考信号IMR的信道特性假设。

[0234]　本发明实施例中，所述装置还包括：

[0235]　所述信令确定单元还用于确定第三类集合；

[0236]　所述信令发送单元还用于向第二通信节点发送第三类集合；

[0237]　其中，第三类集合包括T个集合，其中第i个集合包含Ri个上行参考信号索引元素；T和Ri是大于等于1的整数。

[0238]　本发明实施例中，所述信令确定单元还用于确定第四类信令，所述第四类信令携

带有第四类集合指示信息，用于指示第二通信节点在第一类集合、或第二类集合、或者第三类集合的范围中指定其中的一个集合；

[0239] 所述信令发送单元还用于向第二通信节点发送第四类信令；

[0240] 所述第四类指示信息用于指示如下内容中的至少一个；

[0241] 指示所关联的上行解调参考信号，或者指示所关联的上行解调参考信号的信道特性假设；

[0242] 指示所关联的信道探测参考信号SRS，或者指示所关联的信道探测参考信号SRS的信道特性假设。

[0243] 本发明实施例中，所述第四类信令的信道特征假设，是基于相同的空间滤波器，或者基于相同的天线端口假设，或者基于以下所有参数集合之一或组合：

[0244] 多普勒扩展，多普勒平移，时延拓展，平均时延，平均增益和空间参数；

[0245] 或者，多普勒扩展，多普勒平移，时延拓展，平均时延和空间参数。

[0246] 本发明实施例中，所述上行参考信号包括如下信号之一：信道探测参考信号SRS、物理随机接入信道信号PRACH、上行解调参考信号UL DMRS。

[0247] 本发明实施例中，所述的上行解调参考信号，为物理上行控制信道PUCCH所关联的上行解调参考信号，或物理上行共享信道PUSCH所关联的上行解调参考信号。

[0248] 本发明实施例中，所述的第四类信令的信道特征假设的约束条件，强于所述第三类信令的信道特征假设的约束条件。

[0249] 本发明实施例中，在$E>=2^{Nd}$时，所述信令确定单元还用于从E个SRS资源集合中选择$2^{Nd}-1$个SRS资源，与DCI指示字段关联，用于非周期SRS资源触发；在$E<2^{Nd}$时，将E个SRS资源，直接与DCI指示字段关联，用于非周期SRS资源触发；

[0250] 其中E、Nd和Wi为大于等于1的正整数。

[0251] 本发明实施例中，使用比特地图，从E个SRS资源集合中选择$2^{Nd}-1$个SRS资源集合。

[0252] 本发明实施例中，所述第三类集合下的每一个集合内的索引元素的数目可以都仅为1个。

[0253] 本发明实施例中，所述CSI-RS、SRS或者IMR为非周期参考信号，

[0254] 所述信令确定单元还用于在所述参考信号资源或者资源集合大于等于2^G时，

[0255] 将Y个所述参考信号资源或者资源集合池中选择2^G-1个资源或者资源集合；

[0256] 再将所选择的2^G-1个资源或者资源集合中的每一个集合，与所述第三类信令指定的第二类集合中的集合，或者与所述第三类信令指定的第一类集合中的集合，进行关联，用于指示所选择的资源或者资源集合的信道特征假设。

[0257] 本发明实施例中，所述的信道特征假设，包括如下之一或者组合：准共址，多普勒扩展，多普勒平移，时延拓展，平均时延，平均增益，空间接收参数，空间关系和空间参数。

[0258] 本发明实施例中，根据准则，所述的第二类集合中的约定集合，用于指示所关联的物理上行控制信道(PUCCH)，或者用于指示所关联的物理上行控制信道(PUCCH)的解调参考信号的信道特性假设；

[0259] 本发明实施例中，所述的准则是指如下至少之一：

[0260] 准则1、最低序号的集合；

[0261] 准则2、最高序号的集合；

[0262] 准则3、第一通信节点配置序号，则确定所述序号下的集合；

[0263] 本发明实施例中，所述信令确定单元还用于生成第五类信令，将第二类集合中的一个集合，和/或第一类集合中的一个集合，与第二通信节点的波束报告中关联，根据波束报告结果更新所指示的集合或者集合中的元素。

[0264] 本发明实施例中，所述信令确定单元还用于在用户在收到确认信令之后，更新生效时间，为所述确认信令发送后的X个slot，其中X是大于等于1的整数。

[0265] 本发明实施例中，所述信令确定单元还用于：

[0266] 对与所述的第一类或者第二类集合中的一个集合或元素相关联的下行参考信号的信道特征假设进行更新；

[0267] 或者，激活与第一类或者第二类集合中的一个集合或元素相关联相的下行参考信号。

[0268] 本发明实施例中，所述的下行参考信号包括如下至少之一：

[0269] CSI-RS，用于时频追踪的CSI-RS，或者TRS。

[0270] 本发明实施例中，向第二通信节点发送的确认信息需要特征有如下至少之一：

[0271] 承载确认信令的DCI，调度PDSCH；

[0272] UE不希望承载确认信令的DCI不关联或者不调度PDSCH；

[0273] 本发明实施例中，第一通信节点指示第二通信节点根据一组port index的指示测量上报CSI，其中UE对port index指示的理解满足特性要求。

[0274] 本发明实施例中，所述的特性要求包括层间嵌套的特性。

[0275] 本发明实施例中，所述的层间嵌套特性为：

[0276] 用于测量rank i的port组是rank j的port组的一个子集，i<j，

[0277] 其中i和j为大于等于1的整数。

[0278] 基于与上述实施例相同或相似的构思，本发明实施例还提供一种参考信号信道特征配置装置，设置在通信设备上，优选地所述通信设备为UE，

[0279] 所述装置包括：

[0280] 信令接收单元，用于接收第一通信节点发送的第一类信令；所述第一类信令携带有第一类集合，所述第一类集合包括多个索引元素；

[0281] 集合获取单元，用于保存所述第一类集合。

[0282] 本发明实施例中，所述信令接收单元还用于接收第一通信节点发送的第二类信令；所述第二类信令携带有第二类集合指示信息，用于指示第二通信节点在第一类集合的基础上获取第二类集合；

[0283] 所述集合获取单元，根据接收的第二类信令中携带的第二类集合指示信息，在第一类集合的基础上获取第二类集合；

[0284] 所述根据接收的第二类信令中携带的第二类集合指示信息，在第一类集合的基础上获取第二类集合包括如下方式的至少一种：

[0285] 激活第一类集合中的部分集合，通过激活的第一类集合构成第二类集合；

[0286] 组合第一类集合中的部分或全部集合，构成第二类集合；

[0287] 组合第一类集合中集合内的元素，构成第二类集合。

[0288] 本发明实施例中，UE接收第一通信节点发送的链路重配置请求信令的确认响应；

[0289] 在接收所述确认响应之后，执行如下方式的至少一种：

[0290] 将第一类集合下约定的集合，或者第二类集合下约定的集合，更新为第一通信节点发送链路重配置请求信令所指示的下行参考信号所对应的参考信号索引；

[0291] 确定接收的PDSCH的DMRS与下行参考信号满足信道特征假设；其中，所述下行参考信号为第一通信节点发送链路重配置请求信令所指示的下行参考信号；

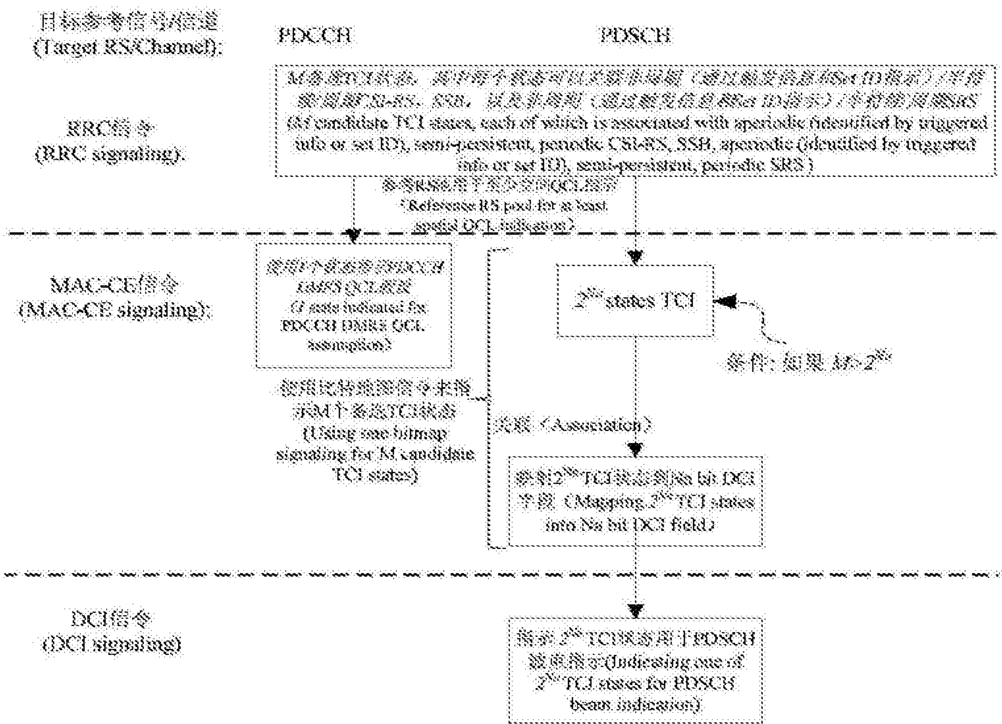
[0292] 确定要发送的PUCCH与上行参考信号满足信道特征假设；其中，所述上行参考信号为第一通信节点发送链路重配置请求信令所指示的上行参考信号；

[0293] 确定要发送的PUCCH与请求信令所使用的PUCCH的信道特征假设相同；其中，请求信令所使用的PUCCH为第一通信节点发送链路重配置请求信令所使用的PUCCH。

[0294] 基于与上述实施例相同或相似的构思，本发明实施例还提供一种终端，包括存储器、处理器及存储在所述存储器上并可在所述处理器上运行的计算机程序，其特征在于，所述处理器执行所述计算机程序时实现本发明实施例提供的任一参考信号信道特征配置方法的处理。

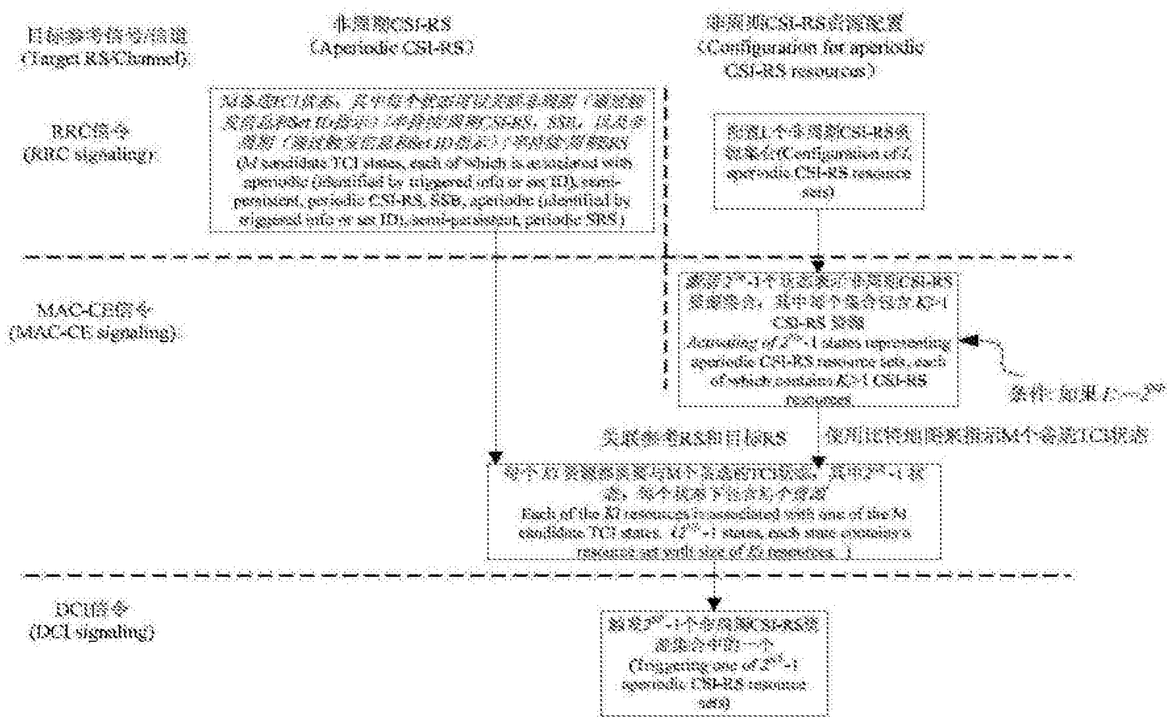
[0295] 基于与上述实施例相同或相似的构思，本发明实施例还提供一种通信设备，所述通信设备包括本发明实施例提供的任一参考信号信道特征配置装置。

[0296] 需要说明的是，以上所述的实施例仅是为了便于本领域的技术人员理解而已，并不用于限制本发明的保护范围，在不脱离本发明的发明构思的前提下，本领域技术人员对本发明所做出的任何显而易见的替换和改进等均在本发明的保护范围之内。



(Target RS/Channel):
PDCCH
PDSCH
RRC信令
(RRC signaling):
(M candidate TCI states, each of which is associated with aperiodic (identified by triggered info or set ID), semi-persistent, periodic CSI-RS, SSB, aperiodic (identified by triggered info or set ID), semi-persistent, periodic SRS)
(Reference RS pool for at least spatial QCL indication)
MAC-CE信令
(MAC-CE signaling):
PDCCH DMRS QCL assumption)
states TCI
关联（Association）
(Using one bitmap signaling for M candidate TCI states)
into Na bit DCI field)
DCI信令
(DCI signaling)
TCI states for PDSCH beam indication)

图1



(Target RS/Channel):
非周期CSI-RS
(Aperiodic CSI-RS)
(Configuration for aperiodic CSI-RS resources)
RRC信令
(RRC signaling):
aperiodic CSI-RS resource sets)
MAC-CE信令
(MAC-CE signaling):
aperiodic CSI-RS resource sets, each of which contains CSI-RS resources
Each of the resources is associated with one of the M candidate TCI states.
DCI信令
(DCI signaling)
aperiodic CSI-RS resource sets)

图2

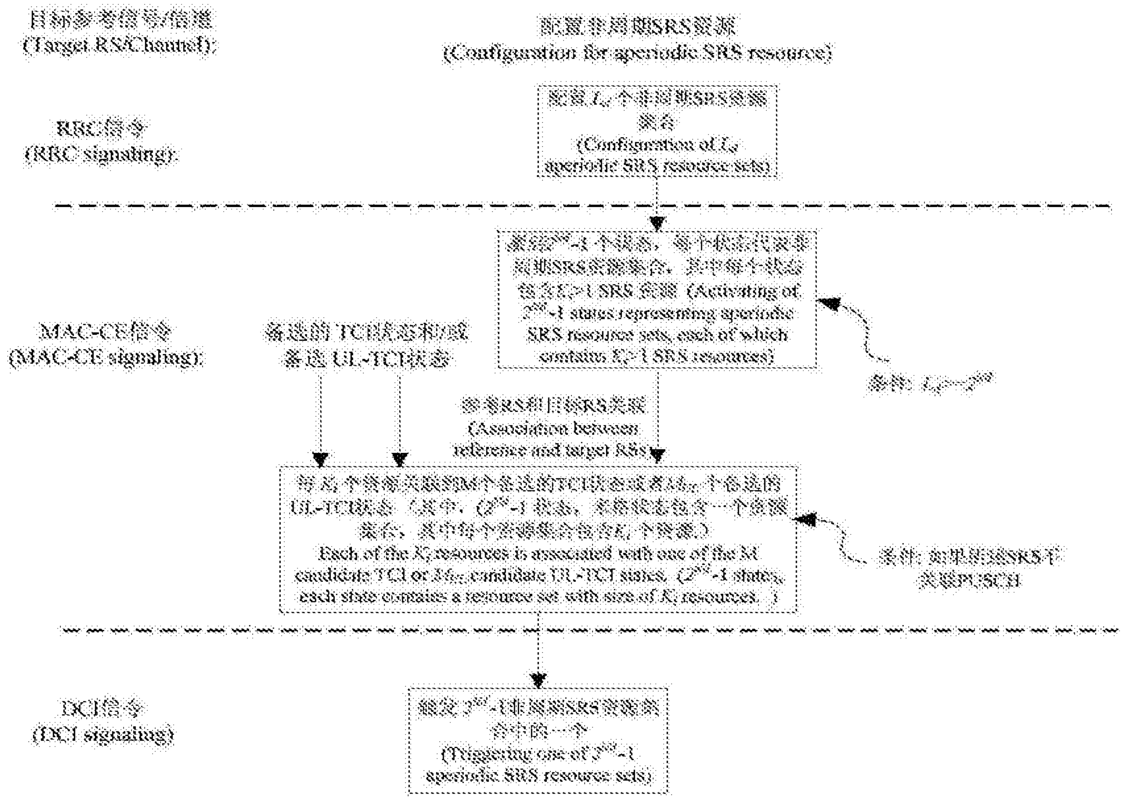

目标参考信号/信道
(Target RS/Channel):
配置非周期SRS资源
(Configuration for aperiodic SRS resource)
RRC信令
(RRC signaling):
(Configuration of L_a
aperiodic SRS resource sets)
(Activating of
2^{N_B}-1 states representing aperiodic
SRS resource sets, each of which
contains K_i>1 SRS resources)
MAC-CE信令
(MAC-CE signaling):
备选的 TCI状态和/或
备选 UL-TCI状态
参考RS和目标RS关联
(Association between
reference and target RSs)
Each of the K_i resources is associated with one of the M
candidate TCI or M_{UL} candidate UL-TCI states. (2^{N_B}-1 states,
each state contains a resource set with size of K_i resources.)
DCI信令
(DCI signaling)
(Triggering one of 2^{N_B}-1
aperiodic SRS resource sets)

图3

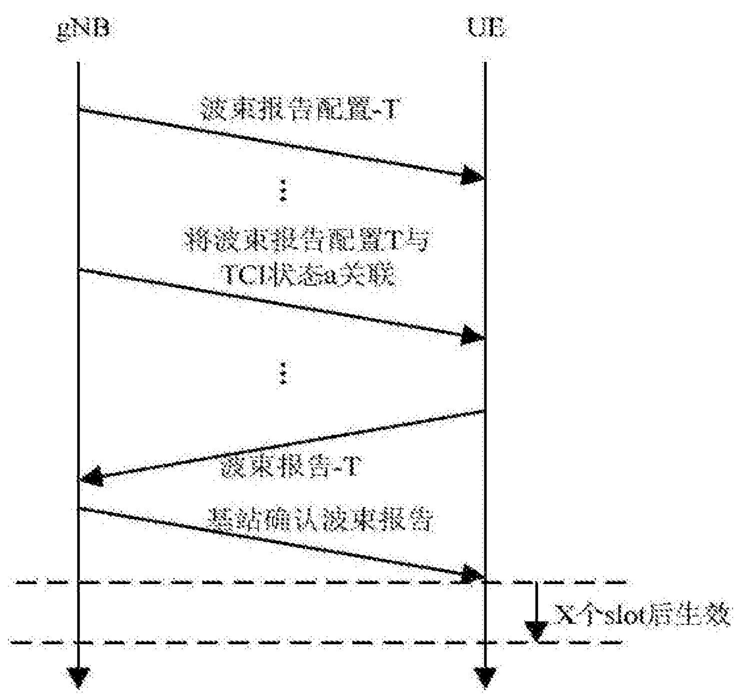

gNB
UE
波束报告配置-T
将波束报告配置T与
TCI状态a关联
波束报告-T
基站确认波束报告
X个slot后生效

图4

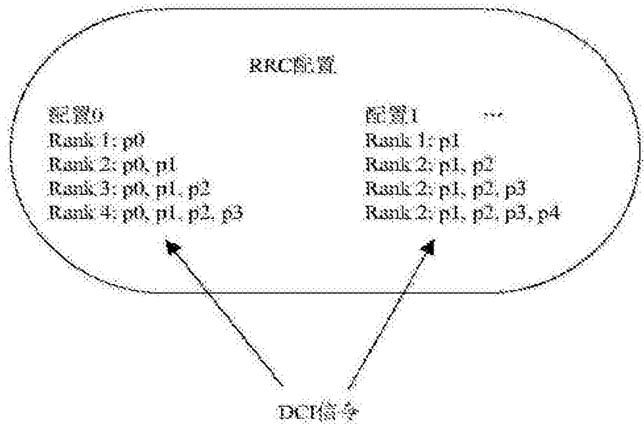

RRC配置
配置0
Rank 1: p0
Rank 2: p0, p1
Rank 3: p0, p1, p2
Rank 4: p0, p1, p2, p3
配置1
…
Rank 1: p1
Rank 2: p1, p2
Rank 2: p1, p2, p3
Rank 2: p1, p2, p3, p4
DCI信令

图5

OAV

(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

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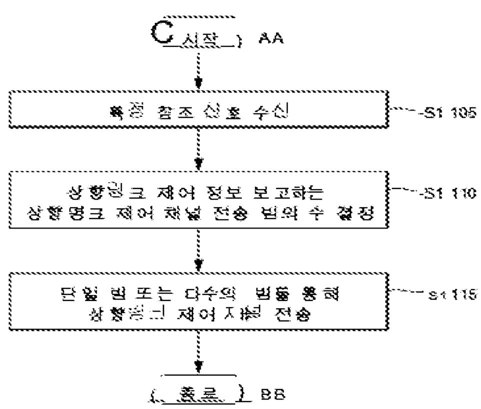
(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD,

(54) Title: METHOD FOR TRANSMITTING/RECEIVING UPLINK CHANNEL IN WIRELESS COMMUNICATION SYSTEM, AND DEVICE THEREFOR

(54) 발명의 명칭: 무선 통신 시스템에서 상향링크 채널을 송수신하는 방법 및 이를 위한 장치



S1105 ... Receive specific reference signal
S1110 ... Determine number of beams for transmitting uplink control channel for reporting uplink control information
S1115 ... Transmit uplink control channel via single beam or plurality of beams
AA ... Start
BB ... End

(57) Abstract: Disclosed are a method for transmitting/receiving an uplink channel in a wireless communication system, and a device therefor. Specifically, a method for a terminal transmitting an uplink channel comprises the steps of: receiving a specific reference signal (CSI-RS) from a base station; determining the number of beams for transmitting an uplink control channel for reporting uplink control information generated on the basis of the CSI-RS; and transmitting the uplink control channel to the base station via a single beam or a plurality of beams according to the determined number of beams, wherein the number of beams may be determined on the basis of at least one among measurement information by a downlink reference signal received from the base station, or the type of the uplink control information.

(57) 요약서: 본 발명에서는 무선 통신 시스템에서 상향링크 채널을 송수신하는 방법 및 이를 위한 장치가 개시된다. 구체적으로, 단말이 상향링크 채널을 전송하는 방법은, 기지국으로부터 특정 참조 신호(specific reference signal, CSI-RS)를 수신하는 과정과, 상기 특정 참조 신호에 기반하여 생성된 상향링크 제어 정보(uplink control information)를 보고(report)하는 상향링크 제어 채널(uplink control channel)을 전송할 빔의 수를 결정하는 과정과, 상기 결정된 빔의 수에 따라, 단일 빔(single beam) 또는 다수의 빔들(a plurality of beams)을 통해, 상기 기지국으로 상기 상향링크 제어 채널을 전송하는 과정을 포함하며, 상기 빔의 수는, 상기 기지국으로부터 수신된 하향링크 참조 신호(downlink reference signal)에 의한 측정 정보 또는 상기 상향링크 제어 정보의 유형(type) 중 적어도 하나에 기반하여 결정될 수 있다.

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[다음 쪽 계속]

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(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

공개:

– 국제조사보고서와 함께 (조약 제21조(3))

명세서

발명의 명칭: 무선 통신 시스템에서 상향링크 채널을 송수신하는 방법 및 이를 위한 장치

기술분야

[1] 본 발명은 무선 통신 시스템에 관한 것으로서, 보다 상세하게 하나 이상의 빔(beam) 들을 통해 상향링크 채널을 송수신하기 위한 방법 및 이를 지원하는 장치에 관한 것이다.

배경기술

[2] 이동 통신 시스템은 사용자의 활동성을 보장하면서 음성 서비스를 제공하기 위해 개발되었다. 그러나 이동통신 시스템은 음성뿐 아니라 데이터 서비스까지 영역을 확장하였으며, 현재에는 폭발적인 트래픽의 증가로 인하여 자원의 부족 현상이 야기되고 사용자들이 보다 고속의 서비스를 요구하므로, 보다 발전된 이동 통신 시스템이 요구되고 있다.

[3] 차세대 이동 통신 시스템의 요구 조건은 크게 폭발적인 데이터 트래픽의 수용, 사용자 당 전송률의 획기적인 증가, 대폭 증가된 연결 디바이스 개수의 수용, 매우 낮은 단대단 지연(End-to-End Latency), 고에너지 효율을 지원할 수 있어야 한다. 이를 위하여 이중 연결성(Dual Connectivity), 대규모 다중 입출력(Massive MIMO: Massive Multiple Input Multiple Output), 전이중(In-band Full Duplex), 비직교 다중접속(NOMA: Non-Orthogonal Multiple Access), 초광대역(Super wideband) 지원, 단말 네트워킹(Device Networking) 등 다양한 기술들이 연구되고 있다.

발명의 상세한 설명

기술적 과제

[4] 본 명세서는, 무선 통신 시스템에서 상향링크 채널(uplink channel) 을 송수신하는 방법을 제안한다.

[5] 구체적으로, 본 명세서는, 단말이 하나 또는 그 이상의 빔들을 이용하여 상향링크 채널을 전송하는 방법을 제안한다.

[6] 또한, 본 명세서는, 상향링크 제어 채널의 참조 신호(reference signal) 에 기반하여 빔 조정(beam refinement) 을 수행하는 방법을 제안한다.

[7] 또한, 본 명세서는, 다른 상향링크 채널 전송을 위한 빔 지시 정보(beam indication information) 를 이용하여 상향링크 제어 채널의 전송 빔을 설정하는 방법을 제안한다.

[8] 본 발명에서 이루고자 하는 기술적 과제들은 이상에서 언급한 기술적 과제들로 제한되지 않으며, 언급하지 않은 또 다른 기술적 과제들은 아래의 기재로부터 본 발명이 속하는 기술분야에서 통상의 지식을 가진 자에게 명확하게 이해될 수 있을 것이다.

과제 해결 수단

[9] 본 발명의 실시 예에 따른 무선 통신 시스템에서 단말이 상향링 크 채널(uplink channel) 을 전송하는 방법에 있어서, 상기 방법은, 기지국으로부터 특정 참조 신호(Channel State Information-Reference Signal, CSI-RS) 를 수신하는 과정과, 상기 특정 참조 신호에 기반하여 생성된 상 향링크 제어 정보(uplink control information) 를 보고(report) 하는 상 향 링크 제어 채널(uplink control channel) 을 전송할 빔의 수를 결정하는 과정과, 상기 결정된 빔의 수에 따라, 단일 빔(single beam) 또는 다수의 빔들(a plurality of beams) 을 통해, 상기 기지국으로 상기 상향링 크 제어 채널을 전송하 는 과정을 포함하며, 상기 빔의 수는, 상기 기지국으로부터 수신된 하향링크 참조 신호(downlink reference signal) 에 의한 측정 정보 또는 상기 상 향링크 제어 정보의 유형(type) 중 적어도 하나에 기반하여 결정된다.

[10] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 측정 정보가 나타내 는 값이 미리 설정된 임계 값보다 작은 경우, 상기 상향링 크 제어 채널은 상기 다수의 빔들을 통해 전송될 수 있다.

[11] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 미리 설정된 임계 값은, 상기 다수의 빔들의 빔의 수에 따라 다르게 설정될 수 있다.

[12] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 하향링 크 참조 신호는, CSI-RS 를 포함하고, 상기 측정 정보는, 채널 품질 지시자(channel quality indicator), 수신 전력(received power) 정보, 또는 수신 품질(received quality) 정보 중 적어도 하나를 포함할 수 있다.

[13] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 상향링 크 제어 정보가 랭크 지시자(rank indicator) 또는 빔 인덱스(beam index) 중 적어도 하나를 나타내는 정보를 포함하는 경우, 상기 상 향링크 제어 채널은 상기 다수의 빔들을 통해 전송될 수 있다.

[14] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 단말이 상기 다수의 빔들을 통해 상기 상향링 크 제어 채널을 전송하는 경우, 상기 다수의 빔들은, 이전 시점의 상 향링크 제어 정보 보고에 이용된 특정 빔을 포함하고, 상기 특정 빔은, 상기 상 향링크 제어 채널 전송을 위해 설정된 자원(resource) 들 중 미리 설정된 특정 자원에 할당될 수 있다.

[15] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 단말이 상기 다수의 빔들을 통해 상기 상향링 크 제어 채널을 전송하는 경우, 상기 다수의 빔들은 미리 설정된 다수의 빔 집합(beam set)들 중 하나에 속할 수 있다.

[16] 또한, 본 발명의 실시 예에 따른 상기 방법은, 상기 기지국으로부터, 상기 다수의 빔들의 적용 여부를 나타내 는 정보, 상기 빔의 수를 나타내 는 정보, 또는 상기 상향링 크 제어 채널의 전송에 이용될 적어도 하나의 빔의 인덱스(index) 를 나타내는 정보 중 적어도 하나를 수신하는 과정을 포함할 수 있다.

[17] 또한, 본 발명의 실시 예에 따른 상기 방법은, 상기 기지국으로부터, 상기 상향링크 제어 채널의 전송과 관련된 빔 설정 정보(beam configuration information) 를 수신하는 과정을 더 포함하고, 상기 빔 설정 정보는, 상기 단일 빔을 위한 제1 빔 설정 정보 및 상기 다수의 빔을 위한 제2 빔 설정 정보를 포함하며, 상기 제1 빔 설정 정보 및 상기 제2 빔 설정 정보 각각은, 상기 상향링크 제어 채널의 전송과 관련된 자원 정보(resource information), 시간 오프셋 정보(time offset information), 또는 주기 정보(period information) 중 적어도 하나를 포함할 수 있다.

[18] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 단말은, 주기적(periodic) 또는 반-지속적(semi-persistent) 으로 상향링크 제어 정보를 보고하도록 설정될 수 있다.

[19] 또한, 본 발명의 실시 예에 따른 상기 방법은, 상기 단말이, 상기 기지국으로부터, 상향링크 공유 채널(uplink shared channel) 또는 하향링크 공유 채널(downlink shared channel) 을 위한 빔 지시 정보를 수신하는 경우, 상기 빔 지시 정보가 나타내는 빔을 이용하여 후속(subsequent) 채널 상태 정보를 보고하는 상향링크 제어 채널을 후속 보고 시점에서 전송하는 과정을 더 포함할 수 있다.

[20] 또한, 본 발명의 실시 예에 따른 상기 방법은, 상기 단말이 상기 다수의 빔들을 통해 상기 상향링크 제어 채널을 전송하는 경우, 상기 기지국으로부터 상기 다수의 빔들과 관련된 신호 품질 정보(signal quality information) 를 수신하는 과정과, 상기 수신된 신호 품질 정보에 기반하여 선택된 적어도 하나의 특정 빔을 통해 후속 상향링크 채널을 전송하는 과정을 더 포함할 수 있다.

[21] 또한, 본 발명의 실시 예에 따른 상기 방법에 있어서, 상기 신호 품질 정보는, 상기 상향링크 제어 채널의 복조(demodulation) 를 위해 이용되는 참조 신호(reference signal) 에 의해 측정된 각 빔 별 신호 품질에 기반하여 결정되며, 상기 신호 품질 정보는, 상기 참조 신호의 자원 인덱스 정보(resource index information) 또는 상기 참조 신호에 대한 수신 품질 정보(received quality information) 중 적어도 하나를 포함할 수 있다.

[22] 또한, 본 발명의 실시 예에 따른 상기 방법은, 상기 기지국으로, 상기 상향링크 제어 채널의 전송을 위한 상기 다수의 빔의 적용 여부 또는 상기 빔의 수 중 적어도 하나에 대한 정보를 전송하는 과정을 더 포함할 수 있다.

[23] 본 발명의 실시 예에 따른 무선 통신 시스템에서 상향링크 채널(uplink channel) 을 전송하는 단말에 있어서, 상기 단말은, 무선 신호를 송수신하기 위한 RF(Radio Frequency) 유닛과, 상기 RF 유닛과 기능적으로 연결되어 있는 프로세서를 포함하고, 상기 프로세서는, 기지국으로부터 특정 참조 신호(specific reference signal) 를 수신하고, 상기 특정 참조 신호에 기반하여 생성된 채널 상태 정보(channel state information) 를 보고(report) 하는 상향링크 제어 채널(uplink control channel) 을 전송할 빔의 수를 결정하고, 상기 결정된 빔의 수에 따라, 단일

빔(single beam) 또는 다수의 빔들(a plurality of beams)을 통해, 상기 기지국으로 상기 상향링크 제어 채널을 전송하도록 제어하며, 상기 빔의 수는, 상기 기지국으로부터 수신된 하향링크 참조 신호(downlink reference signal)에 의한 측정 정보 또는 상기 상향링크 제어 정보의 유형(type) 중 적어도 하나에 기반하여 결정된다.

발명의 효과

[24] 본 발명의 실시 예에 따르면, 상향링크 채널 전송에 대한 링크 품질(또는 빔 품질)이 저하되는 경우에도, 품질 정도에 따라 하나 또는 그 이상의 빔들을 이용함으로써 불필요한 빔 복구 절차(beam recovery procedure) 및/또는 링크 복구 절차(link recovery procedure)를 방지할 수 있는 효과가 있다. 이를 통해, 불필요한 전력 소모를 줄일 수 있으며, 복구될 때까지의 통신 단절 및 지연 문제를 방지할 수 있는 효과가 있다.

[25] 또한, 본 발명의 실시 예에 따르면, 정보의 중요도(또는 신뢰도)에 따라 이용되는 빔의 수를 달리 설정할 수 있으므로, 기지국과 단말 간의 통신에 있어서 불확실성을 줄일 수 있는 효과가 있다.

[26] 또한, 본 발명의 실시 예에 따르면, 상향링크 제어 채널에 포함된 참조 신호를 이용하여 빔 조정 절차를 수행할 수 있다. 이에 따라, 기존의 빔 조정 절차에서 요구되는 별도의 참조 신호의 시그널링 없이도 빔 조정을 수행할 수 있는 점에서, 시그널링 오버헤드 및 통신 지연을 감소시킬 수 있는 효과가 있다.

[27] 본 발명에서 얻을 수 있는 효과는 이상에서 언급한 효과로 제한되지 않으며, 언급하지 않은 또 다른 효과들은 아래의 기재로부터 본 발명이 속하는 기술분야에서 통상의 지식을 가진 자에게 명확하게 이해될 수 있을 것이다.

도면의 간단한 설명

[28] 본 발명에 관한 이해를 돕기 위해 상세한 설명의 일부로 포함되는, 첨부 도면은 본 발명에 대한 실시 예를 제공하고, 상세한 설명과 함께 본 발명의 기술적 특징을 설명한다.

[29] 도 1은 본 명세서에서 제안하는 방법이 적용될 수 있는 NR의 전체적인 시스템 구조의 일례를 나타낸 도이다.

[30] 도 2는 본 명세서에서 제안하는 방법이 적용될 수 있는 무선 통신 시스템에서 상향링크 프레임과 하향링크 프레임 간의 관계를 나타낸다.

[31] 도 3은 본 명세서에서 제안하는 방법이 적용될 수 있는 무선 통신 시스템에서 지원하는 자원 그리드(resource grid)의 일 예를 나타낸다.

[32] 도 4는 본 명세서에서 제안하는 방법이 적용될 수 있는 안테나 포트 및 뉴머롤로지 별 자원 그리드의 예들을 나타낸다.

[33] 도 5는 아날로그 빔포머(analog beamformer) 및 RF 체인(RF chain)으로 구성되는 송신단(transmitter)의 블록도(block diagram)의 일례를 나타낸다.

[34] 도 6은 디지털 빔포머(digital beamformer) 및 RF 체인으로 구성되는 송신단의

블록도의 일례를 나타낸다.

[35] 도 7은 본 발명의 다양한 실시 예들에 따른 아날로그 빔 스캐닝 방식의 일례를 나타낸다.

[36] 도 8은 주기적 또는 반-지속적 CSI 보고와 관련된 빔 엇갈림 현상의 일 예를 나타낸다.

[37] 도 9는 본 명세서에서 제안하는 방법이 적용될 수 있는 다수의 빔들을 통해 UL 제어 정보를 전송하는 방법의 일 예를 나타낸다.

[38] 도 10은 본 명세서에서 제안하는 방법이 적용될 수 있는 다수의 빔들을 통해 UL 제어 정보를 전송하는 방법의 다른 예를 나타낸다.

[39] 도 11은 본 명세서에서 제안하는 방법이 적용될 수 있는 무선 통신 시스템에서 상향링크 채널을 전송하는 단말의 동작 순서도를 나타낸다.

[40] 도 12는 본 명세서에서 제안하는 방법들이 적용될 수 있는 무선 통신 장치의 블록 구성도를 예시한다.

발명의 실시를 위한 형태

[41] 이하, 본 발명에 따른 바람직한 실시 형태를 첨부된 도면을 참조하여 상세하게 설명한다. 첨부된 도면과 함께 이하에 개시될 상세한 설명은 본 발명의 예시적인 실시형태를 설명하고자 하는 것이며, 본 발명이 실시될 수 있는 유일한 실시형태를 나타내고자 하는 것이 아니다. 이하의 상세한 설명은 본 발명의 완전한 이해를 제공하기 위해서 구체적 세부사항을 포함한다. 그러나, 통상의 기술자는 본 발명이 이러한 구체적 세부사항 없이도 실시될 수 있음을 안다.

[42] 몇몇 경우, 본 발명의 개념이 모호해지는 것을 피하기 위하여 공지의 구조 및 장치는 생략되거나, 각 구조 및 장치의 핵심기능을 중심으로 한 블록도 형식으로 도시될 수 있다.

[43] 본 명세서에서 기지국은 단말과 직접적으로 통신을 수행하는 네트워크의 종단 노드(terminal node)로서의 의미를 갖는다. 본 문서에서 기지국에 의해 수행되는 것으로 설명된 특정 동작은 경우에 따라서는 기지국의 상위 노드(upper node)에 의해 수행될 수도 있다. 즉, 기지국을 포함하는 다수의 네트워크 노드들(network nodes)로 이루어지는 네트워크에서 단말과의 통신을 위해 수행되는 다양한 동작들은 기지국 또는 기지국 이외의 다른 네트워크 노드들에 의해 수행될 수 있음은 자명하다. '기지국(BS: Base Station)' 은 고정국(fixed station), Node B, eNB (evolved-NodeB), gNB (generation-NodeB), BTS(base transceiver system), 액세스 포인트(AP: Access Point) 등의 용어에 의해 대체될 수 있다. 또한, '단말(Terminal)' 은 고정되거나 이동성을 가질 수 있으며, UE(User Equipment), MS(Mobile Station), UT(user terminal), MSS(Mobile Subscriber Station), SS(Subscriber Station), AMS(Advanced Mobile Station), WT(Wireless terminal), MTC(Machine-Type Communication) 장치, M2M(Machine-to-Machine) 장치, D2D(Device-to-Device) 장치 등의 용어로 대체될 수 있다.

[44] 이하에서, 하향링크(DL: downlink)는 기지국에서 단말로의 통신을 의미하며, 상향링크(UL: uplink)는 단말에서 기지국으로의 통신을 의미한다. 하향링크에서 송신기는 기지국의 일부이고, 수신기는 단말의 일부일 수 있다. 상향링크에서 송신기는 단말의 일부이고, 수신기는 기지국의 일부일 수 있다.

[45] 이하의 설명에서 사용되는 특정 용어들은 본 발명의 이해를 돕기 위해서 제공된 것이며, 이러한 특정 용어의 사용은 본 발명의 기술적 사상을 벗어나지 않는 범위에서 다른 형태로 변경될 수 있다.

[46] 이하의 기술은 CDMA(code division multiple access), FDMA(frequency division multiple access), TDMA(time division multiple access), OFDMA(orthogonal frequency division multiple access), SC-FDMA(single carrier frequency division multiple access), NOMA(non-orthogonal multiple access) 등과 같은 다양한 무선 접속 시스템에 이용될 수 있다. CDMA는 UTRA(universal terrestrial radio access)나 CDMA2000과 같은 무선 기술(radio technology)로 구현될 수 있다. TDMA는 GSM(global system for mobile communications)/GPRS(general packet radio service)/EDGE(enhanced data rates for GSM evolution)와 같은 무선 기술로 구현될 수 있다. OFDMA는 IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802-20, E-UTRA(evolved UTRA) 등과 같은 무선 기술로 구현될 수 있다. UTRA는 UMTS(universal mobile telecommunications system)의 일부이다. 3GPP(3rd generation partnership project) LTE(long term evolution)은 E-UTRA를 사용하는 E-UMTS(evolved UMTS)의 일부로써, 하향링크에서 OFDMA를 채용하고 상향링크에서 SC-FDMA를 채용한다. LTE-A(advanced)는 3GPP LTE의 진화이다.

[47] 본 발명의 실시 예들은 무선 접속 시스템들인 IEEE 802, 3GPP 및 3GPP2 중 적어도 하나에 개시된 표준 문서들에 의해 뒷받침될 수 있다. 즉, 본 발명의 실시 예들 중 본 발명의 기술적 사상을 명확히 드러내기 위해 설명하지 않은 단계들 또는 부분들은 상기 문서들에 의해 뒷받침될 수 있다. 또한, 본 문서에서 개시하고 있는 모든 용어들은 상기 표준 문서에 의해 설명될 수 있다.

[48] 설명을 명확하게 하기 위해, 3GPP LTE/LTE-A/NR(New RAT)을 위주로 기술하지만 본 발명의 기술적 특징이 이에 제한되는 것은 아니다.

[49]

[50]

[51] <u>용어 정의</u>

[52] eLTE eNB: eLTE eNB는 EPC 및 NGC에 대한 연결을 지원하는 eNB의 진화(evolution)이다.

[53] gNB: NGC와의 연결뿐만 아니라 NR을 지원하는 노드.

[54] 새로운 RAN: NR 또는 E-UTRA를 지원하거나 NGC와 상호 작용하는 무선 액세스 네트워크.

[55] 네트워크 슬라이스(network slice): 네트워크 슬라이스는 종단 간 범위와 함께 특정 요구 사항을 요구하는 특정 시장 시나리오에 대해 최적화된 솔루션을

제공하도록 operator 에 의해 정의된 네트워크.

[56] 네트워크 기능(network function): 네트워크 기능은 잘 정의된 외부 인터페이스와 잘 정의된 기능적 동작을 가진 네트워크 인프라 내에서의 논리적 노드.

[57] NG-C: 새로운 RAN 과 NGC 사이의 NG2 레퍼런스 포인트(reference point) 에 사용되 는 제어 평면 인터페이스.

[58] NG-U: 새로운 RAN 과 NGC 사이의 NG3 레퍼런스 포인트(reference point) 에 사용되 는 사용자 평면 인터페이스.

[59] 비독립형(Non-standalone) NR: gNB 가 LTE eNB 를 EPC 로 제어 플레인 연결을 위한 앵커로 요구하거 나 또는 eLTE eNB 를 NGC 로 제어 플레인 연결을 위한 앵커로 요구하는 배치 구성.

[60] 비독립형 E-UTRA: eLTE eNB 가 NGC 로 제어 플레인 연결을 위한 앵커로 gNB 를 요구하는 배치 구성.

[61] 사용자 평면 게이트웨이 :NG-U 인터페이스의 종단점.

[62]

[63] 시스템 일반

[64] 도 1은 본 명세서에서 제안하는 방법이 적용될 수 있는 NR의 전체적인 시스템 구조의 일례를 나타낸 도이다.

[65] 도 1을 참조하면, NG-RAN 은 NG-RA 사용자 평면(새로운 AS sublayer/PDCP/RLC/MAC/PHY) 및 UE(User Equipment) 에 대한 제어 평면(RRC) 프로토콜 종단을 제공하는 gNB 들로 구성된다.

[66] 상기 gNB 는 Xn 인터페이스를 통해 상호 연결된다.

[67] 상기 gNB 는 또한, NG 인터페이스를 통해 NGC 로 연결된다.

[68] 보다 구체적으로는, 상기 gNB 는 N2 인터페이스를 통해 AMF (Access and Mobility Management Function) 로, N3 인터페이스를 통해 UPF (User Plane Function) 로 연결된다.

[69]

[70] NR(New Rat) 뉴머롤로지 HVumerologv) 및 프레임(frame) 구조

[71] NR 시스템에서는 다수의 뉴머롤로지 (numerology) 들이 지원될 수 있다. 여기에서, 뉴머롤로지 는 서브캐리어 간격(subcarrier spacing) 과 CP(Cyclic Prefix) 오버헤드에 의해 정의될 수 있다. 이 때, 다수의 서브캐리어 간격은 기본 서브캐리어 간격을 정수 N(또는, μ)으로 스케일링(scaling) 함으로써 유도될 수 있다. 또한, 매우 높은 반송파 주파수에서 매우 낮은 서브캐리어 간격을 이용하지 않는다고 가정될지라도, 이용되는 뉴머롤로지 는 주파수 대역과 독립적으로 선택될 수 있다.

[72] 또한, NR 시스템에서는 다수의 뉴머롤로지에 따른 다양한 프레임 구조들이 지원될 수 있다.

[73] 이하, NR 시스템에서 고려될 수 있는 OFDM(Orthogonal Frequency Division

Multiplexing) 뉴머롤로지 및 프레임 구조를 살펴본다.

[74] NR 시스템에서 지원되는 다수의 OFDM 뉴머롤로지들은 표 1과 같이 정의될 수 있다.

[75]

[76] [표 1]

μ	$\Delta f = 2^{\mu} \cdot 15$ [kHz]	Cyclic prefix
0	15	Normal
1	30	Normal
2	60	Normal, Extended
3	120	Normal
4	240	Normal
5	480	Normal

[77]

[78] NR 시스템에서의 프레임 구조(frame structure) 와 관련하여, 시간 영역의 다양한 필드의 크기는 기 $= 1/(\Delta f_{max} \cdot N_f)$ 의 시간 단위의 배수로 표현된다. 여기에서, $\Delta f_{max} = 480 \cdot 10^{3}$ 이고, $N_f = 4096$ 이다. 하향링크 (downlink) 및 상향링크 (uplink) 전송은 $T_f = (\Delta f_{max} N_f / 100) \cdot T_s = 10ms$ 의 구간을 가지는 무선 프레임(radio frame) 으로 구성된다. 여기에서, 무선 프레임은 각각 $T_{sf} = (\Delta f_{max} N_f / 1000) \cdot T_s = 1ms$ 의 구간을 가지는 10 개의 서브프레임(subframe) 들로 구성된다. 이 경우, 상향링크에 대한 한 세트의 프레임들 및 하향링크에 대한 한 세트의 프레임들이 존재할 수 있다.

[79] 도 2는 본 명세서에서 제안하는 방법이 적용될 수 있는 무선 통신 시스템에서 상향링크 프레임과 하향링크 프레임 간의 관계를 나타낸다.

[80] 도 2에 나타난 것과 같이, 단말(User Equipment, UE) 로 부터의 상향링크 프레임 번호 i의 전송은 해당 단말에서의 해당 하향링크 프레임의 시작보다 $T_{TA} = N_{TA} T_s$ 이전에 시작해야 한다.

[81] 뉴머롤로지 μ 에 대하여, 슬롯(slot) 들은 서브프레임 내에서 $n_s^{\mu} \in \{0, \ldots, N_{subframe}^{slots, \mu} - 1\}$ 의 증가하는 순서로 번호가 매겨지고, 무선 프레임 내에서 $n_{s,f}^{\mu} \in \{0, \ldots, N_{frame}^{slots, \mu} - 1\}$ 의 증가하는 순서로 번호가 매겨진다. 하나의 슬롯은 N_{symb}^{μ} 의 연속하는 OFDM 심볼들로 구성되고, N_{symb}^{μ} 는, 이용되는 뉴머롤로지 및 슬롯 설정(slot configuration) 에 따라 결정된다. 서브프레임에서 슬롯 n_s^{μ} 의 시작은 동일 서브프레임에서 OFDM 심볼 $n_s^{\mu} N_{symb}^{\mu}$ 의 시작과 시간적으로 정렬된다.

[82] 모든 단말이 동시에 송신 및 수신을 할 수 있는 것은 아니며, 이는 하향링크 슬롯(downlink slot) 또는 상향링크 슬롯(uplink slot) 의 모든 OFDM 심볼들이 이용될 수는 없다는 것을 의미한다.

[83] 표 2는 뉴머롤로지 μ 에서의 일반(normal) CP에 대한 슬롯 당 OFDM 심볼의 수를 나타내고, 표 3은 뉴머롤로지 μ 에서의 확장(extended) CP에 대한 슬롯 당 OFDM 심볼의 수를 나타낸다.

[84]

[85] [표 2]

μ	Slot configuration					
	0			1		
	N_{symb}^{μ}	$N_{frame}^{slots,\mu}$	$N_{subframe}^{slots,\mu}$	N_{symb}^{μ}	$N_{frame}^{slots,\mu}$	$N_{subframe}^{slots,\mu}$
0	14	10	1	7	20	2
1	14	20	2	7	40	4
2	14	40	4	7	80	8
3	14	80	8	-	-	-
4	14	160	16	-	-	-
5	14	320	32	-	-	-

[86]

[87] [표 3]

μ	Slot configuration					
	0			1		
	N_{symb}^{μ}	$N_{frame}^{slots,\mu}$	$N_{subframe}^{slots,\mu}$	N_{symb}^{μ}	$N_{frame}^{slots,\mu}$	$N_{subframe}^{slots,\mu}$
0	12	10	1	6	20	2
1	12	20	2	6	40	4
2	12	40	4	6	80	8
3	12	80	8	-	-	-
4	12	160	16	-	-	-
5	12	320	32	-	-	-

[88]

[89] NR 물리 자원(NR Physical Resource)

[90] NR 시스템에서의 물리 자원(physical resource) 과 관련하여, 안테나 포트(antenna port), 자원 그리드(resource grid), 자원 요소(resource element), 자원 블록(resource block), 캐리어 파트(carrier part) 등이 고려될 수 있다.

[91] 이하, NR 시스템에서 고려될 수 있는 상기 물리 자원들에 대해 구체적으로 살펴본다.

[92] 먼저, 안테나 포트와 관련하여, 안테나 포트는 안테나 포트 상의 심볼이 운반되는 채널이 동일한 안테나 포트 상의 다른 심볼이 운반되는 채널로부터 추론될 수 있도록 정의된다. 하나의 안테나 포트 상의 심볼이 운반되는 채널의 광범위 특성(large-scale property) 이 다른 안테나 포트 상의 심볼이 운반되는 채널로부터 추론될 수 있는 경우, 2 개의 안테나 포트는 QC/QCL(quasi co-located 혹은 quasi co-location) 관계에 있다고 할 수 있다. 여기에서, 상기 광범위 특성은 지연 확산(Delay spread), 도플러 확산(Doppler spread), 주파수 쉬프트(Frequency shift), 평균 수신 파워(Average received power), 수신 타이밍(Received Timing) 중 하나 이상을 포함한다.

[93] 도 3은 본 명세서에서 제안하는 방법이 적용될 수 있는 무선 통신 시스템에서 지원하는 자원 그리드(resource grid) 의 일 예를 나타낸다.

[94] 도 3을 참고하면, 자원 그리드가 주파수 영역 상으로 $N_{RB}^{\mu}N_{sc}^{RB}$ 서브캐리어들로 구성되고, 하나의 서브프레임이 14 x 2^{u} OFDM 심볼들로 구성되는 것을 예시적으로 기술하나, 이에 한정되는 것은 아니다.

[95] NR 시스템에서, 전송되는 신호(transmitted signal) 는 $N_{RB}^{\mu}N_{sc}^{RB}$ 서브캐리어들로

구성되는 하나 또는 그 이상의 자원 그리드들 및 $2^{\mu} N_{symb}^{(\mu)}$의 OFDM 심볼들에 의해 설명된다. 여기에서, 《 ≤A긔 이다. 상기 N 긔 는 최대 전송 대역폭을 나타내 고, 이는, 뉴머롤로지 들뿐만 아니라 상향링 크와 하향링 크 간에도 달라질 수 있다.

[96] 이 경우, 도 4와 같이, 뉴머롤로지 μ 및 안테나 포트 p 별로 하나의 자원 그리드가 설정될 수 있다.

[97] 도 4는 본 명세서에서 제안하는 방법이 적용될 수 있는 안테나 포트 및 뉴머롤로지 별 자원 그리드의 예들을 나타낸다.

[98] 뉴머롤로지 μ 및 안테나 포트 p에 대한 자원 그리드의 각 요소는 자원 요소(resource element) 로 지칭되며, 인덱스 쌍 $(k,\bar{l})$에 의해 고유적 으로 식별된다. 여기에서, $k = 0,\ldots,N_{RB}^{\mu}N_{sc}^{RB} - 1$는 주파수 영역 상의 인덱스이고, $\bar{l} = 0,\ldots,2^{\mu} N_{symb}^{(\mu)} - 1$는 서브프레 임 내에서 심볼의 위치를 지칭한다. 슬롯에 서 자원 요소를 지칭할 때에는, 인덱스 쌍 (k,l)이 이용된다. 여기에서, $l = 0,\ldots,N_{symb}^{\mu} - 1$이다.

[99] 뉴머롤로지 μ 및 안테나 포트 p에 대한 자원 요소 $(k,\bar{l})$는 복소 값(complex value) $a_{k,\bar{l}}^{(p,\mu)}$에 해당한다. 혼동(confusion) 될 위험이 없는 경우 혹은 특정 안테나 포트 또는 뉴머롤로지가 특정되지 않은 경우에는, 인덱스들 p 및 ^"는 드롭(drop) 될 수 있으며, 그 결과 복소 값은 a었 또는 $a_{k,\bar{l}}$이 될 수 있다.

[100] 또한, 물리 자원 블록(physical resource block) 은 주파수 영역 상의 $N_{sc}^{RB} = 12$ 연속적인 서브 캐리어들로 정의된다. 주파수 영역 상에서, 물리 자원 블록들은 0부터 $N_{RB}^{\mu} - 1$까지 번호가 매겨진다. 이 때, 주파수 영역 상의 물리 자원 블록 번호(physical resource block number) n_{PRB}와 자원 요소들 (k,l) 간의 관계는 수학식 1과 같이 주어진다.

[101]

[102] [수식 1]

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

[103]

[104] 또한, 캐리어 파트(carrier part) 와 관련하여, 단말은 자원 그리드의 서브셋 (subset) 만을 이용하여 수신 또는 전송하도록 설정될 수 있다. 이 때, 단말이 수신 또는 전송하도록 설정된 자원 블록의 집합(set) 은 주파수 영역 상에서 0부터 $N_{URB}^{\mu} - 1$ 까지 번호가 매겨진다.

[105]

[106] <u>빔 관리(Beam management)</u>

[107] NR에서 빔 관리는 다음과 같이 정의된다.

[108] 빔 관리(Beam management): DL 및 UL 송수신에 사용될 수 있는 TRP (들) 및/또는 UE 빔들의 세트(set)를 획득하고 유지하기 위한 L1/L2 절차들의 세트로서, 적어도 다음 사항들을 포함한다:

[109] - 빔 결정: TRP (들) 또는 UE가 자신의 송신 / 수신 빔을 선택하는 동작.

[110] - 빔 측정: TRP (들) 또는 UE가 수신된 빔 형성 신호의 특성을 측정하는 동작.

[111] - 빔 보고: UE가 빔 측정에 기반하여 빔 형성된 신호의 정보를 보고하는 동작.

[112] - 빔 스위핑 (Beam sweeping): 미리 결정된 방식으로 시간 간격 동안 송신 및/또는 수신된 빔을 이용하여 공간 영역을 커버하는 동작.

[113]

[114] 또한, TRP 및 UE에서의 Tx / Rx 빔 대응(correspondence) 는 다음과 같이 정의된다.

[115] - TRP 에서의 Tx / Rx 빔 대응은 다음 중 적어도 하나가 충족되면 유지된다.

[116] - TRP 는 TRP 의 하나 이상의 송신 빔에 대한 UE의 하향링크 측정에 기초하여 상향링크 수신을 위한 TRP 수신 빔을 결정할 수 있다.

[117] - TRP 는 TRP 의 하나 이상의 Rx 빔들에 대한 TRP 의 상향링크 측정에 기초하여 하향링크 전송에 대한 TRP Tx 빔을 결정할 수 있다.

[118] - UE에서의 Tx / Rx 빔 대응은 다음 중 적어도 하나가 충족되면 유지된다.

[119] - UE는 UE의 하나 이상의 Rx 빔에 대한 UE의 하향링크 측정에 기초하여 상향링크 전송을 위한 UE Tx 빔을 결정할 수 있다.

[120] - UE는 하나 이상의 Tx 빔에 대한 상향링크 측정에 기초한 TRP 의 지시에 기초하여 하향링크 수신을 위한 UE 수신 빔을 결정할 수 있다.

[121] - TRP 로 UE 빔 대응 관련 정보의 능력 지시가 지원된다.

[122]

[123] 다음과 같은 DL L1/L2 빔 관리 절차가 하나 또는 다수의 TRP 들 내에서 지원된다.

[124] P-1: TRP Tx 빔 / UE Rx 빔 (들) 의 선택을 지원하기 위해 상이한 TRP Tx 빔에 대한 UE 측정을 가능하게 하기 위해 사용된다.

[125] - TRP 에서의 빔포밍의 경우 일반적으로 서로 다른 빔 세트에 서 인트라 (intra)/ 인터(inter)-TRP Tx 빔 스윕(sweep) 을 포함한다. UE에서의 빔포밍을 위해, 그것은 통상적 으로 상이한 빔들의 세트로부터 의 UE Rx 빔 sweep 를 포함한다.

[126] P-2: 상이한 TRP Tx 빔에 대한 UE 측정이 인터/인트라 -TRP Tx 빔(들) 을 변경하도록 하기 위해 사용된다.

[127] P-3: UE가 빔 포밍을 사용하는 경우에 동일한 TRP Tx 빔에 대한 UE 측정이 UE Rx 빔을 변경시키는데 사용된다.

[128]

[129] 적어도 네트워크에 의해 트리거된 비주기적 보고(apreiodic reporting) 는 P-1, P-2 및 P-3 관련 동작에서 지원된다.

[130] 빔 관리 (적어도 CSI-RS) 를 위한 RS에 기초한 UE 측정은 K (빔의 총 개수) 빔으로 구성되며, UE는 선택된 N 개의 Tx 빔들의 측정 결과를 보고한다. 여기서, N은 반드시 고정된 수는 아니다. 이동성 목적을 위한 RS에 기반한 절차는 배제되지 않는다. 보고 정보는 적어도 N < K 인 경우 N 개의 빔 (들) 에 대한 측정량 및 N 개의 DL 송신 빔을 나타내는 정보를 포함한다. 특히, UE가 K'> 1 논-제로 -파워 (NZP) CSI- RS 자원들에 대해, UE는 N'의 CRI (CSI-RS 자원 지시자) 를 보고 할 수 있다.

[131] UE는 빔 관리를 위해 다음과 같은 상위 계층 파라미터(higher layer parameter) 들로 설정될 수 있다.

[132] - N>1 보고 설정(setting), M>1 자원 설정

[133] - 보고 설정과 자원 설정 간의 링크들은 합의된 CSI 측정 설정에서 설정된다.

[134] - CSI-RS 기반 P-1 및 P-2는 자원 및 보고 설정으로 지원된다.

[135] - P-3은 보고 설정의 유무에 관계없이 지원될 수 있다.

[136] - 적어도 이하 사항들을 포함하는 보고 설정(reporting setting)

[137] - 선택된 빔을 나타내는 정보

[138] - L1 측정 보고(Ll measurement reporting)

[139] - 시간 영역 동작(예: 비주기적(aperiodic) 동작, 주기적(periodic) 동작, 반-지속적(semi-persistent) 동작)

[140] - 여러 주파수 세분성(frequency granularity) 이 지원되는 경우의 주파수 세분성

[141] - 적어도 이하 사항들을 포함하는 리소스 설정(resource setting)

[142] - 시간 영역 동작(예: 비주기적 동작, 주기적 동작, 반-지속적 동작)

[143] - RS 유형: 적어도 NZP CSI-RS

[144] - 적어도 하나의 CSI-RS 자원 세트. 각 CSI-RS 자원 세트는 K ≥ l CSI-RS 자원들을 포함(K 개의 CSI-RS 자원들의 일부 파라미터들은 동일할 수 있다. 예를 들어, 포트 번호, 시간 영역 동작, 밀도 및 주기)

[145]

[146] 또한, NR은 L> 1 인 L 그룹을 고려하여 다음 빔 보고를 지원한다.

[147] - 최소한의 그룹을 나타내는 정보

[148] - N1 빔에 대한 측정량(measurement quantity)(Ll RSRP 및 CSI 보고 지원 (CSI-RS 가 CSI 획득을 위한 경우))

[149] - 적용 가능한 경우, N_l 개의 DL 송신 빔을 나타내는 정보

[150] 상술한 바와 같은 그룹 기반의 빔 보고는 UE 단위로 구성할 수 있다. 또한, 상기 그룹 기반의 빔 보고는 UE 단위로 턴-오프 (turn-off) 될 수 있다(예를 들어, L = 1 또는 N_{1}= 1 인 경우).

[151]

[152] NR은 UE가 빔 실패로부터 복구하는 메커니즘을 트리거할 수 있음을 지원한다.

[153] 빔 실패(beam failure) 이벤트는 연관된 제어 채널의 빔 쌍 링크(beam pair link) 의 품질이 충분히 낮을 때 발생한다(예를 들어 임계 값과의 비교, 연관된 타이머의

타임 아웃). 빔 실패(또는 장애) 로부터 복구하는 메커니즘은 빔 장애가 발생할 때 트리거된다.

[154] 네트워크는 복구 목적으로 UL 신호를 전송하기 위한 자원을 갖는 UE에 명시적으로 구성한다. 자원들의 구성은 기지국이 전체 또는 일부 방향으로부터 (예를 들어, random access region) 청취(listening) 하는 곳에서 지원된다.

[155] 빔 장애를 보고하는 UL 송신/자원은 PRACH (PRACH 자원에 직교하는 자원) 와 동일한 시간 인스턴스 (instance) 에 또는 PRACH 와 다른 시간 인스턴스 (UE 에 대해 구성 가능) 에 위치할 수 있다. DL 신호의 송신은 UE가 새로운 잠재적인 빔들을 식별하기 위해 빔을 모니터할 수 있도록 지원된다.

[156]

[157] NR은 빔 관련 지시(beam-related indication) 에 관계 없이 빔 관리를 지원한다. 빔 관련 지시가 제공되는 경우, CSI-RS 기반 측정을 위해 사용된 UE 측 빔 형성/수신 절차에 관한 정보는 QCL 을 통해 UE에 지시될 수 있다. NR에서 지원할 QCL 파라미터로는 LTE 시스템에서 사용하던 delay, Doppler, average gain 등에 대한 파라미터 뿐만 아니라 수신단에서의 빔포밍을 위한 공간 파라미터가 추가될 예정이며, 단말 수신 빔포밍 관점에서 angle of arrival (AOA) 관련 파라미터 및/또는 기지국 수신 빔포밍 관점에서 angle of departure (AOD) 관련 파라미터들이 포함될 수 있다.

[158] NR에서 상기 angle of arrival 관련 파라미터를 통칭하여 spatial Rx(receive) parameter 라 명칭하기로 하였다. 즉, 특정 antenna port 가 다른 antenna port 와 spatial Rx parameter 관점에서 QCL 되어 있다고 함은 해당 두 antenna port 를 수신하는 수신기가 동일한 수신 빔(spatial filter) 을 사용해도 무방함을 지칭한다. 이는, 하향링크 관점에서 기지국이 해당 두 antenna port 를 전송할 때 동일 혹은 유사한 전송 빔을 적용함을 단말에게 알려주는 것과 동일하다.

[159] NR은 제어 채널 및 해당 데이터 채널 전송에서 동일하거나 다른 빔을 사용하는 것을 지원한다.

[160] 빔 쌍 링크 블로킹 (beam pair link blocking) 에 대한 견고성 (robustness) 를 지원하는 NR-PDCCH 전송을 위해, UE는 동시에 M 개의 빔 쌍 링크상에서 NR-PDCCH 를 모니터링하도록 구성될 수 있다. 여기서, M≥1 및 M 의 최대값은 적어도 UE 능력에 의존할 수 있다.

[161] UE는 상이한 NR-PDCCH OFDM 심볼들에서 상이한 빔 쌍 링크(들) 상의 NR-PDCCH 를 모니터링하도록 구성될 수 있다. 다수의 빔 쌍 링크들 상에서 NR-PDCCH 를 모니터링하기 위한 UE Rx 빔 설정과 관련된 파라미터는 상위 계층 시그널링 또는 MAC CE에 의해 구성되거나 및/또는 탐색 공간 설계에서 고려된다.

[162] 적어도, NR은 DL RS 안테나 포트(들) 과 DL 제어 채널의 복조를 위한 DL RS 안테나 포트(들) 사이의 공간 QCL 가정의 지시를 지원한다. NR-PDCCH (즉,

NR-PDCCH 를 모니터링하는 구성 방법)에 대한 빔 지시를 위한 후보 시그널링 방법은 MAC CE 시그널링, RRC 시그널링, DCI 시그널링, 스펙 transparent 및/또는 암시적 방법, 및 이들 시그널링 방법의 조합이다.

[163] 유니캐스트 DL 데이터 채널의 수신을 위해, NR은 DL RS 안테나 포트와 DL 데이터 채널의 DMRS 안테나 포트 사이의 공간 QCL 가정의 지시를 지원한다.

[164] RS 안테나 포트를 나타내는 정보는 DCI (다운 링크 허가)를 통해 표시된다. 또한, 이 정보는 DMRS 안테나 포트와 QCL 되어 있는 RS 안테나 포트를 나타낸다. DL 데이터 채널에 대한 DMRS 안테나 포트의 상이한 세트는 RS 안테나 포트의 다른 세트와 QCL 로서 나타낼 수 있다.

[165]

[166] UL(PUCCH/PUSCH) 빔 지시에 대해 간략히 살펴본다. 여기서, UL 빔 지시는 일반적인 용어이며, NR에서 UL 빔 지시는 spatial_relation_info. field 설정에 의해 UL 빔이 지시된다.

[167] 상기 spatial_relation_info. field 는 SRS 기반의 UL 빔 페어 결정 절차가 수행된 경우 SRS resource ID(s) (SRI) 로, DL 빔과 UL 빔 간에 빔 호혜성(혹은 빔 대응성)이 존재하는 경우 DL 빔을 지시하기 위한 DL RS인 CSI-RS resource ID(s) (CRI) 혹은 SSB(synchronization signal block) ID (혹은 SSB ID에 상응하는 다른 ID, e.g. PBCH DMRS ID) 를 포함할 수 있다.

[168] 일례로, PUCCH 에 대한 UL 빔 지시는 (1) RRC layer 에서 하나의 SRI, CRI 또는 SSB ID를 spatial_relation_info. field 설정에 의해 지시하거나, (2) RRC layer 에서 복수의 SRIs, CRIs 또는 SSB IDs를 설정한 후 MAC layer 에서 그 중 하나의 ID를 지정하는 방식으로 지시할 수 있다.

[169] 여기서, (2)의 경우, RRC layer 에서 spatial_relation_info. field 가 복수 개 설정되는 특징을 갖는다.

[170] 또한, PUSCH 에 대한 UL 빔 지시 역시 상기 PUCCH 에 대한 UL 빔 지시와 유사하나 차이점은 UL 빔 페어(beam pair) 결정이 끝난 이후에도 UL link adaptation 을 위해 (맞춰진 UL 빔 페어를 통해) SRS 전송이 수행될 것이므로 최종적인 PUSCH 빔 지시는 해당 SRS resource ID (SRI) 를 DCI 로 지시한다.

[171] 이 때, 해당 SRI는 higher layer 에서 기 설정된 복수의 SRS resource IDs 중 하나를 지시하는 역할이며, 상기 SRS resource ID들은 각각 (beam management 용도의) CRI, SSB ID, 또는 SRI와 spatial_relation_info. field 로 빔 설정될 수 있다.

[172]

[173] 또한, NR에서는 반-지속적(semi-persistent) CSI 보고를 PUCCH 뿐만 아니라 PUSCH 로도 지원한다.

[174] 이때, 반-지속적 CSI 보고를 PUSCH 로 수행하기 위해서는 SPS(semi-persistent scheduling) PUSCH 자원 할당 방식과 유사하게 일반적인 one-shot scheduling 을 수행하는 데 사용하는 C-RNTI 와는 별도의 RNTI 를 통해 scheduling grant 를 지시한다.

[175] 이때, 상기 RNTI 는 RRC message로 설정한다.

[176] 아래 표 4는 PUCCH 빔 지시 관련 RRC 파라미터의 일례를 나타내고, 표 5는 PUCCH 빔 지시 관련 MAC CE 파라미터의 일례를 나타낸다.

[177]

[178] [표 4]

Parameter name in specification	Parameter name in text	Description	Value range
PUCCH-SpatialRelationInfo	PUCCH-SpatialRelationInfo	List of configurations of the spatial relation between a reference RS and PUCCH. Reference RS can be SSB/CSI-RS/SRS. If the list has more than one element, MAC-CE selects a single element.	Each element of the list is an SSB Index, NZP-CSI-RS-ResourceConfigId, or SRS-ResourceConfigId

[179]

[180] [표 5]

Parameter Name	Description	Size/format
PUCCH-SpatialRelationInfo	Provides the spatial relation for a PUCCH resource	PUCCH resource ID | Bitmap of size [8] (Bitmap activates one of the [8] entries within the RRC parameter *PUCCH-Spatial-relation-info*)

[181]

[182] 또한, 단일 빔을 적용하는 PUCCH 와 복수 개의 빔을 적용하는 PUCCH 는 한 slot 에서 N 번 반복 전송되는 복수의 PUCCH 자원들 (혹은 심볼 그룹들) 에 대해 N 개의 빔들이 각각 정해진다.

[183] 이때, 각각의 N 빔들이 동일한 빔으로 설정(또는 지시 또는 적용)되는지 아니면 다른 빔으로 설정되는지로 구분될 수도 있다.

[184] 예를 들어, 상술한 spatial_relation_info field 가 한 slot 내에서 반복 전송되는 복수 개의 PUCCH 자원들에 각각 설정/지시되고, 이때 동일한 spatial_relation_info 값을 적용하는지 여부, 또는 한 slot 내에서 전송되는 하나의 PUCCH 자원의 PUCCH symbol group 별로 spatial_relation_info 값을 동일하게 설정하는지 또는 다르게 설정하는지 여부로 구분될 수 있다.

[185] PUSCH 의 경우, 심볼 그룹 단위로 반복 전송을 수행하며, 서로 다른 심볼 그룹에 동일한 SRI 값을 적용하는지 아닌지에 따라 구분될 수 있다.

[186] 또한, NR 시스템에서 DL 관련 DCI 에 포함된 TCI(transmission configuration indicator) field 는 LTE 의 PQI field 와 유사하게 higher layer 에서 설정된 다수의 QCL reference 자원들 (e.g. CSI-RS 자원들 혹은 SSB 자원들) 의 후보들 중에서 동적으로 하나를 지시하는 역할을 수행한다.

[187] 여기서, QCL 지시는 spatial parameter 에 대한 QCL 지시를 포함할 수 있다. 예를 들어, higher layer 에서 설정된 복수의 DL RS 자원들 중에서 TCI field 를 통해 해당 PDSCH 가 어느 DL RS 빔으로 전송되는지를 지시할 수 있다.

[188] 이를 수신한 단말은 해당 DL RS의 수신에 적합하도록 미리 training 된 수신 빔을 적용하여 해당 PDSCH 빔을 수신할 수 있다.

[189]

[190] 하이브리드 빔포밍(Hybrid beamforming)

[191] 다중 안테나(multiple antenna) 를 이용하는 기존의 빔 형성(beamforming) 기술은 빔 형성 가중치 백터(weight vector)/ 프리코딩 백터(precoding vector) 를 적용하는 위치에 따라 아날로그 빔 형성(analog beamforming) 기법과 디지털 빔 형성(digital beamforming) 기법으로 구분될 수 있다.

[192] 아날로그 빔 형성 기법은 초기 다중 안테나 구조에 적용된 빔 형성 기법이다. 이는, 디지털 신호 처리가 완료된 아날로그 신호를 다수의 경로로 분기한 후, 각 경로에 대해 위상 쉬프트 (Phase-Shift, PS) 와 전력 증폭기 (Power Amplifier, PA) 설정을 적용하여 빔을 형성하는 기법을 의미할 수 있다.

[193] 아날로그 빔 형성을 위해서는, 각 안테나에 연결된 PA 와 PS가 단일 디지털 신호로부터 파생된 아날로그 신호를 처리(process) 하는 구조가 요구된다. 다시 말해, 아날로그 단에서 상기 PA 및 상기 PS가 복소 가중치 (complex weight 를 처리한다.

[194] 도 5는 아날로그 빔포머(analog beamformer) 및 RF 체인(RF chain) 으로 구성되는 송신단 (transmitter) 의 블록도 (block diagram) 의 일례를 나타낸다. 도 2는 단지 설명의 편의를 위한 것일 뿐, 본 발명의 범위를 제한하는 것이 아니다.

[195] 도 5에서, RF 체인은 기저대역(baseband, BB) 신호가 아날로그 신호로 변환되는 처리 블록을 의미한다. 아날로그 빔 형성 기법은 상기 PA 와 상기 PS의 소자의 특성에 따라 빔의 정확도가 결정되고, 상기 소자의 제어 특성상 협대역(narrowband) 전송에 유리할 수 있다.

[196] 또한, 아날로그 빔 형성 기법의 경우, 다중 스트림 (stream) 전송을 구현하기 어려운 하드웨어 구조로 구성되므로, 전송률 증대를 위한 다중화 이득(multiplexing gain) 이 상대적으로 작다. 또한, 이 경우, 직교 자원할당 기반의 단말 별 빔 형성이 용이하지 않을 수도 있다.

[197]

[198] 이와 달리, 디지털 빔 형성 기법의 경우, MIMO 환경에서 다이버시티(diversity) 와 다중화 이득을 최대화하기 위해 BB(Baseband) 프로세스를 이용하여 디지털 단에서 빔 형성이 수행된다.

[199] 도 6은 디지털 빔포머(digital beamformer) 및 RF 체인으로 구성되는 송신단의 블록도의 일례를 나타낸다. 도 3은 단지 설명의 편의를 위한 것일 뿐, 본 발명의 범위를 제한하는 것이 아니다.

[200] 도 6의 경우, 빔 형성은 BB 프로세스에서 프리코딩이 수행됨에 따라 수행될 수

있다. 여기에서, RF 체인은 PA를 포함한다. 이는, 디지털 빔 형성 기법의 경우, 빔 형성을 위해 도출된 복소 가중치 가 송신 데이터에 직접적으로 적용되기 때문이다.

[201] 또한, 단말 별로 상이한 빔 형성이 수행될 수 있으므로, 동시에 다중 사용자 빔 형성을 지원할 수 있다. 뿐만 아니라, 직교 자원이 할당된 단말 별로 독립적인 빔 형성이 가능하므로, 스케줄링의 유연성이 향상되고, 이에 따라, 시스템 목적에 부합하는 송신단의 운용이 가능하다. 또한, 광대역 전송을 지원하는 환경에서 MIMO-OFDM 과 같은 기술이 적용되는 경우에, 부반송파 (subcarrier) 별로 독립적인 빔이 형성될 수도 있다.

[202] 따라서, 디지털 빔 형성 기법은 시스템의 용량 증대와 강화된 빔 이득을 기반으로 하여 단일 단말(또는 사용자) 의 최대 전송률 을 극대화할 수 있다. 상술한 바와 같은 특징에 기반하여, 기존의 3G/4G (예 :LTE(-A)) 시스템에서는 디지털 빔포밍 기반의 MIMO 기법이 도입되었다.

[203]

[204] NR 시스템에서, 송수신 안테나가 크게 증가하는 거대(massive) MIMO 환경이 고려될 수 있다. 일반적으로 셀룰러 (cellular) 통신에서는 MIMO 환경에 적용되는 최대 송수신 안테나가 8개로 가정된다. 그러나, 거대 MIMO 환경이 고려됨에 따라, 상기 송수신 안테나의 수는 수십 또는 수백 개 이상으로 증가할 수 있다.

[205] 이 때, 거대 MIMO 환경에서 앞서 설명된 디지털 빔 형성 기술이 적용되면, 송신단은 디지털 신호 처리를 위하여 BB 프로세스를 통해 수백 개의 안테나에 대한 신호 처리를 수행해야 한다. 이에 따라, 신호 처리의 복잡도가 매우 커지고, 안테나 수만큼의 RF 체인이 필요하므로 하드웨어 구현의 복잡도도 매우 커질 수 있다.

[206] 또한, 송신단은 모든 안테나에 대해 독립적인 채널 추정(channel estimation) 이 필요하다. 뿐만 아니라, FDD 시스템의 경우, 송신단은 모든 안테나로 구성된 거대 MIMO 채널에 대한 피드백 정보가 필요하므로, 파일럿(pilot) 및/또는 피드백 오버헤드가 매우 커질 수 있다.

[207] 반면, 거대 MIMO 환경에서 앞서 설명된 아날로그 빔 형성 기술이 적용되면, 송신단의 하드웨어 복잡도는 상대적으로 낮다.

[208] 이에 반해, 다수 안테나를 이용한 성능의 증가 정도는 매우 작으며, 자원 할당의 유연성이 낮아질 수 있다. 특히, 광대역 전송 시, 주파수 별로 빔을 제어하는 것이 용이하지 않다.

[209] 따라서, 거대 MIMO 환경에서는 아날로그 빔 형성과 디지털 빔 형성 기법 중 한 개 만을 배타적으로 선택하는 것이 아닌, 아날로그 빔 형성과 디지털 빔 형성 구조가 결합된 하이브리드(hybrid) 형태의 송신단 구성 방식이 필요하다.

[210] 이 때, 아래의 표 1에 나타난 것과 같은 아날로그 빔 형성 기법과 디지털 빔 형성 기법의 성능 이득 및 복잡도의 관계를 이용하여, 하이브리드 형태의 송신단이 구성될 수 있다.

[211]

[212] 아날로그 빔포밍(analog beamfroming)

[213] 일반적으로, 아날로그 빔포밍은 순수 아날로그 빔포밍 송수신단과 하이브리드 빔포밍 송수신 단에서 이용될 수 있다. 이 때, 아날로그 빔 스캐닝은 동일한 시간에 한 개의 빔에 대한 추정을 수행할 수 있다. 따라서, 빔 스캐닝에 필요한 빔 트레이닝(beam training) 시간은 전체 후보 빔의 수에 비례하게 된다.

[214] 상술한 바와 같이, 아날로그 빔 포밍의 경우, 송수신단 빔 추정을 위하여 시간 영역에서의 빔 스캐닝 과정이 반드시 요구된다. 이 때, 전체 송수신 빔에 대한 추정 시간 !;는 아래 수학식 2와 같이 표현될 수 있다.

[215]

[216] [수식 2]

$$T_S = t_s \times (K_T \times K_R)$$

[217]

[218] 수학식 2에서, t_s는 하나의 빔 스캐닝을 위해 필요한 시간을 의미하고, K_T는 송신 빔의 수를 의미하고, K_R은 수신 빔의 수를 의미한다.

[219] 도 7은 본 발명의 다양한 실시 예들에 따른 아날로그 빔 스캐닝 방식의 일례를 나타낸다. 도 7은 단지 설명의 편의를 위한 것일 뿐, 본 발명의 범위를 제한하는 것이 아니다.

[220] 도 7의 경우, 전체 송신 빔의 수 K_T가 L 이고, 전체 수신 빔의 수 K_R가 1인 경우가 가정된다. 이 경우, 전체 후보 빔의 개수는 총 L 개가 되므로, 시간 영역에서 L 개의 시간 구간이 요구된다.

[221] 다시 말해, 아날로그 빔 추정을 위하여 단일 시간 구간에 서 1개의 빔 추정만이 수행될 수 있으므로, 도 7에 나타난 바와 같이, 전체 L 개의 빔(P_1 내지 P_L) 추정을 수행하기 위하여 L 개의 시간 구간이 요구된다. 단말은 아날로그 빔 추정 절차가 종료된 후, 가장 높은 신호 세기를 갖는 빔의 식별자(예: ID) 를 기지국으로 피드백한다. 즉, 송수신 안테나 수의 증가에 따라 개별 빔 수가 증가할 수록, 보다 긴 트레이닝 시간이 요구될 수 있다.

[222] 아날로그 빔포밍은 DAC(Digital-to-Analog Converter) 이후에 시간 영역의 연속적인 파형(continuous waveform) 의 크기와 위상각을 변화시키기 때문에, 디지털 빔포밍과 달리 개별 빔에 대한 트레이닝 구간이 보장될 필요가 있다. 따라서, 상기 트레이닝 구간의 길이가 증가할수록 시스템의 효율이 감소(즉, 시스템의 손실(loss) 이 증가) 될 수 있다.

[223]

[224] 채널 상태 정보 피드백(Channel State Information feedback)

[225] 레거시(legacy) LTE 시스템을 포함한 대부분의 셀룰러 시스템(cellular system) 에서, 단말은 채널 추정(channel estimation) 을 위한 파일럿 신호(예: 참조 신호(Reference Signal, RS)) 를 기지국으로부터 수신하여 채널 상태 정보(Channel State Information, CSI) 를 산출하고, 산출된 값을 기지국으로 보고(report) 한다.

기지국은 단말로부터 피드백(feedback) 받은 CSI 정보에 기반하여 데이터(data) 신호(즉, 하향링크 데이터)를 전송한다. LTE 시스템의 경우, 단말이 피드백하는 CSI 정보는 채널 품질 정보(Channel Quality Information, CQI), 프리코딩 행렬 인덱스(Precoding Matrix Index, PMI), 랭크 지시자(Rank Indicator, RI)를 포함한다. 이하, CQI 피드백, PMI 피드백, 및 RI 피드백에 대해 구체적으로 살펴본다.

[226] 먼저, CQI 피드백은 기지국이 데이터를 전송할 때 어떠한 변조 및 부호화 기법(Modulation and Coding Scheme, MCS) 을 적용할 지에 대한 정보를 제공하려는 목적으로 단말이 기지국으로 제공하는 무선 채널 품질 정보이다. 기지국과 단말 간의 무선 품질이 높은 경우, 단말은 높은 CQI 값을 기지국으로 피드백한다. 높은 CQI 값을 피드백 받은 기지국은 상대적으로 높은 변조 차수(modulation order) 와 낮은 채널 코딩 비율(channel coding rate) 을 적용하여 데이터를 전송한다. 이와 달리, 기지국과 단말 간의 무선 품질이 낮은 경우, 단말은 낮은 CQI 값을 기지국으로 피드백한다. 낮은 CQI 값을 피드백 받은 기지국은 상대적으로 낮은 변조 차수와 높은 채널 코딩 비율을 적용하여 데이터를 전송한다.

[227] 다음으로, PMI 피드백은 기지국이 다중 안테나(multiple-antenna) 를 설치한 경우, 어떠한 MIMO(Multiple-Input Multiple-Output) 프리코딩 기법(precoding scheme) 을 적용할 지에 대한 정보를 제공하려는 목적으로 단말이 기지국으로 제공하는 선호되는 프리코딩 행렬(preferred precoding matrix) 정보이다. 단말은 파일럿 신호로부터 기지국과 단말 간의 하향링크 MIMO 채널을 추정하고, 기지국이 어떠한 MIMO 프리코딩을 적용하면 효율적일 지에 대한 정보를 PMI 피드백을 통해 전달한다. LTE 시스템의 경우, PMI 구성에 있어 행렬 형태로 표현 가능한 선형 MIMO 프리코딩(linear MIMO precoding) 만 고려된다.

[228] 이 경우, 기지국과 단말은 다수의 프리코딩 행렬들로 구성된 코드북 (codebook) 을 공유하고 있으며, 코드북 내 각각의 MIMO 프리코딩 행렬은 고유의 인덱스(index) 를 갖는다. 따라서, 단말은 코드북 내에서 가장 선호하는 MIMO 프리코딩 행렬에 해당하는 인덱스를 PMI 를 통해 피드백함에 따라, 단말의 피드백 정보량을 최소화한다. 이 때, PMI 값이 반드시 하나의 인덱스로만 구성될 필요는 없다. 일례로, 송신 안테나 포트(transmission antenna port) 의 수가 8 개인 경우, 두 개의 인덱스들(즉, 제1 PMI(first PMI) 및 제2 PMI(second PMI)) 을 결합하여 최종적인 8 Tx(Transmission) MIMO 프리코딩 행렬이 도출될 수 있다.

[229] 다음으로, RI 피드백은 기지국과 단말이 다중 안테나를 설치하여 공간 다중화 (spatial multiplexing) 을 통한 다중-레이어(multi-layer) 전송이 가능한 경우, 단말이 선호하는 전송 레이어의 수에 대한 정보를 제공하려는 목적으로 단말이 기지국으로 제공하는 선호하는 전송 레이어 수에 대한 정보이다. 이 때, RI는 PMI 와 밀접한 관계가 있는데, 이는, 전송 레이어 수에 따라 기지국은 각각의 레이어에 대해 어떠한 프리코딩을 적용해야 하는 지 알 수 있어야 하기 때문이다.

[230] PMI/RI 피드백 구성에 있어, 단일 레이어 전송을 기준으로 PMI 코드북을 구성한 후 레이어 별로 PMI 를 정의하여 단말이 피드백하는 방법이 고려될 수 있다. 다만, 이러한 방법은 전송 레이어 수의 증가에 따라 PMI/RI 피드백의 정보량이 크게 증가하는 단점이 있다. 따라서, LTE 시스템의 경우, 각각의 전송 레이어 수에 따른 PMI 코드북이 정의되어 있다. 즉, R-레이어(R-layer) 전송을 위하여, 크기 Nt x R의 행렬 N 개가 코드북 내에 정의된다. 여기에서, R은 레이어의 수, Nt는 송신 안테나 포트 수, N은 코드북의 크기를 의미한다. 따라서, LTE 시스템의 경우, 전송 레이어 수에 관계없이 PMI 코드북의 크기가 정의된다. 이 경우, 전송 레이어 수(R)는 프리코딩 행렬(Nt x R 행렬)의 랭크(rank) 값과 일치하게 된다.

[231] 본 명세서에서 설명되는 PMI/RI 는, 프리코딩 행렬(Nt x R 행렬)의 인덱스 값과 프리코딩 행렬의 랭크 값을 의미하는 LTE 시스템에서의 PMI/RI 를 의미하는 것으로 제한되지 않는다. 또한, 본 명세서에서 설명되는 PMI 는 송신단에서 적용 가능한 MIMO 프리코더 중에서 선호하는 MIMO 프리코더 정보를 나타내는 정보를 의미한다. 이 경우, 프리코더의 형태는 행렬로 표현가능 한 선형 프리코더 만으로 한정되지 않는다. 또한, 본 명세서에서 설명되는 RI는 선호하는 전송 레이어 수를 나타내는 피드백 정보를 모두 포함하는 것으로, LTE 에서의 RI보다 더 넓은 의미로 해석될 수 있다.

[232] 이러한 CSI 정보는 전체 시스템 주파수 영역에 대해 생성되거나, 또는 일부 주파수 영역에 대해 생성될 수도 있다. 특히, 광대역 시스템(wideband (또는 broadband) system)에서는 단말 별로 선호하는 일부 주파수 영역(예: 서브밴드 (subband))에 대한 CSI 정보를 생성하여 피드백하는 방법이 효율적일 수 있다.

[233] 또한, LTE 시스템에서 CSI 정보에 대한 피드백은 상향링크 채널을 통해 수행된다. 일반적으로, 주기적인(periodic) CSI 피드백은 PUCCH(Physical Uplink Control Channel)를 통해 수행되고, 비주기적인(aperiodic) CSI 피드백은 PUSCH(Physical Uplink Shared Channel)을 통해 수행된다.

[234] PUCCH 를 통해 수행되는 주기적인 CSI 피드백에 대한 PUCCH CSI 보고 모드(PUCCH CSI reporting mode)는 표 6과 같이 정의될 수 있다. 여기에서, PUCCH CSI 보고 모드는, 단말이 주기적인 CSI 피드백을 수행하는 경우에 단말이 어떠한 정보를 피드백해야 하는 지에 대해 모드로 구분한 것을 의미한다.

[235]

[236] [표 6]

		PMI Feedback Type	
		No PMI (OL, TD, single-antenna)	Single PMI (CL)
CQI Feedback Type	Wideband	Mode 1-0 RI (only for Open-loop SM) One wideband CQI(4bit) when RI>1, CQI of first codeword	Mode 1-1 RI Wideband CQI(4bit) Wideband spatial CQI(3bit) for RI>1 Wideband PMI(4bit)
	UE selected	Mode 2-0 RI (only for Open-loop SM) Wideband CQI(4bit) Best-1 CQI(4bit) in each BP Best-1 indicator(L-bit label) when RI>1, CQI of first codeword	Mode 2-1 RI Wideband CQI(4bit) Wideband spatial CQI(3bit) for RI>1 Wideband PMI(4bit) Best-1 CQI(4bit) 1 in each BP Best-1 spatial CQI(3bit) for RI>1 Best-1 indicator(L-bit label)

[237]

[238] 주기적인 CSI 피드백과 달리, 비주기적인 CSI 피드백은 기지국이 CSI 피드백 정보를 요청하는 경우에만 일시적으로 수행된다. 이 경우, 기지국은 PDCCH(Physical Downlink Control Channel)/ePDCCH(enhanced PDCCH)와 같은 하향링크 제어 채널을 통해 비주기적인 CSI 피드백을 트리거(trigger) 한다. LTE 시스템에서 비주기적인 CSI 피드백이 트리거된 경우, 단말이 어떠한 정보를 피드백해야 하는 지에 대한 PUSCH CSI 보고 모드(PUSCH CSI reporting mode)는 표 7과 같이 정의될 수 있다. 이 경우, 단말이 동작할 PUSCH CSI 보고 모드는 상위 계층 시그널링(higher layer signaling) (즉, 상위 계층 메시지)을 통해 지시될 수 있다.

[239]

[240] [표7]

		PMI Feedback Type	
		No PMI (OL, TD, single-antenna)	With PMI (CL)
PUSCH CQI feedback type	Wideband (wideband CQI)		Mode 1-2 Multiple PMI RI 1st wideband CQI(4bit) 2nd wideband CQI(4bit) if RI> 1 Subband PMI on each subband
	UE Selected (subband CQI)	Mode 2-0 RI (only for Open-loop SM) Wideband CQI(4bit) + Best-M CQI(2bit) Best-M index when RI>1 , CQI of first codeword	Mode 2-2 Multiple PMI RI 1st wideband CQI(4bit) + Best-M CQI(2bit) 2nd wideband CQI(4bit) + Best-M CQI(2bit) if RI>1 Wideband PMI Best-M PMI Best-M index
	Higher layer-configured (subband CQI)	Mode 3-0 RI (only for Open-loop SM) WidebandCQI(4bit)+subbandCQI(2bit) when RI>1 , CQI of first codeword	Mode 3-1 Single PMI RI 1st wideband CQI(4bit)+subband CQIs(2bit) 2nd wideband CQI (4bit)+subband CQI(2bit) if RI>1 Wideband PMI

[241]

[242] PUCCH 는 PUSCH 보다 한 번에 전송할 수 있는 데이터의 양(즉, 페이로드 크기(payload size))이 작으므로, PUCCH 의 경우, 전송하고자 하는 CSI 정보를 한 번에 전송하기 어려울 수 있다. 이에 따라, 각 PUCCH CSI 보고 모드에 따라 CQI 및 PMI 를 전송하는 시점(예: 서브프 레임)과 RI를 전송하는 시점이 다르게 설정될 수 있다. 예를 들어, 표 4의 Mode 1-0의 경우, 단말은 특정 PUCCH 전송 시점에서 RI만 전송하고, 다른 PUCCH 전송 시점에서 광대역 CQI(wideband CQI) 를 전송할 수 있다.

[243] 또한, PUCCH 보고 유형(PUCCH reporting type)은 특정 PUCCH 전송 시점에 구성되는 CSI 정보의 종류에 따라 정의될 수 있다. 예를 들어, RI만 전송하는 보고 유형은 유형 3(type 3)에 해당하고, 광대역 CQI 만 전송하는 보고 유형은 유형 3(type 4)에 해당한다. RI 에 대한 피드백 주기(feedback period) 및 오프셋 (offset) 값과 CQI/PMI 에 대한 피드백 주기 및 오프셋 값은 상위 계층 시그널링 (즉, 상위 계층 메시지)를 통해 단말로 지시(또는 설정) 될 수 있다.

[244] 앞서 설명된 CSI 피드백 정보는 상향링크 제어 정보(Uplink Control Channel, UCI) 에 포함된다.

[245]

[246] <u>참조 신호(Reference Signal, RS)</u>

[247] 무선 통신 시스템에서 데이터는 무선 채널을 통해 전송되기 때문에, 신호는 전송 중에 왜곡될 수 있다. 수신단에서 왜곡된 신호를 정확하게 수신하기 위하여, 수신된 신호의 왜곡은 채널 정보를 이용하여 보정되어야 한다. 채널 정보를 검출하기 위하여 송신측과 수신측 모두 알고 있는 신호 전송 방법과

신호가 채널을 통해 전송될 때 왜곡된 정도를 이용하여 채널 정보를 검출하는 방법을 주로 이용한다. 상술한 신호를 파일럿 신호(pilot signal) 또는 참조 신호(Reference Signal, RS) 라고 한다.

[248] 또한 최근 대부분의 이동 통신 시스템에서 패킷(packet) 을 전송할 때, 지금까지 한 개의 송신안테나와 한 개의 수신안테나를 사용했던 것에서 탈피, 다중 송신 안테나와 다중 수신 안테나를 채택해 송수신 데이터 효율을 향상시 킬 수 있는 방법을 사용한다. 다중 입출력 안테나를 이용하여 데이터를 송수신할 때, 신호를 정확하게 수신하기 위하여 송신 안테나와 수신 안테나 간의 채널 상태가 검출되어야 한다. 따라서 각 송신 안테나는 개별적인 참조 신호를 가져야 한다.

[249] LTE 시스템의 경우, 파일럿 신호 또는 RS의 용도는 다음과 같이 4 개의 유형으로 정의될 수 있다.

[250] (1) 측정 RS(Measurement RS) :채널 상태 측정용 파일럿

[251] 1) CSI 측정(measurement)/ 보고(reporting) 용도 (단기 측정(short term measurement): 링크 적응(link adaptation), 랭크 적응(rank adaptation), 폐루프(closed loop) MIMO 프리코딩 등의 목적

[252] 2) 장기(long term) 측정/보고 용도: 핸드오버 (handover), 셀 선택/재선택 (cell selection/reselection) 등의 목적

[253] (2) 복조 RS(Demodulation RS): 물리 채널 수신용 파일럿

[254] (3) 포지셔닝 Repositioning RS): 단말 위치 추정용 파일럿

[255] (4) MBSFN RS (Multicast-Broadcast Single-Frequency Network Reference Signal): 멀티캐스트(Multicast)/ 브로드캐스트(Broadcast) 서비스를 위한 파일럿

[256]

[257] 이동 통신 시스템에서 RS는 그 목적에 따라 크게 두 가지로 구분될 수 있다. 채널 정보 획득을 위한 목적의 RS와 데이터 복조를 위해 사용되는 RS가 있다. 전자는 UE가 하향 링크로의 채널 정보를 획득하는데 그 목적이 있으므로, 광대역으로 전송되어야 하고, 특정 서브 프레임에서 하향 링크 데이터를 수신하지 않는 UE라도 그 RS를 수신하고 측정할 수 있어야 한다. 또한 이는 핸드오버 등의 측정 등을 위해서도 사용된다. 후자는 기지국이 하향링크 를 보낼 때 해당 리소스에 함께 보내는 RS로서, UE는 해당 RS를 수신함 으로써 채널 추정을 할 수 있고, 따라서 데이터를 복조할 수 있게 된다. 이 RS는 데이터가 전송되는 영역에 전송되어야 한다.

[258] 이 경우, 안테나의 수가 많아짐 에 따른 RS 오버헤드(overhead) 문제를 해결하기 위하여, 채널 정보 획득을 위한 목적의 RS로 CSI-RS(Channel State Information-RS) 가 이용되고, 데이터 복조를 위해 사용되는 RS로 단말-특정 (UE-specific) RS가 이용될 수 있다. CSI-RS 는 CSI 측정 및 피드백 전용으로 설계된 RS이며, CRS(Cell-specific Reference Signal) 에 비해 매우 낮은 RS 오버헤드를 갖는다. 또한, CRS 는 4 개의 다중 안테나 포트까지 지원하는데 반해, CSI-RS 는 8 개의 다중 안테나 포트까지 지원 가능하도록 설계되었다.

[259] 또한, 단말-특정 RS는 데이터 채널의 복조 전용으 로 설계되어, CRS와 달리, 해당 단말에 대한 데이터 전송 시에 적용된 MIMO 프리코딩 기법이 파일럿 신호에 동일하게 적용된 RS(즉, 프리코딩된 RS(precoded RS)) 이다. 따라서, 단말-특정 RS는 전송 레이어(layer) 의 수(즉, 전송 랭크(rank)) 만큼만 전송되면 될 뿐, CRS 및 CSI-RS 와 같이 안테나 포트의 개수만큼 전송될 필요가 없다. 또한, 단말-특정 RS는 기지국의 스케쥴러 (scheduler) 를 통해 각 단말에 대해 할당된 데이터 채널 자원 영역과 동일한 자원 영역에서 해당 단말의 데이터 채널 수신 용도로 전송되 므로, 단말 특정적인 RS라는 특징이 있다.

[260] 또한, LTE 상향링 크의 경우, 측정 RS로 사운딩 RS(Sounding RS, SRS) 가 존재하고, 상향링 크 데이터 채널(PUSCH) 에 대한 복조 RS(즉, DM-RS) 와 ACK/NACK 및 CSI 피드백을 위한 상향링크 제어 채널(PUCCH) 에 대한 복조 RS가 각각 존재한다.

[261] 또한, NR 시스템의 경우, 위상(phase) 의 변화를 측정(measurement) 및 추적(tracking) 하기 위한 PTRS(Phase-Tracking Reference Signal) 이 추가적으로 존재할 수 있다.

[262]

[263] 기지국은 단말에 대해 주기적(periodic) CSI 보고, 반-지속적(semi-persistent) CSI 보고, 및/또는 비주기적(aperiodic) CSI 보고를 요청할 수 있다. 여기에서, 상기 반-지속적 CSI 보고는 특정 시간 구간 동안에 만 주기적 CSI 보고가 활성화되는 것을 의미할 수 있다. 이 때, 주기적 CSI 보고 및 반-지속적 CSI 보고가 활성화(activation) 된 기간(duration) 에서는, CSI 보고를 위한 UL 자원(예 : PUCCH) 이 특정 주기로 단말에게 할당된다.

[264] 단말의 CSI 측정을 위하여, 기지국은 DL 참조 신호(downlink reference signal, DL RS) 를 전송할 필요가 있다. 빔포밍(예: 아날로그 빔포밍) 이 적용되는 시스템의 경우, DL RS의 송수신을 위한 DL 송신 및 수신 빔 쌍(downlink transmission/reception beam pair, DL Tx/Rx beam pair) 이 결정(또는 설정) 될 필요가 있다. 뿐만 아니라, UL 제어 정보(예 :HARQ-ACK 정보, CSI) 의 송수신을 위한 UL 송신 및 수신 빔 쌍(uplink transmission/reception beam pair, UL Tx/Rx beam pair) 도 결정될 필요가 있다. 이하, 본 명세서에서 설명의 편의를 위하여, DL 송신 및 수신 빔 쌍은 DL 빔 쌍(DL beam pair) 으로 지칭되고, UL 송신 및 수신 빔 쌍은 UL 빔 쌍(UL beam pair) 으로 지칭된다.

[265] DL 빔 쌍을 결정하는 절차는, 다음과 같은 두 단계의 절차들의 조합으로 설정될 수 있다. 구체적으로, 상기 두 단계의 절차들 중 하나는, 기지국이 다수의 기지국 송신 빔(즉, TRP 송신 빔)들에 해당하는 DL RS를 단말로 전송하고, 해당 단말이 다수의 기지국 송신 빔들 중 하나를 선택 및/또는 보고하는 절차(즉, 기지국 송신 빔 선택 절차) 이다. 또한, 나머지 절차는, 기지국이 각 기지국 송신 빔에 해당하는 동일한 DL RS를 반복하여 전송하고, 단말이 반복하여 전송되는 신호들에 대해 서로 다른 단말 수신 빔(UE Rx beam) 을 이용하여 측정을

수 행하고, 측정에 따라 단말 수신 빔을 선택(또는 결정) 하는 절차이다.

[266] 이와 유사하게, UL 빔 쌍을 결정하는 절차도, 다음과 같은 두 단계의 절차들의 조합으로 설정될 수 있다. 구체적으로, 상기 두 단계의 절차들 중 하나는, 단말이 다수의 단말 송신 빔(UE Tx beam)들에 해당하는 UL RS를 기지국으로 전송하고, 해당 기지국이 다수의 단말 송신 빔들 중 하나를 선택 및/또는 시그널링 (signaling) 하는 절차(즉, 단말 송신 빔 선택 절차) 이다. 또한, 나머지 절차는, 단말이 각 단말 송신 빔에 해당하는 동일한 UL RS를 반복하여 전송하고, 기지국이 반복하여 전송되는 신호들에 대해 서로 다른 기지국 수신 빔(즉, TRP 수신 빔)을 이용하여 측정을 수행하고, 측정에 따라 기지국 수신 빔을 선택하는 절차이다.

[267] 이 때, DL 빔과 UL 빔 간에 빔 호혜성(beam reciprocity) 이 성립하는 경우, 상술한 DL 빔 쌍을 결정하는 절차 또는 UL 빔 쌍을 결정하는 절차 중 어느 하나는 생략될 수 있다. 이는, 빔 대응성(beam correspondence) 이 성립하는 경우에도 동일하게 적용될 수 있다. 여기에서, 빔 호혜성 (또는 빔 대응성) 이 성립한다는 것은, 기지국과 단말 간의 통신에서 기지국 전송 빔과 기지국 수신 빔이 일치하고, 단말 전송 빔과 단말 수신 빔이 일치한다고 가정할 수 있는 것을 의미할 수 있다. 여기에서, 기지국 전송 빔 및 기지국 수신 빔은 각각 DL 송신 빔 및 DL 수신 빔을 의미하고, 단말 전송 빔 및 단말 수신 빔은 각각 UL 송신 빔 및 UL 수신 빔을 의미할 수 있다.

[268] 상술한 DL 빔 쌍을 결정하는 절차 및 UL 빔 쌍을 결정하는 절차는 주기적 또는 비주기적으로 수행될 수 있다. 다만, 후보 빔(candidate beam)의 수가 많은 경우에는 빔 쌍 결정을 위해 요구되는 RS 오버헤드(RS overhead) 가 클 수 있으므로, 상기 절차들을 빈번하게 (frequently) 수행하는 것은 비효율적일 수 있다.

[269]

[270] 이 때, 앞서 언급된 주기적 CSI 보고 또는 반-지속적 CSI 보고는, 상술한 DL 빔 쌍을 결정하는 절차 및 UL 빔 쌍을 결정하는 절차가 완료된 이후에 수행되는 것으로 가정할 수 있다.

[271] 이 때, 단일 또는 다수의 안테나 포트(antenna port) 들을 포함하는 CSI-RS (상술한 단말의 CSI 측정을 위한 CSI-RS) 는 DL 빔으로 결정된 기지국 전송 빔을 통해 빔포밍되어 전송될 수 있다. 이 경우, CSI-RS 의 전송 주기(transmission period) 는 CSI 보고 주기와 동일하거나, 또는 더 짧게(즉, CSI-RS 전송이 CSI 보고보다 빈번하게 수행되도록) 설정될 수 있다. 또한, 비주기적 CSI-RS 를 CSI 보고 주기에 맞추어 전송하는 방법 또는 비주기적 CSI-RS 전송이 CSI 보고보다 빈번하게 수행되도록 설정하는 방법도 고려될 수 있다. 이 후, 단말은 상술한 UL 빔 쌍을 결정하는 절차에 따라 결정된 단말 송신 빔(즉, UL 송신 빔)을 통해 CSI를 주기적으로 전송할 수 있다.

[272] 다만, 단말의 위치 이동, 단말의 회전(rotation), 및/또는 주변 물체의 이동으로

인하여 무선 채널 환경이 변경되는 경우, 최적의 DL 빔 쌍 및/또는 UL 빔 쌍은 변경될 수 있다. 예를 들어, 빔 차단(block) 으로 인해 LoS(Line of Sight) 환경이 Non-LoS 환경으로 변환되는 경우, 최적의 빔 쌍이 변경될 수 있다. 이 때, 매 CSI 보고 시점(instance, timing) 마다 DL 빔 및/또는 UL 빔을 보정하는 절차를 수행하 는 것은 RS 오버헤드 및/또는 시그널링 오버헤드 측면에서 비효율적일 수 있다. 특히, 주기적(또는 반-지속적) CSI 보고는 기지국과 단말 간에 데이터 트래픽 (data traffic) 이 존재하지 않는 경우에도 링크 유지 및 트래픽 발생 시 신속한 스케줄링 (scheduling) 을 위해 활성화될 수 있다.

[273] 상술한 점들을 고려하면, 단말과 기지국의 전력 소모 관점에서, 최적의 빔 쌍을 결정하는 절차를 빈번하게 수행하는 것은 바람직하지 않을 수 있다. 따라서, 빔 쌍을 결정하는 절차는 CSI 보고보다 덜 빈번하게 수행되도록 설정될 수 있다. 이 경우, 빔이 엇갈리게 배열될(misaligned) 수 있으며, 이에 따라 통신 품질이 떨어지는 문제가 발생될 수 있다.

[274]

[275] 도 8은 주기적 또는 반-지속적 CSI 보고와 관련된 빔 엇갈림 현상의 일 예를 나타낸다. 도 8은 단지 설명의 편의를 위한 것일 뿐, 본 발명의 범위를 제한하는 것이 아니다.

[276] 도 8을 참고하면, 기지국 및 단말은 최적의 빔 쌍(즉, 최적의 DL 빔 쌍 및 UL 빔 쌍)을 결정하기 위한 빔 관리 절차(beam management procedure) 802를 수행하는 경우가 가정된다. 또한, DL 빔과 UL 빔 간에 빔 호혜성(또는 빔 대응성)을 만족하며, 단말이 회전함에 따라 빔이 어긋나는 경우가 가정된다.

[277] 도 8에 나타난 것과 같이, 빔 관리 절차(즉, 최적의 빔 쌍을 결정하는 절차) 가 CSI 보고 주기보다 길게 설정되는 경우, 빔 쌍을 구성하는 빔들 간에 어긋나는 경우가 발생될 수 있다.

[278] 구체적으로, 구간 804에서, 단말은 빔 관리 절차 802를 통해 결정된 최적의 빔 쌍을 이용하여 기지국으로부터 전송되는 CSI-RS 를 수신하고, CSI 보고를 전송할 수 있다. 다만, 구간 806에서와 같이, 단말의 회전 등에 의해 빔 쌍을 구성하는 빔들이 서로 어긋나는 경우가 발생될 수 있다. 또한, 구간 808을 참고하면, 구간 806과 비교하여 시간이 지남에 따라 빔들 간의 어긋나는 정도가 더 커질 수도 있다.

[279] 이와 같이, 빔 관리 절차를 통해 결정된 최적의 빔 쌍이 단말의 회전 등을 통해 서로 어긋나는 경우, 기지국과 단말 간의 통신 품질이 저하될 수 있다. 구체적으로, CSI 보고에 대한 빔 품질이 저하되는 경우, DL 적응(DL adaptation) 시의 MCS(Modulation and Coding Scheme) 저하(예 :CQI 저하)뿐만 아니라, CSI 피드백 정보 자체가 기지국으로 전달되지 않는 경우가 발생될 수 있다. 이 경우, 별도의 빔 복구 절차(beam recovery procedure) 및/또는 링크 복구 절차(link recovery procedure) 등이 요구될 수 있다. 이와 같은 별도의 절차들은 일반적으로 기지국 및/또는 단말의 시그널링에 따른 전력 소모(power consumption), 복구되기

전까지의 통신 단절(disconnection) 및 지연(latency, delay) 등과 같은 문제들을 야기할 수 있다.

[280] 이하, 본 명세서에서는, 단말이 주기적(또는 반-지속적) CSI 보고를 수행하는 경우에 발생될 수 있는 상술한 문제들을 해결하기 위한 방법들을 살펴본다. 구체적으로, 주기적(또는 반-지속적) CSI 보고 도중에, 추가적인 빔 관리 절차(즉, 최적의 빔 쌍을 결정하는 절차)를 수행하지 않으면서도 기지국과 단말 간의 링크 품질(또는 채널 품질, 빔 품질)을 유지하기 위한 방법을 제안한다.

[281] 또한, 본 명세서에서 설명되는 방법은 CSI 보고뿐만 아니라, 다른 UL 제어 정보(예: HARQ-ACK 정보, 스케줄링 요청(Scheduling Request, SR), 빔 실패 복구(beam failure recovery) 를 위한 정보 등)에도 적용될 수 있음은 물론이다.

[282] 또한, 이하 설명되는 실시 예들은 설명의 편의를 위하여 구분된 것일 뿐, 어느 실시 예의 일부 구성이나 특징은 다른 실시 예에 포함될 수 있고, 또는 다른 실시 예의 대응하는 구성 또는 특징과 교체될 수 있다. 예를 들어, 이하 제1 실시 예에서 설명되는 방식이 제2 실시 예 및/또는 제3 실시 예에서 설명되는 방식에 추가적으로 적용될 수 있으며, 그 반대의 경우도 가능하다.

[283]

[284] 제1 실시 예 - UL 채널 전송을 위한 빔의 수를 변경하는 방법

[285] 먼저, 단말이 UL 채널(예: PUCCH) 을 스위핑(sweeping) 하는 방법이 고려될 수 있다. 다시 말해, 단말이 UL 제어 정보를 다수의 빔들을 통해 분할(division) 또는 반복(repetition) 하여 전송하는 방법이 고려될 수 있다.

[286]

[287] 도 9는 본 명세서에서 제안하는 방법이 적용될 수 있는 다수의 빔들을 통해 UL 제어 정보를 전송하는 방법의 일 예를 나타낸다. 도 9는 단지 설명의 편의를 위한 것일 뿐, 본 발명의 범위를 제한하는 것이 아니다.

[288] 도 9를 참고하면, 앞서 설명된 도 8과 같이, 기지국 및 단말은 빔 관리 절차 902를 통해 최적의 빔 쌍을 결정하여 주기적(또는 반-지속적) CSI 보고 절차를 수행하는 경우가 가정된다.

[289] 또한, 단말은 다수의 빔의 적용과 관련하여 미리 설정된 조건을 만족하는지 여부에 따라, 단일 빔 또는 다수의 빔들을 통해 UL 채널을 전송하도록 설정될 수 있다.

[290] 구간 904 및 구간 906은 앞서 설명된 도 8의 구간 804 및 806에 대응될 수 있다. 즉, 구간 904에서, 단말은 설정된 최적의 빔 쌍에 따른 수신 빔을 이용하여 CSI-RS를 수신하고, 최적의 빔 쌍에 따른 송신 빔을 이용하여 CSI를 보고할 수 있다.

[291] 이와 달리, 구간 906의 경우, 단말의 회전에 의해 구간 904에서 이용된 단말 빔이 기지국 빔과 어긋나게 배열된다. 다만, 이 경우에도, 미리 설정된 조건(예: 링크 품질이 임계 값 이하로 측정되는 경우)이 충족되지 않음에 따라, 단말은 그대로 단일 빔을 이용하여 CSI를 보고한다.

[292] 이후, 단말의 회전이 더욱 진행됨에 따라 미리 설정된 조건이 충족되는 경우, 구간 908에 나타난 것과 같이, 단말은 다수의 빔들을 이용하여 CSI를 보고할 수 있다.

[293] 이와 같이, 단말이 다수의 빔들을 이용하여 CSI를 보고함에 따라, 빔의 어긋남에 의해 발생될 수 있는 CSI 보고 메시지 손실을 방지할 수 있는 효과가 있으며, 불필요한 빔 복구 절차(또는 링크 복구 절차) 등이 수행될 확률이 낮아질 수 있다.

[294]

[295] 이하, 단말이 UL 채널 전송을 위하여 단일 빔 또는 다수의 빔들을 이용하여 즉, 적용되는 빔의 수를 변경하여 UL 채널을 전송하는 방법에 대한 구체적인 내용에 대해 살펴본다.

[296] 예를 들어, 단말이 주기적 또는 반-지속적 CSI 보고를 수행할 때, DL RS를 이용하여 (즉, DL RS에 의해) 측정된 링크 품질 수준이 낮아지면, 단말은 CSI 보고를 위한 UL 채널(예: PUCCH) 에 이용되는 UL 송신 빔의 수를 증가시 킬 수 있다. 이 때, 단말이 링크 품질 수준이 낮아지는 것을 판단(또는 결정) 하기 위하여 일정 수준 값(즉, 임계(threshold) 값, 미리 설정된 수준 값)이 이용될 수도 있다. 여기에서, DL RS를 이용하여 측정되는 링크 품질(즉, 측정 정보)은 아래와 같은 정보들 중 적어도 하나일 수 있다.

[297] - CSI 보고를 위해 측정된 채널 품질 지시자(Channel Quality Indicator, CQI) 정보

[298] - CSI 보고를 위해 측정된 랭크 지시자(Rank Indicator, RI)에 관계 없이 DL 전송 RI를 '1'로 가정하여 측정된 CQI 정보

[299] - DL RS에 대한 수신 전력 정보 (예: RSRP(Reference Signal Received Power) 등)

[300] - DL RS에 대한 수신 품질 정보 (예: RSRQ(Reference Signal Received Quality) 등)

[301]

[302] 이 때, 단말이 UL 채널 전송을 위해 다수의 빔들을 적용하는 방법은 다음과 같을 수 있다.

[303] 일례로, 단말은 링크 품질이 일정 수준 이상인 경우 PUCCH 전송을 위해 단일 빔(single beam)을 적용하고, 링크 품질이 일정 수준 이하인 경우 PUCCH 전송을 위해 다수의 빔들(a plurality of beams)을 적용하도록 설정될 수 있다. 다시 말해, 측정된 링크 품질이 미리 설정된 조건(또는 값)을 만족하는지 여부에 따라, 단말은 단일 빔 또는 다수의 빔들을 통해 PUCCH를 전송할 수 있다.

[304] 또는, 링크 품질에 대한 일정 수준(즉, 임계 값)을 다중화하여 링크 품질 구간이 떨어질 때마다 PUCCH 전송에 이용되는 빔의 수를 점차적으로 증가시키는 방법도 고려될 수 있다. 다시 말해, 단말은 링크 품질에 대해 미리 설정된 다수의 임계 값들에 따라, PUCCH 전송에 이용할 빔의 수 또는 빔 집합을 단계적으로 변경(즉, 감소 또는 증가) 할 수 있다.

[305] 예를 들어, 상대적으로 인접한 빔포밍 방향들의 빔들로 구성된 빔 집합 A 및

상대적으로 멀리 떨어진 빔포밍 방향들의 빔들로 구성된 빔 집합 B 등과 같이, 동일한 빔 수로 구성된 다수의 집합들이 존재할 수 있다. 이 경우, 단말은 링크 품질이 우수한 경우(즉, 일정 수준 이상인 경우)에는 빔 집합 A 를 적용하고, 우수하지 못한 경우에는 빔 집합 B 를 적용하도록 설정될 수 있다. 이와 같은 빔 집합들은 단말에 의해 결정되거나, 기지국에 의해 미리 설정될 수도 있다.

[306] 본 명세서에서는 CSI 보고를 위한 UL 제어 채널을 PUCCH 로 지칭한다. 다만, 이는 설명의 편의를 위한 것일 뿐, 임의의 CSI 보고를 위해 설정된 물리 채널(예: PUSCH) 에도 상술한 방법이 적용될 수 있음은 물론이다.

[307]

[308] 상술한 방법의 경우, 단말은 측정된 링크 품질에 따라 PUCCH 전송에 이용되는 빔의 수 또는 빔 집합을 결정할 수 있다. 이는, 링크 품질이 저하되는 경우에 CSI 피드백(feedback) 정보 전달의 신뢰성(reliability) 를 향상시키기 위함이다. 다만, 단말은 링크 품질 뿐만 아니라, 피드백 정보의 중요성 (또는 유형) 에 따라 PUCCH 전송에 이용되는 빔의 수 또는 빔 집합을 결정할 수도 있다.

[309] 예를 들어, 단말은 CSI 보고 정보에 따라 CSI 보고를 위한 UL 채널(예: PUCCH, PUSCH) 에 이용되는 UL 송신 빔의 수 또는 빔 집합을 결정(또는 변경) 할 수 있다. 구체적으로, 단말이 비교적 높은 신뢰도(reliability) 로 기지국으로 전달될 필요가 있는 정보를 전송하는 경우, 단말은 다수의 빔들을 이용하여 PUCCH 를 전송할 수 있다. 여기에서, 상기 정보는 RI, 빔 인덱스(beam index), CSI-RS 자원 지시자(CSI-RS Resource Indicator, CRI) 등을 포함할 수 있다.

[310] 이와 달리, 단말이 상대적으로 중요도가 낮은 정보를 전송하는 경우, 단말은 단일 빔을 이용하여 PUCCH 를 전송할 수 있다. 여기에서, 상기 정보는 PMI(Precoding Matrix Indicator), CQI, 명시적인(explicit) 피드백 정보(예:채널 공분산 행렬(channel covariance matrix), 고유 백터/값(eigen vector/value), 채널 계수(channel coefficient)) 등을 포함할 수 있다.

[311] 또한, 단일 빔이 적용된 PUCCH 와 다수의 빔들이 적용된 PUCCH 와 관련하여, 하나의 슬롯(또는 서브프레임)에서 N 번 반복 전송되는 복수의 PUCCH 자원들 (또는 심볼 그룹들) 에 대해 N 개의 빔들이 각각 결정될 수 있다. 이 때, 단일 빔이 적용된 PUCCH 와 다수의 빔들이 적용된 PUCCH 는, N 개의 빔들에 대해 동일한 빔으로 설정(또는 지시, 적용)되는지 또는 다른 빔으로 설정되는지에 따라 구분될 수 있다.

[312] 일례로, 상술한 spatial_relation_info field 가 하나의 슬롯 내에서 반복하여 전송되는 다수의 PUCCH 자원들 각각에 대해 설정 또는 지시될 수 있다. 이 때, 단일 빔이 적용된 PUCCH 와 다수의 빔들이 적용된 PUCCH 는, 다수의 PUCCH 자원들 모두 대해 동일한 spatial_relation_info 값이 적용되는지 여부에 따라 구분될 수 있다. 또는, 단일 빔이 적용된 PUCCH 와 다수의 빔들이 적용된 PUCCH 는, 하나의 슬롯 내에서 전송되는 하나의 PUCCH 자원의 PUCCH 심볼 그룹 별로 spatial_relation_info 값이 동일하게 또는 다르게 설정되는지 여부에

따라 구분될 수도 있다.

[313] 또한, 단일 빔이 적용된 PUSCH 와 다수의 빔들이 적용된 PUSCH 는, 심볼 그룹 단위로 반복 전송을 수행하며 서로 다른 심볼 그룹에 동일한 SRI 값이 적용되는지 여부에 따라 구분될 수 있다.

[314]

[315] 또한, 앞서 언급한 바와 같이, 정보의 중요도에 따라 단말이 이용할 빔의 수 또는 빔 집합을 결정하는 방법은 CSI 뿐만 아니라 다른 UL 제어 정보에도 적용될 수 있다. 예를 들어, HARQ-ACK 정보, CSI, SR, 및 빔 실패 복구와 관련된 정보 등에 대해 단말은 각각 다른 수의 빔(들)을 이용하여 전송을 수행할 수도 있다.

[316] 구체적으로, PUCCH 포맷에 따라 빔의 수 및/또는 빔 집합이 다르게 설정될 수 있다. 특히, SR, ACK/NACK 과 같이 정보량이 많지 않으나 우선 순위(priority) 가 높은 정보를 전송하는 PUCCH 포맷의 경우, 슬롯 내에서 PUCCH 를 반복 전송하면서 서로 다른 빔이 적용되도록 설정될 수 있다. 이와 달리, CSI 정보와 같이 정보량이 많으며 우선 순위가 높지 않은 정보를 전송하는 PUCCH 포맷의 경우에는, 슬롯 내에서 PUCCH 를 반복 전송하지 않거나, 반복 전송을 허용하되 동일한 빔이 적용되도록 설정될 수 있다.

[317]

[318] 상술한 바와 같이 단말이 다수의 빔들을 이용하여 UL 채널(예: PUCCH) 을 전송하는 방식(예: 다수 빔 기반 PUCCH 전송) 의 경우, 단말은 다음과 같은 세 가지 방법들에 따라 단말 송신 빔을 선택할 수 있다.

[319] 먼저, 단말이 임의로 빔 집합(beam set)(즉, 하나 이상의 빔들)을 선택하는 방법이 고려될 수 있다. 이 때, 기지국이 단말에 의해 선택한 빔 집합을 인식할 수 없는 경우가 가정된다. 또는, PUCCH 자원(즉, PUCCH 전송을 위해 할당된 자원) 의 일부에 적용될 빔 집합은 기지국과 단말 간에 미리 정의(또는 약속, 설정) 되고, 나머지 빔 집합은 단말이 임의로 선택하는 방법이 고려될 수 있다. 또는, PUCCH 전송에 이용할 빔 집합이 미리 설정(또는 규정) 되거나, 또는 기지국이 지정하는 방법이 고려될 수도 있다.

[320] 다만, 두 번째 방법 및 세 번째 방법은, 첫 번째 방법과 달리, 기지국과 단말 간 무선 채널의 시간적 변화가 급격하게 발생되지 않는 경우에 유효할 수 있다. 다시 말해, 두 번째 방법 및 세 번째 방법의 경우, CSI 보고 시점들 간의 간격이 짧게 설정될 수도 있다.

[321] 세 번째 방법의 구체적인 일 예로, PUCCH 자원에 대해 N 개($N \geq 1$)의 spatial_relation_info field (들) 가 RRC 메시지를 통해 설정되는 경우를 가정한다. 이 때, MAC 메시지를 통해 이들 중에 하나의 entity 를 지시하는 경우, MAC 메시지로 복수의 entities 를 지시하도록 하여 복수의 빔을 지시하도록 설정할 수 있다. 그리고/또는, RRC 메시지로 복수(i.e. N>l) 개의 빔이 설정된 경우라 하더라도, MAC 메시지를 받지 않고 해당 빔들을 모두 사용하여 PUCCH 를 전송하도록 설정할 수도 있다.

[322] 이 경우, 단말은 이전 CSI 전송에 이용된 송신 빔들 중 일부를 재사용 (reuse) 하도록 설정될 수도 있다. 구체적으로, 주기적(또는 반-지속적) CSI 보고 도중에 단말이 특정 보고 시점에서 PUCCH 전송을 위한 빔의 수를 증가시키는 경우, 단말은 직전(즉, 바로 이전) CSI 보고 시점에서의 최적의 단말 송신 빔(들) (best UE Tx beam(s)) 을 PUCCH 전송에 대해 미리 설정된 일부 또는 전체 시간/주파수 자원에서 이용할 수 있다.

[323] 예를 들어, 단말이 이전 보고 시점에서 단일 빔을 이용하여 CSI 보고를 수행하고, 다음 보고 시점에서 다수의 빔들(예: 2 개의 빔들)을 이용하여 CSI 보고를 수행하도록 설정될 수 있다. 이 경우, 이전 보고 시점에서 이용된 빔은 PUCCH 전송을 위한 자원(예: 심볼)들 중에서 미리 설정된 일부 자원에 적용(또는 할당) 되고, 나머지 빔(들) 은 나머지 자원들에 적용될 수 있다. 여기에서, 나머지 빔(들) 은 단말에 의해 임의로 선택된 또는 기지국에 의해 지시 또는 미리 설정된 빔(들) 을 의미할 수 있다. 이 때, 추가되는 빔(들) 은 이전 보고 시점에서 이용된 빔과 유사한 방향(즉, 전송 방향) 을 갖는 빔들로 구성될 수도 있다.

[324] 또는, DL 빔 쌍 및/또는 UL 빔 쌍을 결정하는 과정에서 단말이 N 개의 최적의 송신 빔을 알고 있는 경우, 단말은 전송 빔 수에 따라 미리 설정된(또는 약속된) 심볼 집합(symbol set) 에서 선택하여 이용할 수 있다. 상기 N 개의 최적의 송신 빔은 단말이 선택하여 보고한 N 개의 빔이거나, 기지국에 의해 지정된 N 개의 빔일 수 있다. 상기 심볼 집합이 미리 설정되는 것에 대한 일 예로, PUCCH DMRS 심볼과 해당 심볼 그룹 간의 인접한 정도에 의해 심볼 집합마다 전송 신뢰도가 다를 수 있으므로, 인접된 순서에 따라 최적 빔(best beam), 두 번째 최적 빔(second best beam), 세 번째 최적 빔(third best beam) 으로 설정될 수 있다.

[325] 이 때, 단말은 빔 품질로 정렬된 순서대로 설정된 심볼 집합에서 순서대로 선택할 수도 있다.

[326]

[327] 앞서 설명된 링크 품질에 따라 UL 채널(예: PUCCH) 의 전송에 이용되는 빔의 수를 결정하는 방법의 경우, 단말이 UL 채널을 다수의 빔을 통해 전송할지 여부(예: PUCCH 복수 빔 적용 여부) 를 판단한다. 그러나, 기지국이 다수의 빔을 통해 UL 채널을 전송할지 여부, UL 채널 전송에 이용될 빔의 수, 및/또는 빔(또는 빔 그룹(beam group)) 의 인덱스를 지시하는 방법도 고려될 수 있다. 이 경우, 기지국은 이와 같은 지시 정보를 물리 계층 시그널링(physical layer signaling) 및/또는 상위 계층 시그널링 (higher layer signaling) 을 통해 단말로 전달할 수 있다.

[328] 물리 계층 시그널링이 이용되는 경우, 지시 정보는 DL 제어 정보(Downlink Control Information, DCI) 형태로 전달될 수 있다. 이와 달리, 상위 계층 시그널링이 이용되는 경우, 지시 정보는 MAC-CE(Medium Access Control-Control Element), RRC-IE(Radio Resource Control-Information Element) 등의 형태로 전달될 수 있다. 또한, 지시 정보가 상위 계층 제어 정보(예 :MAC CE) 로

설정되는 경우, 단말은 추가적으로 지시 정보에 대한 ACK/NACK 정보를 기지국으로 전송할 수 있다. 이 때, NACK 정보가 전송되는 경우, 기지국은 상기 지시 정보를 재전송할 수 있다.

[329]

[330] 또한, 상술한 방법들에서, 다수의 빔 기반의 UL 채널 전송에 대한 전송 주기(transmission period) 및/또는 시간 오프셋 (time offset) 은 단일 빔 기반의 UL 채널 전송에 대한 전송 주기 및/또는 시간 오프셋과 별도로 설정될 수 있다. 예를 들어, CSI 보고를 위한 PUCCH 자원을 두 개 설정하고, 하나는 단일 빔을 적용하여 전송하고, 다른 하나는 다수의 빔들을 적용하여 전송하도록 설정하는 방법이 고려될 수 있다. 또는, PUCCH 전송에 대한 전송 주기 및 시간 오프셋은 동일하게 설정하되, 특정 주기에서만 다수의 빔 기반의 PUCCH 전송을 적용하도록 설정하는 방법도 고려될 수 있다. 일례로, PUCCH 전송 자원이 5 밀리 초(msec) 주기로 설정되는 경우, 단말은 4 번에 한 번 즉, 20 msec 마다 다수의 빔 기반의 PUCCH 전송을 수행하고, 나머지 전송 시점들에서는 단일 빔 기반의 PUCCH 전송을 수행할 수 있다.

[331] 상기 예시는 설명의 편의를 위하여 단일 빔 및 다수의 빔들 즉, 두 가지 경우로만 구분했을 뿐, UL 채널 전송을 위한 빔들이 세 가지 이상의 경우로 구분되는 경우에도 상술한 방법이 적용될 수 있음은 물론이다. 예를 들어, N_1 개 빔 PUCCH 전송 모드, N_2 개 빔 PUCCH 전송 모드, ..., N_k 개 빔 PUCCH 전송 모드 등을 별도로 설정하거나, 단일 설정 내에서 주기(또는 오프셋) 가 다르게 설정될 수도 있다.

[332] 또한, 상술한 방법들은, 서로 다른 빔을 적용해서 UL 채널 전송을 수행할 때 설명의 편의상 하나의 slot 내에서 서로 다른 빔을 적용하는 것을 기준으로 설명하였으나, 다수의 slot들에 걸쳐서 서로 다른 빔을 적용하는 경우로 확장될 수도 있다. 예를 들어, 짧은 주기로 설정된 주기적인 혹은 반-지속적 PUCCH 자원에 대해 전송 시점(slot) 마다 동일 빔을 적용할 지 아니면 빔을 바꾸어 가면서 전송을 수행할 지에 대한 판단 기준으로 상기 제안 방식들이 적용될 수 있다. 이 때, 빔 집합을 지시/설정하는 경우, 해당 빔 집합은 복수 개의 slot들에 걸쳐서 적용되는 빔 집합으로 정의될 수 있다. 일례로, 슬롯 마다 N 개의 심볼 그룹이 정의(또는 설정) 되고, M 개의 슬롯 단위로 빔 집합이 적용될 때, 총 $N \chi M$ 빔들이 정의(또는, 설정, 지시, 적용)될 수 있다.

[333] 또한, 상술한 방법들에서는 단말이 다수의 빔 기반의 UL 채널 전송을 수행하는 경우, 기지국의 UL 채널 수신 빔(예: PUCCH 수신 빔)이 고정되는 경우가 가정되었다. 그러나, 단말의 송신 빔에 따라 기지국의 최적의 수신 빔은 다를 수 있으므로, 기지국도 UL 채널 수신을 위하여 다수의 수신 빔들을 이용하도록 설정될 수 있다.

[334] 일례로, 기지국이 단말의 PUCCH 전송을 위한 빔 집합(즉, PUCCH 전송 빔 집합)을 지정하는 경우, 기지국은 각 PUCCH 송신 빔에 대한 최적의 PUCCH

수신 빔으로 순차적으로 변경하여 수신할 수 있다. 또는, 이 경우, 기지국은 해당 수신 빔 그룹으로 합성 빔(composite beam)을 설정하여 동시에 PUCCH 를 수신할 수도 있다. 합성 빔을 설정하여 수신하는 방법과 관련하여, 기지국이 다수의 TXRU(Transmission and Reception Point) 들 또는 패널(panel) 들을 갖는 경우, 기지국은 각 TXRU 또는 패널의 수신 빔을 다르게 설정하여 동시에 PUCCH 를 수신할 수도 있다. 또는, 기지국은 수신 빔 계수를 합성하여 두 방향을 모두 수신할 수 있는 빔(즉, 빔 폭(beam width) 이 확대된 빔)을 이용하여 동시에 수신할 수도 있다.

[335] 이와 달리, 기지국이 단말의 PUCCH 전송을 위한 빔 집합을 지정하지 않는 경우, 특정 경우를 만족하는 경우에 기지국이 다수의 PUCCH 수신 빔을 적용하도록 설정(또는 규정) 될 수 있다. 여기에서, 상기 특정 조건은, 기지국이 이전의 PUCCH 수신에 실패한 경우, 이전에 수신된 PUCCH 의 수신 감도가 일정 값 이하인 경우, 이전에 단말이 보고한 CQI 또는 RSRP 와 같은 피드백 정보(예: DL 피드백 정보)가 일정 값 이하인 경우, 또는 기지국이 이전에 수신한 다른 UL 신호(예: PUSCH, SRS(Sounding Reference Signal)) 의 품질이 일정 값 이하인 경우 등일 수 있다. 또한, 상기 특정 조건이 만족되는 경우, 기지국은 단말에게 PUCCH 전송 전력의 증가를 지시할 수도 있다.

[336]

[337] 상술한 방법들에 기반하여, 단말은 상황에 맞게 단일 빔 또는 다수의 빔을 이용하여 UL 제어 정보(예: CSI) 를 전달할 수 있다.

[338]

[339] <u>제2 실시 예 - UL RS 기반의 UL 빔 조정 방법</u>

[340] 이 때, 상술한 방법들을 이용하여 단말이 다수의 빔을 이용하여 UL 채널 전송을 수행하는 경우, 기지국은 해당 UL 채널을 통해 전송되는 참조 신호(Reference Signal, RS) 를 이용하여 UL 빔 조정(UL beam refinement) 을 수행할 수 있다.

[341] 구체적으로, 기지국은 UL 채널 복조에 이용되는 RS(예 :PUCCH DMRS) 를 이용하여 각 단말 송신 빔(즉, UL 송신 빔)에 해당하는 RS 신호 품질을 비교할 수 있다. 이를 통해, 기지국은 상기 비교 결과에 따라, RS 자원 인덱스 정보 및/또는 RS 품질 정보를 단말에게 제공할 수 있다. 예를 들어, RS 자원 인덱스 정보는 최적의 PUCCH DMRS 에 대한 자원 및/또는 포트의 인덱스(들) 을 포함할 수 있으며, RS 품질 정보는 RSRP(Reference Signal Received Power), RSRQ(Reference Signal Received Quality) 등을 포함할 수 있다. 다시 말해, 기지국은 다수의 단말 UL 송신 빔들을 통해 전송되는 UL RS를 이용하여 측정을 수행한 후, 단말의 후속하는 UL 전송 또는 DL 수신에 적합한 빔(들) 을 RS 관련 정보를 통해 지시할 수 있다.

[342] 이하, 상향링크 참조 신호 기반의 상향링크 빔 조정 방법과 관련된 단말 및 기지국의 동작을 구체적으로 살펴본다.

[343] 먼저, 기지국으로부터 상기 정보(즉, RS 자원 인덱스 정보 및/또는 RS 품질 정보)를 수신한 단말은 다음 두 가지 동작들 중 적어도 하나를 수행할 수 있다. 단말은 RS 자원 인덱스 정보에 맵핑된 UL 송신 빔(들) 또는 높은 RS 품질에 해당하는 UL 송신 빔(들)을 후속하는 UL 전송에 이용할 수 있다. 또는, 단말은 RS 자원 인덱스 정보에 맵핑된 UL 송신 빔(들) 또는 높은 RS 품질에 해당하는 UL 송신 빔(들)에 상응하는 DL 수신 빔(들)을 통해 DL 신호를 수신할 수 있다. 이 경우, 해당 단말에 대해 DL 및 UL 간 빔 대응성(DL/UL beam correspondence)이 성립되는 경우가 가정된다.

[344] 다음으로, 단말로 상기 정보(즉, RS 자원 인덱스 정보 및/또는 RS 품질 정보)를 전송한 기지국은 다음 두 가지 동작들 중 적어도 하나를 수행할 수 있다. 기지국은 RS 자원 인덱스 정보에 맵핑된 UL 송신 빔(들) 또는 높은 RS 품질에 해당하는 UL 송신 빔(들)에 페어링(pairing) 된 UL 수신 빔(들)을 후속하는 UL 수신에 이용할 수 있다. 또는, 기지국은 RS 자원 인덱스 정보에 맵핑된 UL 송신 빔(들) 또는 높은 RS 품질에 해당하는 UL 송신 빔(들)에 페어링된 UL 수신 빔(들)에 상응하는 DL 송신 빔(들)을 통해 후속하는 DL 신호를 전송할 수 있다. 이 경우, 해당 기지국에 대해 DL 및 UL 간 빔 대응성이 성립되는 경우가 가정된다.

[345] 여기에서, 페어링된 빔은 신호의 송수신 성능이 최적화되도록 맵핑된 빔을 의미할 수 있다. 즉, 단말 UL 송신 빔에 페어링된 기지국 UL 수신 빔은, 단말 송신 빔에 대해 수신 성능이 최적화되도록 맵핑된 기지국 수신 빔을 의미할 수 있다. 이와 같은 빔 쌍 정보(즉, 페어링된 빔들 간의 관계 정보)를 기지국과 단말이 공유하고 있는 경우, 상술한 바와 같은 RS 자원 인덱스 정보 또는 RS 품질 정보를 수신한 단말은, 후속되는 송수신 절차에서 이용될 빔에 대한 별도의 지시를 필요로 하지 않을 수 있다. 이 경우, 단말은, 별도의 지시가 없어도, 후속되는 송수신 절차에서 기지국의 빔이 해당 RS 자원 인덱스 정보 또는 RS 품질 정보로부터 유추한 단말 송신/수신 빔과 페어링된 기지국 수신/송신 빔으로 변경됨을 가정하여, 송수신을 수행할 수 있다.

[346] 또한, 상술한 바와 같은 UL 빔 조정 절차에서, 단말이 복수의 빔을 UL 채널 전송에 적용하였는지 여부 및 적용한 경우의 빔 정보(예: 빔의 수, 빔 인덱스 등)를 기지국이 파악할 수 있도록, 해당 단말이 이에 대한 정보를 기지국에 전달하는 과정이 추가적으로 요구될 수 있다. 이와 같은 정보는 CSI 피드백 정보와 함께 UCI에 포함되거나, 또는 CSI 피드백을 전송하는 물리 채널이 아닌 별도의 UL 물리 채널을 통해 전달될 수도 있다. 또는, 단말은 이와 같은 정보를 물리 계층 메시지뿐만 아니라, 상위 계층(higher layer) 메시지(예: RRC 메시지, MAC-CE 등)를 통해 전달할 수도 있다.

[347] 또는, UL 채널과 함께 전송되는 UL RS(예: PUCCH DMRS)의 파라미터를 상술한 다수의 빔 적용 여부 및/또는 적용된 빔의 정보에 따라 다르게 설정하여, 기지국이 이에 대한 정보를 파악하게 하는 방법도 고려될 수 있다. 여기에서,

상기 UL RS의 파라미터는, 시간 및/또는 주파수 자원 위치, UL RS에 적용된 시퀀스(sequence) 등을 포함할 수 있다.

[348] 예를 들어, UL RS에 자도프-추 시퀀스(Zadoff-Chu sequence)가 이용되는 경우, 스위핑(sweeping) 적용 여부에 따라 루트 인덱스(root index) 또는 순환 쉬프트(cyclic shift)가 다르게 적용될 수 있다. 또는, UL RS에 의사-랜덤 시퀀스(Pseudo-Random sequence)가 이용되는 경우, 스위핑 적용 여부에 따라 스크램블링 시드(scrambling seed) 또는 직교 커버 코드(Orthogonal Cover Code, OCC)가 다르게 적용될 수 있다. 여기에서, 스위핑 적용 여부는, 단말이 UL 채널을 전송하기 위하여 다수의 빔들을 이용하는지 여부를 의미할 수 있다.

[349] 이 경우, 기지국은 스위핑 온(sweeping ON) 및 스위핑 오프(sweeping OFF)에 해당하는 파라미터를 (모두) 적용하는 블라인드 검출(blind detection) 방식을 통해 스위핑 온 또는 스위핑 오프를 판단할 수 있다. 여기에서, 스위핑 온은 스위핑이 적용되는 경우를 의미하고, 스위핑 오프는 스위핑이 적용되지 않는 경우를 의미할 수 있다.

[350] 또는, PUCCH 에러 검출 코드(PUCCH error detecting code)인 CRC(Cyclic Redundancy Check) 비트에 대한 마스킹(masking)을 통해 UL 채널 전송과 관련된 스위핑 여부 및/또는 빔의 수에 대한 정보를 전달하는 방법도 고려될 수 있다. 해당 방법의 경우, PBCH의 CRC 마스킹을 통해 CRS 포트 수에 대한 정보를 전달하는 방식과 동일한 기법이 적용될 수 있다.

[351] 상술한 방법들의 경우, 각각 독립적으로 이용되는 것뿐만 아니라, 다수의 방법들이 함께 이용될 수도 있다. 예를 들어, 스위핑 여부(즉, 빔 스위핑 여부)는 1 비트의 정보로 별도의 물리 채널을 통해 전달되고, 적용된 빔에 대한 빔 인덱스 관련 정보는 UCI에 포함되어 PUCCH를 통해 전달될 수도 있다.

[352]

[353] 도 10은 본 명세서에서 제안하는 방법이 적용될 수 있는 다수의 빔들을 통해 UL 제어 정보를 전송하는 방법의 다른 예를 나타낸다. 도 10은 단지 설명의 편의를 위한 것일 뿐, 본 발명의 범위를 제한하는 것이 아니다.

[354] 도 10을 참고하면, 빔 관리 절차 1002 및 구간들 1004 내지 1008은 앞서 설명된 도 9의 빔 관리 절차 902 및 구간들 904 내지 908과 동일한 바, 이에 대한 구체적인 설명은 생략된다.

[355] 도 10에 나타난 방법의 경우, 단말은 빔 관리 절차 1002를 통해 빔 쌍이 결정된 이후 세 번째 CSI 보고 시에 링크 품질이 미리 설정된 수준 이하로 떨어짐을 감지한다. 이에 따라, 해당 단말은 세 번째 CSI 보고에 대해 PUCCH 스위핑을 수행할 수 있다. 즉, 해당 단말은 다수의 UL 빔들을 통해 세 번째 CSI 보고를 수행할 수 있다.

[356] 이 경우, PUCCH 스위핑을 인지한 기지국은, 각 단말 송신 빔에 해당하는 PUCCH DMRS 자원들에 대한 신호 품질을 비교하여, 비교 결과에 대한 정보를 단말에게 제공할 수 있다. 이를 통해, 기지국은 UL 제어 채널(즉, PUCCH)의

DMRS 기반의 UL 빔 조정을 수행할 수 있다(단계 1010). 비교 결과에 대한 정보를 제공 받은 단말은 품질이 우수한 PUCCH DMRS 자원에 해당하는 빔으로 후속되는 UL 전송을 위한 UL 송신 빔 및/또는 후속되는 DL 수신을 위한 DL 수신 빔을 변경할 수 있다.

[357]

[358] 상술한 절차들을 통해, 빔 조정 절차를 별도로 수행하는 것이 아닌, 단말이 다수의 빔들을 통해 전송하는 UL 채널의 UL RS(예 PUCCH DMRS) 를 이용하여 해당 단말과 기지국 간에 빔 조정을 수행함에 따라, 빔 관리 오버헤드(beam management overhead) 를 줄일 수 있는 장점이 있다.

[359] 또는, 기지국의 설정 혹은 지시에 의해 PUCCH 전송에 다수의 빔들을 전송하는 경우, 빔을 변경하는 단위(예: 심볼 그룹) 별로 자원 혹은 RS의 인택싱을 한 후, 이를 기반으로 기지국은 단말이 후속하는 UL 전송 및/또는 DL 수신에 사용할 빔을 지시할 수 있다.

[360]

[361] <u>제3 실시 예 - UL/DL 데이터 빔 지시에 기반한 UL 제어 채널 빔 설정</u>

[362] 상술한 제1 실시 예에서, 주기적 또는 반-지속적 CSI 보고 시에 단말이 빔 품질에 대한 저하(degradation) 을 판단하여 다수의 빔들을 UL 제어 채널(예: PUCCH) 전송에 이용하는 방법이 제안되었다. 이와 같은 주기적 또는 반-지속적 CSI 보고 시점(또는 인스턴스(instance)) 들 중간에, 특정 상황에 따른 빔 관리 절차가 수행되는 경우가 발생될 수도 있다. 예를 들어, 단말이 CSI 보고를 수행한 후 다음 보고 시점 이전에, 해당 단말에 대한 DL 또는 UL 데이터 트래픽(data traffic) 이 발생되어 빔 관리 절차가 수행될 수 있다. 여기에서, 빔 관리 절차는 단말과 기지국 간의 최적의 빔 쌍을 결정하는 절차를 의미할 수 있다.

[363] 이와 같이, 단말의 CSI 보고 중간에 UL 빔 또는 DL 빔에 대한 기지국의 직접적(또는 간접적) 지시가 존재하는 경우, 해당 지시에 따라 UL 제어 채널 전송을 위한 UL 빔을 보정하는 방법이 고려될 수 있다. 예를 들어, 단말이 CSI 보고 중간에 UL/DL 빔에 대한 지시를 수신하는 경우, 해당 단말은 상기 지시에 기반하여 PUCCH 보고를 위한 UL 빔을 조정할 수 있다.

[364]

[365] 이와 관련된 구체적인 방법의 예는 다음과 같을 수 있다.

[366] 단말이 주기적(또는 반-지속적)으로 보고하도록 설정된 각 CSI 보고 인스턴스(CSI reporting instance) 중간에, UL 데이터에 대한 빔(즉, PUSCH 송신 빔) 또는 DL 데이터에 대한 빔(즉, PDSCH 수신 빔)에 대한 지시가 존재할 수 있다. 다시 말해, CSI 보고 중간에 단말이 UL 데이터에 대한 빔 및/또는 DL 데이터에 대한 빔을 지시하는 빔 지시 정보를 수신하는 경우가 발생할 수 있다.

[367] 이 경우, 단말은 상술한 바와 같이 지시된 빔을 고려하여 후속하는(또는 미리 설정된) 주기적 CSI 보고를 위한 송신 빔(즉, PUCCH 보고 송신 빔)을 설정할 수 있다. 특히, 단말은 지시된 빔을 상기 PUCCH 보고 송신 빔으로 설정할 수도

있다. 이때, DL 데이터에 대한 빔의 경우, 해당 단말에 대해 빔 호혜성(beam reciprocity) 또는 빔 대응성 (beam correspondence) 이 성립되는 경우가 가정된다.

[368] 또한, 상기 지시를 수행한 기지국은 해당 시점 이후에 해당 단말의 주기적(또는 반-지속적) CSI 피드백에 대한 PUCCH 수신 빔을 PUSCH 수신 빔 또는 PDSCH 송신 빔으로 변경할 수 있다.

[369] 여기에서, 상기 빔 지시 정보(즉, UL 데이터에 대한 빔 또는 DL 데이터에 대한 빔을 나타내는 정보)는 물리 계층 시그널링(physical layer signaling) 또는 상위 계층 시그널링 (higher layer signaling) 을 통해 전달될 수 있다. 예를 들어, 단말은 상기 빔 지시 정보를 PDCCH 를 통해 전달되는 DCI 를 이용하여 수신하거나, 상위 계층 메시지(예: RRC 메시지, MAC-CE) 를 통해 수신할 수 있다. 상기 빔 지시 정보가 DCI 를 통해 전송되는 경우, 상기 빔 지시 정보는 UL 그랜트 (예 :PUSCH 자원 할당 정보) 또는 DL 그랜트 (예: PDSCH 자원 할당 정보)와 함께 시그널링될 수도 있다.

[370] 상기 UL 데이터에 대한 빔 정보는, 빔 식별자(beam ID) 또는 UL 빔 측정을 위한 RS 자원 인덱스 등의 형태로 설정될 수 있다. 여기에서, UL 빔 측정을 위한 RS는 SRS, UL DMRS 등을 포함할 수 있다. 또한, 빔 정보는 UL 송신 빔을 직접 지시할 수도 있으나, 간접적으로 UL 송신 빔과 연관된(associated) UL 수신 빔에 대한 정보를 지시할 수도 있다.

[371] 예를 들어, PUSCH 빔 지시에 사용된 SRI filed 를 후속 PUCCH 빔에도 적용할 지를 지시하는 플래그가 설정될 수 있다. 이 경우, 단말이 RRC 메시지 또는 RRC 및 MAC 메시지 들 다를 통해 별도로 지시된 PUCCH 빔을 유지하는 중에 해당 플래그가 온(ON) 된 형태의 UL 관련 DCI 를 수신한 경우, 해당 단말은 후속 PUCCH 빔을 해당 PUSCH 에 적용되도록 지시하는 SRI 값으로 변경하여 적용할 수 있다.

[372] 또한, 상기 DL 데이터에 대한 빔 정보도, 빔 식별자 또는 DL 빔 측정을 위한 RS 자원 인덱스 등의 형태로 설정될 수 있다. 여기에서, DL 빔 측정을 위한 RS는 CSI-RS, DL DMRS 등을 포함할 수 있다. 이 경우에도, 빔 정보는 DL 수신 빔을 직접 지시할 수도 있으나, 간접적으로 DL 수신 빔과 연관된 DL 송신 빔에 대한 정보를 지시할 수도 있다.

[373] 특히, 단말 수신 빔을 지시하는 경우, 서로 다른 안테나 포트 간 QCL(Quasi-Co-Location) 에 대한 시그널링을 통해 간접적으로 빔이 지시될 수 있다. 또한, DL 및 UL 간 빔 대응성이 성립하는 단말은, DL 수신 빔 정보를 이용하여 UL 송신 빔을 결정할 수 있다. 일례로, 기지국은 기지국 송신 빔에 해당하는 CSI-RS 안테나 포트(들) (또는 CSI-RS 자원) 과 DL DMRS (즉, 단말 특정 RS) 포트(들) 간의 QCL 관계에 대한 시그널링을 통해 어느 빔이 DL 데이터 전송에 이용되는지를 알려줄 수 있다.

[374] 이와 관련하여 , NR 시스템에서는, QCL 프레임워크(framework) 는 단말 측의 빔포밍 또는 수신 절차를 지원하기 위하여 새로운 공간 QCL 파라미터(들) (spatial

QCL parameter(s)) 로 확장될 수 있다. 또한, NR 시스템의 하향링크의 경우, 빔 관련 지시가 있는 또는 빔 관련 지시가 없는 빔 관리 절차가 지원될 수 있다. 특히, 빔 관련 지시가 제공되는 경우, 데이터 수신에 이용되는 단말 측의 빔포밍 또는 수신 절차와 관련된 정보는 QCL 을 통해 단말에게 지시될 수 있다.

[375]

[376] 또한, NR 시스템에서 DL 관련 DCI 에 포함된 TCI(transmission configuration indicator) 필드는 (LTE 의 PQI 필드와 유사하게) 상위 계층에서 설정된 다수의 QCL 참조 자원들 (e.g. CSI-RS 자원들 혹은 SSB 자원들) 의 후보들 중에서 동적으로 하나를 지시하는 역할을 수행한다.

[377] 여기서, QCL 지시는 공간 파라미터(spatial parameter) 에 대한 QCL 지시를 포함할 수 있다. 예를 들어, 상위 계층에서 설정된 복수의 DL RS 자원들 중에서 TCI 필드를 통해 해당 PDSCH 가 어느 DL RS 빔으로 전송되는지를 지시할 수 있다. 이를 수신한 단말은 해당 DL RS의 수신에 적합하도록 미리 훈련(training) 된 수신 빔을 적용하여 해당 PDSCH 빔을 수신할 수 있다.

[378] 이와 관련하여, 본 명세서에서 상술한 방법은 PDSCH 자원 할당을 수행하는 DL 관련 DCI 에 플래그를 추가하여 후속 PUCCH 에 해당 PDSCH 수신 빔에 상응하는 송신 빔을 적용할지 여부를 지시하기 위해 이용될 수 있다.

[379] 구체적으로, 상기 제안한 플래그가 온(ON) 이면 단말은 후속하는 UL 채널에 대한 전송 시, 적용할 상향링크 전송 빔을 상기 TCI 필드에서 지시하는 DL RS에 대한 수신 빔에 대응하는 송신 빔으로 설정할 수 있다.

[380] 이 때, PDSCH 빔 지시와 관련하여, DCI 에 TCI 필드가 존재하지 않는 경우, 상위 계층에서 설정된 복수의 TCI 상태들 (states) 중에서 미리 약속된 특정 상태(예: 가장 낮은 인덱스 상태) 가 TCI 필드 값으로 적용될 수 있다. 또는, PDCCH 전송을 위해 설정된 TCI 값이 PDSCH 수신에도 그대로 적용될 수도 있다.

[381] 이 경우에도, DL 관련 DCI 에 플래그를 추가하여 해당 플래그가 온(ON) 이면, 단말은, 후속하는 UL 채널에 대한 전송 시 적용할 상향링크 전송 빔을 해당 TCI 값(예: 가장 낮은 인덱스 상태 또는 PDCCH 에 대한 TCI 상태) 에서 지시하는 DL RS에 대한 수신 빔에 대응하는 송신 빔으로 적용하도록 설정될 수 있다.

[382] 상기 PDCCH 에 대한 빔 지시와 관련하여, 다수의 PDCCH 들(또는 코어셋(CORESET), 탐색 영역(search space))에 대응하는 TCI 값들이 설정된 경우, 해당 스케줄링을 지시한 PDCCH 에 해당하는 TCI 값을 적용하도록 설정하는 방법이 고려될 수 있다. 또는, 특정 규칙에 의해 미리 정해진 PDCCH 에 해당하는 TCI 값(예: 가장 낮은 인덱스의 코어셋)을 적용하도록 설정하는 방법도 고려될 수 있다. 또는, 단말에 대해 별도로 미리 설정(또는 지시)된 PDCCH 에 해당하는 TCI 값을 적용하도록 설정하는 방법도 고려될 수 있다.

[383]

[384] 도 11은 본 명세서에서 제안하는 방법이 적용될 수 있는 무선 통신 시스템에서

상향링크 채널을 전송하는 단말의 동작 순서도를 나타낸다. 도 11은 단지 설명의 편의를 위한 것일 뿐, 본 발명의 범위를 제한하는 것이 아니다.

[385] S1105 단계에서, 단말은 기지국으로부터 특정 참조 신호(예: 됴S1-RS_를 수신한다.

[386] S1110 단계에서, 해당 단말은 상기 수신된 특정 참조 신호에 기반하여 생성된 상향링크 제어 정보(예: 채널 상태 정보(CSI)) 를 보고하는 상향링크 제어 채널을 전송할 빔의 수를 결정할 수 있다. 이 경우, 해당 단말은 상술한 실시 예들에서 설명된 방법을 통해 상향링크 제어 채널(예: PUCCH) 을 전송할 빔의 수를 결정할 수 있다. 예를 들어, 단말은 상기 상향링 크 제어 채널의 전송을 위하여 빔 스위핑을 적용할지 여부를 결정할 수 있다. 이 때, 상기 빔의 수는 상기 기지국으로부터 수신된 DL RS에 의한 측정 정보(예: 링크 품질) 또는 상기 상향링크 제어 정보의 유형(type) (예: 피드백 정보의 중요성 및/또는 신뢰도에 따른 정보 유형) 중 적어도 하나에 기반하여 결정될 수 있다.

[387] S1115 단계에서, 해당 단말은 상기 결정된 빔의 수에 따라, 단일 빔(single beam) 또는 다수의 빔들($_a$ plurality of beams) 을 통해, 상기 기지국으로 상기 상향링크 제어 채널을 전송한다.

[388] 이 때, 상기 측정 정보가 나타내는 값이 미리 설정된 임계 값보다 작은 경우, 상기 상향링 크 제어 채널은 상기 다수의 빔들을 통해 전송될 수 있다. 여기에서, 상기 미리 설정된 임계 값은, 상기 다수의 빔들의 빔의 수에 따라 다르게 설정될 수 있다. 또한, 상기 하향링크 참조 신호는, CSI-RS 를 포함하며, 상기 측정 정보는, 채널 품질 지시자(CQI), 수신 전력 정보(예: RSRP), 또는 수신 품질 정보(예 :RSRQ) 중 적어도 하나를 포함할 수 있다.

[389] 또한, 상기 상향링 크 제어 정보가 랭크 지시자(RI) 또는 빔 인덱스(또는 빔 식별자) 중 적어도 하나를 나타내는 정보를 포함하는 경우, 상기 상향링 크 제어 채널은 상기 다수의 빔들을 통해 전송될 수 있다.

[390] 또한, 상기 단말이 상기 다수의 빔들을 통해 상기 상향링 크 제어 채널을 전송하는 경우, 상기 다수의 빔들은, 이전 시점의 상향링크 제어 정보 보고에 이용된 특정 빔을 포함할 수 있다. 이 때, 상기 특정 빔은, 상기 상향링크 제어 채널 전송을 위해 설정된 자원(resource) 들 중 미리 설정된 특정 자원에 할당될 수 있다.

[391] 또한, 상기 단말이 상기 다수의 빔들을 통해 상기 상향링 크 제어 채널을 전송하는 경우, 상기 다수의 빔들은 미리 설정된 다수의 빔 집합들 중 하나에 속할 수 있다.

[392] 또한, 단말은 상기 다수의 빔들의 적용 여부를 나타내는 정보, 상기 빔의 수를 나타내는 정보, 또는 상기 상향링크 제어 채널의 전송에 이용될 적어도 하나의 빔의 인덱스를 나타내는 정보 중 적어도 하나를 기지국으로부터 수신할 수도 있다. 즉, 해당 단말은 기지국으로부터 상향링 크 제어 채널의 전송에 이용될 빔에 대한 지시 정보를 수신할 수도 있다.

[393] 또한, 단말은 상기 상향링크 제어 채널의 전송과 관련된 빔 설정 정보(beam configuration information) 를 수신할 수 있다. 이 경우, 상기 빔 설정 정보는, 상기 단일 빔을 위한 제1 빔 설정 정보 및 상기 다수의 빔을 위한 제2 빔 설정 정보를 포함할 수 있다. 또한, 상기 제1 빔 설정 정보 및 상기 제2 빔 설정 정보 각각은, 상기 상향링크 제어 채널의 전송과 관련된 자원 정보(resource information), 시간 오프셋 정보(time offset information), 또는 주기 정보(period information) 중 적어도 하나를 포함할 수 있다.

[394] 또한, 상기 단말은 주기적 또는 반-지속적으로 상향링크 제어 정보를 보고하도록 설정될 수 있다. 예를 들어, 상기 단말이, 상기 기지국으로 부터, 상향링크 공유 채널(예: PUSCH) 또는 하향링크 공유 채널(PDSCH) 을 위한 빔 지시 정보를 수신하는 경우, 상기 단말은 상기 빔 지시 정보가 나타내는 빔을 이용하여 후속(subsequent) 채널 상태 정보를 보고하는 상향링크 제어 채널을 후속 보고 시점에서 전송할 수 있다.

[395] 또한, 상기 단말이 상기 다수의 빔들을 통해 상기 상향링크 제어 채널을 전송하는 경우, 상기 단말은 상기 기지국으로부터 상기 가수의 빔들과 관련된 신호 품질 정보를 수신할 수 있다. 또한, 상기 단말은 상기 수신된 신호 품질 정보에 기반하여 선택된 적어도 하나의 특정 빔을 통해 후속 상향링크 채널을 전송할 수 있다. 또한, 이 경우, 상기 단말은 상기 기지국으로, 상기 상향링크 제어 채널의 전송을 위한 상기 다수의 빔의 적용 여부 또는 상기 빔의 수 중 적어도 하나의 대한 정보를 전송할 수도 있다.

[396] 여기에서, 상기 신호 품질 정보는, 상기 상향링크 제어 채널의 복조를 위해 이용되는 참조 신호(예 :UL DMRS) 에 의해 측정된 각 빔 별 신호 품질(즉, RS 신호 품질) 에 기반하여 결정된다. 이 때, 상기 신호 품질 정보는, 상기 참조 신호의 자원 인덱스 정보(resource index information) 또는 상기 참조 신호에 대한 수신 품질 정보(received quality information) 중 적어도 하나를 포함할 수 있다.

[397]

[398] <u>본 발명이 적용될 수 있는 장치 일반</u>

[399] 도 12는 본 명세서에서 제안하는 방법들이 적용될 수 있는 무선 통신 장치의 블록 구성도를 예시한다.

[400] 도 12를 참조하면, 무선 통신 시스템은 기지국(1210) 과 기지국(1210) 영역 내에 위치한 다수의 단말(1220) 을 포함한다.

[401] 기지국(1210) 은 프로세서 (processor, 1211), 메모리 (memory, 1212) 및 RF부(radio frequency unit, 1213) 을 포함한다. 프로세서 (1211) 는 앞서 도 1 내지 도 11에서 제안된 기능, 과정 및/또는 방법을 구현한다. 무선 인터페이스 프로토콜의 계층들은 프로세서 (1211) 에 의해 구현될 수 있다. 메모리 (1212) 는 프로세서 (1211) 와 연결되어, 프로세서 (1211) 를 구동하기 위한 다양한 정보를 저장한다. RF부(1213) 는 프로세서 (1211) 와 연결되어, 무선 신호를 송신 및/또는 수신한다.

[402] 단말(1220) 은 프로세서(1221), 메모리(1222) 및 RF부(1223) 을 포함한다.

[403] 프로세서(1221) 는 앞서 도 1 내지 도 11에서 제안된 기능, 과정 및/또는 방법을 구현한다. 무선 인터페이스 프로토콜의 계층들은 프로세서(1221) 에 의해 구현될 수 있다. 메모리(1222) 는 프로세서(1221) 와 연결되어, 프로세서(1221) 를 구동하기 위한 다양한 정보를 저장한다. RF부(1223) 는 프로세서(1221) 와 연결되어, 무선 신호를 송신 및/또는 수신한다.

[404] 메모리(1212, 1222) 는 프로세서(1211, 1221) 내부 또는 외부에 있을 수 있고, 잘 알려진 다양한 수단으로 프로세서(1211, 1221) 와 연결될 수 있다. 또한, 기지국(1210) 및/또는 단말(1220) 은 한 개의 안테나(single antenna) 또는 다중 안테나(multiple antenna) 를 가질 수 있다.

[405]

[406] 이상에서 설명된 실시 예들은 본 발명의 구성요소들과 특징들이 소정 형태로 결합된 것들이다. 각 구성요소 또는 특징은 별도의 명시적 언급이 없는 한 선택적인 것으로 고려되어야 한다. 각 구성요소 또는 특징은 다른 구성요소나 특징과 결합되지 않은 형태로 실시될 수 있다. 또한, 일부 구성요소들 및/또는 특징들을 결합하여 본 발명의 실시 예를 구성하는 것도 가능하다. 본 발명의 실시 예들에서 설명되는 동작들의 순서는 변경될 수 있다. 어느 실시예의 일부 구성이나 특징은 다른 실시 예에 포함될 수 있고, 또는 다른 실시예의 대응하는 구성 또는 특징과 교체될 수 있다. 특허청구범위에서 명시적인 인용 관계가 있지 않은 청구항들을 결합하여 실시 예를 구성하거나 출원 후의 보정에 의해 새로운 청구항으로 포함시킬 수 있음은 자명하다.

[407] 본 발명에 따른 실시 예는 다양한 수단, 예를 들어, 하드웨어, 펌웨어(firmware), 소프트웨어 또는 그것들의 결합 등에 의해 구현될 수 있다. 하드웨어에 의한 구현의 경우, 본 발명의 일 실시 예는 하나 또는 그 이상의 ASICs(application specific integrated circuits), DSPs(digital signal processors), DSPDs(digital signal processing devices), PLDs(programmable logic devices), FPGAs(field programmable gate arrays), 프로세서, 콘트롤러, 마이크로 콘트롤러, 마이크로 프로세서 등에 의해 구현될 수 있다.

[408] 펌웨어나 소프트웨어에 의한 구현의 경우, 본 발명의 일 실시 예는 이상에서 설명된 기능 또는 동작들을 수행하는 모듈, 절차, 함수 등의 형태로 구현될 수 있다. 소프트웨어 코드는 메모리에 저장되어 프로세서에 의해 구동될 수 있다. 상기 메모리는 상기 프로세서 내부 또는 외부에 위치하여, 이미 공지된 다양한 수단에 의해 상기 프로세서와 데이터를 주고 받을 수 있다.

[409] 본 발명은 본 발명의 필수적 특징을 벗어나지 않는 범위에서 다른 특정한 형태로 구체화될 수 있음은 통상의 기술자에게 자명하다. 따라서, 상술한 상세한 설명은 모든 면에서 제한적으로 해석되어서는 아니 되고 예시적인 것으로 고려되어야 한다. 본 발명의 범위는 첨부된 청구항의 합리적 해석에 의해 결정되어야 하고, 본 발명의 등가적 범위 내에서의 모든 변경은 본 발명의

범위에 포함된다.

산업상 이용가능성

[410] 본 발명의 무선 통신 시스템에서 상향링크 채널을 전송하는 방안은 3GPP LTE/LTE-A 시스템, 5G 시스템(New RAT 시스템) 에 적용되는 예를 중심으로 설명하였으나, 이외에도 다양한 무선 통신 시스템에 적용하는 것이 가능하다.

청구범위

[청구항 1] 무선 통신 시스템에서 단말이 상향링크 채널(uplink channel) 을 전송하는 방법에 있어서,

기지국으로부터 특정 참조 신호(specific reference signal) 를 수신하는 과정과,

상기 특정 참조 신호에 기반하여 생성된 상향링크 제어 정보(uplink control information) 를 보고(report) 하는 상향링크 제어 채널(uplink control channel) 을 전송할 빔의 수를 결정하는 과정과,

상기 결정된 빔의 수에 따라, 단일 빔(single beam) 또는 다수의 빔들(a plurality of beams) 을 통해, 상기 기지국으로 상기 상향링크 제어 채널을 전송하는 과정을 포함하며,

상기 빔의 수는, 상기 기지국으로부터 수신된 하향링크 참조 신호(downlink reference signal) 에 의한 측정 정보 또는 상기 상향링크 제어 정보의 유형(type) 중 적어도 하나에 기반하여 결정되는 방법.

[청구항 2] 제 1항에 있어서,

상기 측정 정보가 나타내는 값이 미리 설정된 임계 값보다 작은 경우,

상기 상향링크 제어 채널은 상기 다수의 빔들을 통해 전송되는 방법.

[청구항 3] 제 2항에 있어서,

상기 미리 설정된 임계 값은, 상기 다수의 빔들의 빔의 수에 따라 다르게 설정되는 방법.

[청구항 4] 제 2항에 있어서,

상기 하향링크 참조 신호는, CSI-RS 를 포함하고,

상기 측정 정보는, 채널 품질 지시자(channel quality indicator), 수신 전력(received power) 정보, 또는 수신 품질(received quality) 정보 중 적어도 하나를 포함하는 방법.

[청구항 5] 제 1항에 있어서,

상기 상향링크 제어 정보가 랭크 지시자(rank indicator) 또는 빔 인덱스(beam index) 중 적어도 하나를 나타내는 정보를 포함하는 경우,

상기 상향링크 제어 채널은 상기 다수의 빔들을 통해 전송되는 방법.

[청구항 6] 제 1항에 있어서,

상기 단말이 상기 다수의 빔들을 통해 상기 상향링크 제어 채널을 전송하는 경우, 상기 다수의 빔들은, 이전 시점의 상향링크 제어 정보 보고에 이용된 특정 빔을 포함하고,

상기 특정 빔은, 상기 상향링크 제어 채널 전송을 위해 설정된 자원(resource) 들 중 미리 설정된 특정 자원에 할당되는 방법.

[청구항 7] 제 1항에 있어서,

상기 단말이 상기 다수의 빔들을 통해 상기 상향링크 제어 채널을

전송하는 경우, 상기 다수의 빔들은 미리 설정된 다수의 빔 집합(beam set)들 중 하나에 속하는 방법.

[청구항 8] 제 1항에 있어서,
상기 기지국으로 부터, 상기 다수의 빔들의 적용 여부를 나타내는 정보, 상기 빔의 수를 나타내는 정보, 또는 상기 상향링크 제어 채널의 전송에 이용될 적어도 하나의 빔의 인덱스(index) 를 나타내는 정보 중 적어도 하나를 수신하는 과정을 포함하는 방법.

[청구항 9] 제 1항에 있어서,
상기 기지국으로 부터, 상기 상향링크 제어 채널의 전송과 관련된 빔 설정 정보(beam configuration information) 를 수신하는 과정을 더 포함하고,
상기 빔 설정 정보는, 상기 단일 빔을 위한 제1 빔 설정 정보 및 상기 다수의 빔을 위한 제2 빔 설정 정보를 포함하며,
상기 제1 빔 설정 정보 및 상기 제2 빔 설정 정보 각각은, 상기 상향링크 제어 채널의 전송과 관련된 자원 정보(resource information), 시간 오프셋 정보(time offset information), 또는 주기 정보(period information) 중 적어도 하나를 포함하는 방법.

[청구항 10] 제 1항에 있어서,
상기 단말은, 주기적(periodic) 또는 반-지속적(semi-persistent) 으로 상향링크 제어 정보를 보고하도록 설정되는 방법.

[청구항 11] 제 10항에 있어서,
상기 단말이, 상기 기지국으로부터, 상향링크 공유 채널(uplink shared channel) 또는 하향링크 공유 채널(downlink shared channel) 을 위한 빔 지시 정보를 수신하는 경우, 상기 빔 지시 정보가 나타내는 빔을 이용하여 후속(subsequent) 채널상태 정보를 보고하는 상향링크 제어 채널을 후속 보고 시점에서 전송하는 과정을 더 포함하는 방법.

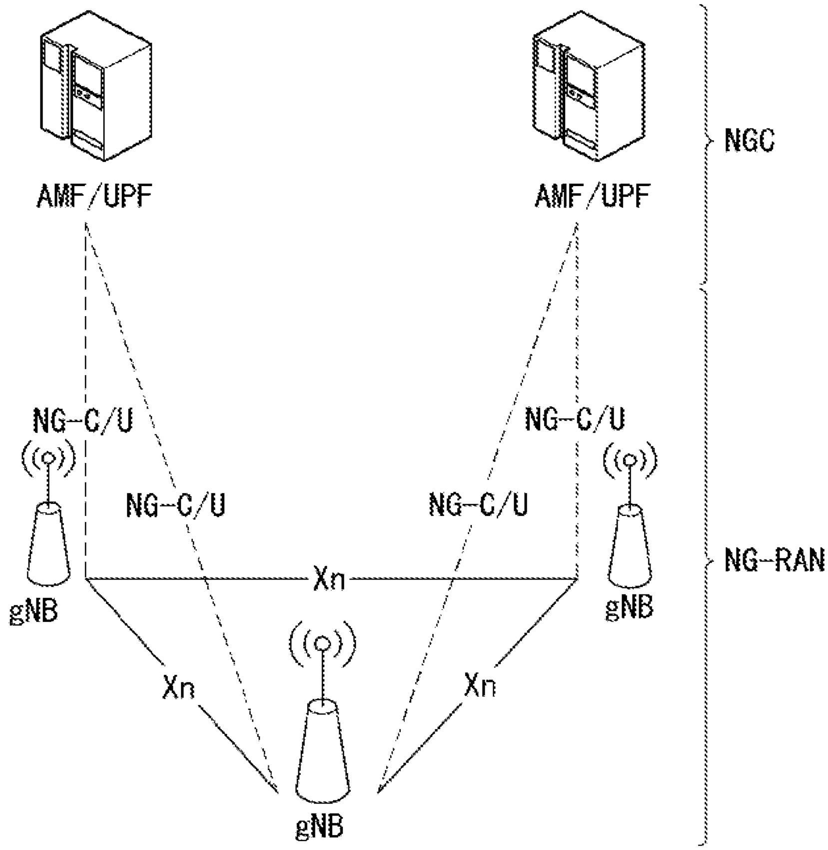
[청구항 12] 제 1항에 있어서,
상기 단말이 상기 다수의 빔들을 통해 상기 상향링크 제어 채널을 전송하는 경우, 상기 기지국으로부터 상기 다수의 빔들과 관련된 신호 품질 정보(signal quality information) 를 수신하는 과정과,
상기 수신된 신호 품질 정보에 기반하여 선택된 적어도 하나의 특정 빔을 통해 후속 상향링크 채널을 전송하는 과정을 더 포함하는 방법.

[청구항 13] 제 12항에 있어서,
상기 신호 품질 정보는, 상기 상향링크 제어 채널의 복조(demodulation) 를 위해 이용되는 참조 신호(reference signal) 에 의해 측정된 각 빔 별 신호 품질에 기반하여 결정되며,
상기 신호 품질 정보는, 상기 참조 신호의 자원 인덱스 정보(resource index information) 또는 상기 참조 신호에 대한 수신 품질 정보(received quality information) 중 적어도 하나를 포함하는 방법.

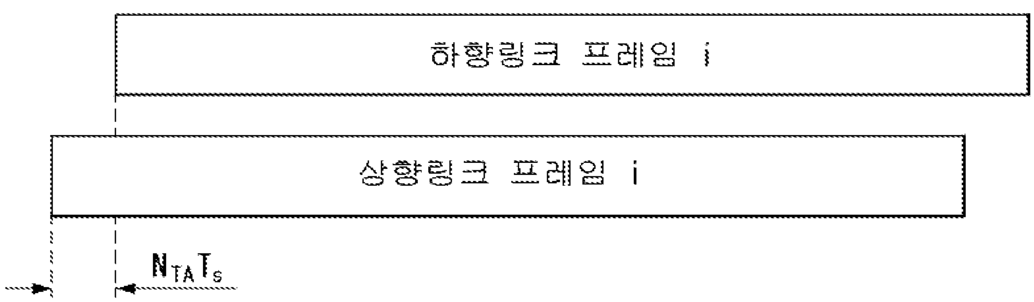
[청구항 14] 제 12항에 있어서,
상기 기지국으로, 상기 상향링크 제어 채널의 전송을 위한 상기 다수의 빔의 적용 여부 또는 상기 빔의 수 중 적어도 하나에 대한 정보를 전송하는 과정을 더 포함하는 방법.

[청구항 15] 무선 통신 시스템에서 상향링크 채널(uplink channel)을 전송하는 단말에 있어서,
무선 신호를 송수신하기 위한 RF(Radio Frequency) 유닛과,
상기 RF 유닛과 기능적으로 연결되어 있는 프로세서를 포함하고,
상기 프로세서는,
기지국으로부터 특정 참조 신호(specific reference signal)를 수신하고,
상기 특정 참조 신호에 기반하여 생성된 상향링크 제어 정보(uplink control information)를 보고(report)하는 상향링크 제어 채널(uplink control channel)을 전송할 빔의 수를 결정하고,
상기 결정된 빔의 수에 따라, 단일 빔(single beam) 또는 다수의 빔들(a plurality of beams)을 통해, 상기 기지국으로 상기 상향링크 제어 채널을 전송하도록 제어하며,
상기 빔의 수는, 상기 기지국으로부터 수신된 하향링크 참조 신호(downlink reference signal)에 의한 측정 정보 또는 상기 상향링크 제어 정보의 유형(type) 중 적어도 하나에 기반하여 결정되는 단말.

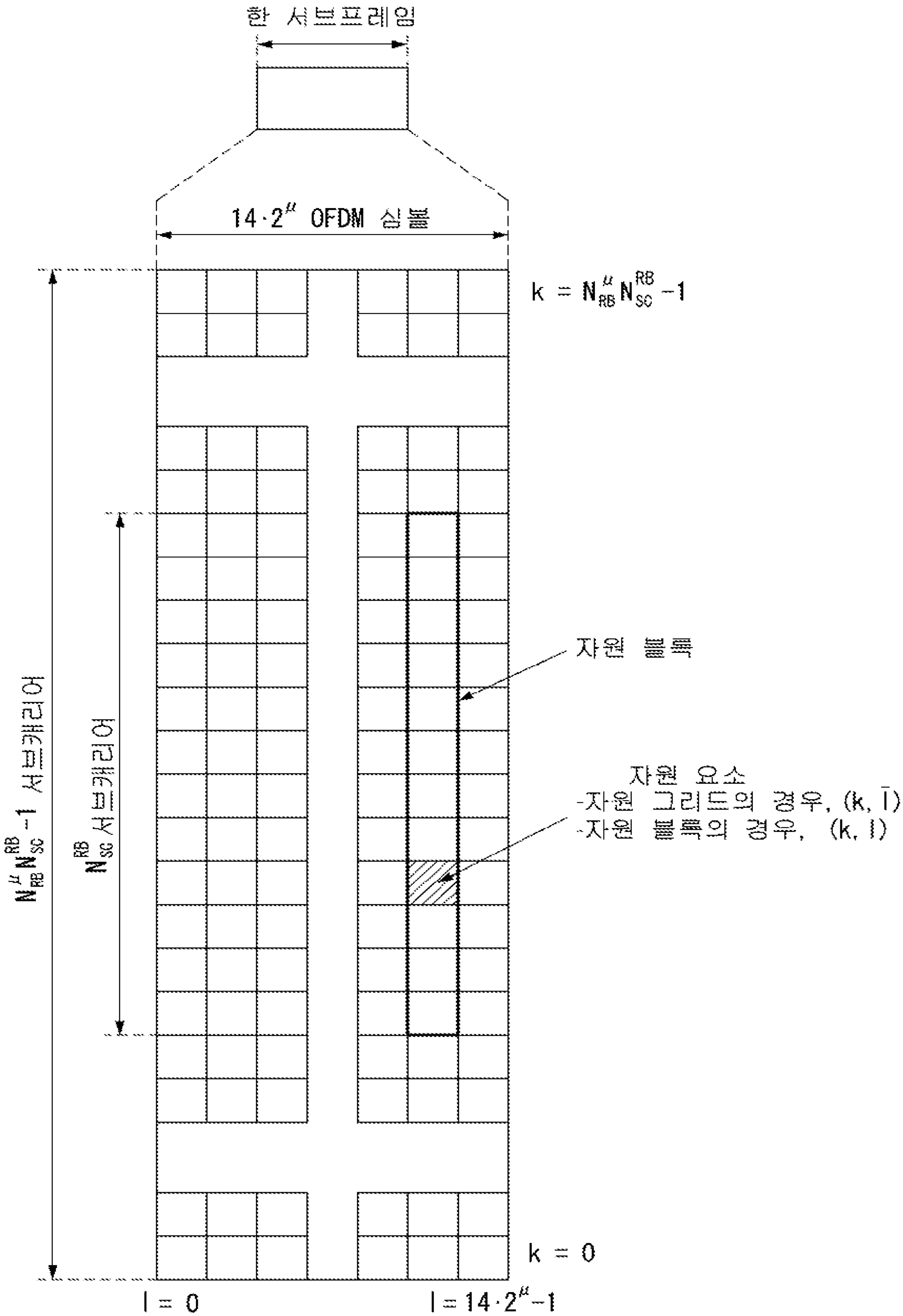
[도1]


AMF/UPF
AMF/UPF
NGC
NG-C/U
NG-C/U
NG-C/U
NG-C/U
Xn
Xn
Xn
gNB
gNB
gNB
NG-RAN

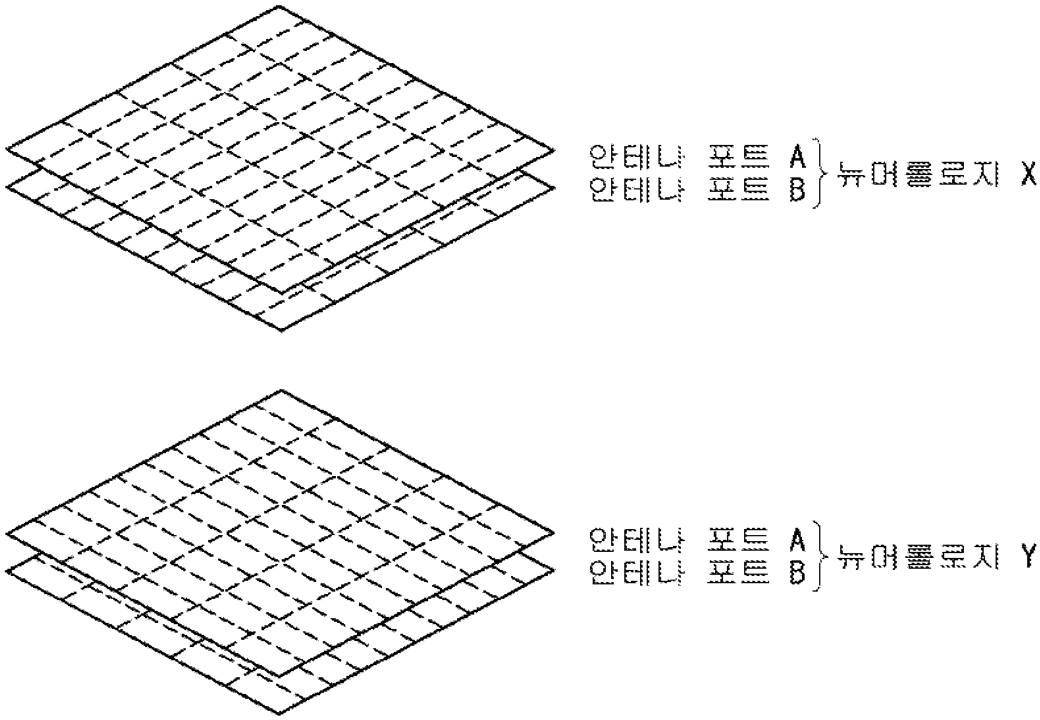
[도2]


하향링크 프레임 i
상향링크 프레임 i
$N_{TA}T_s$

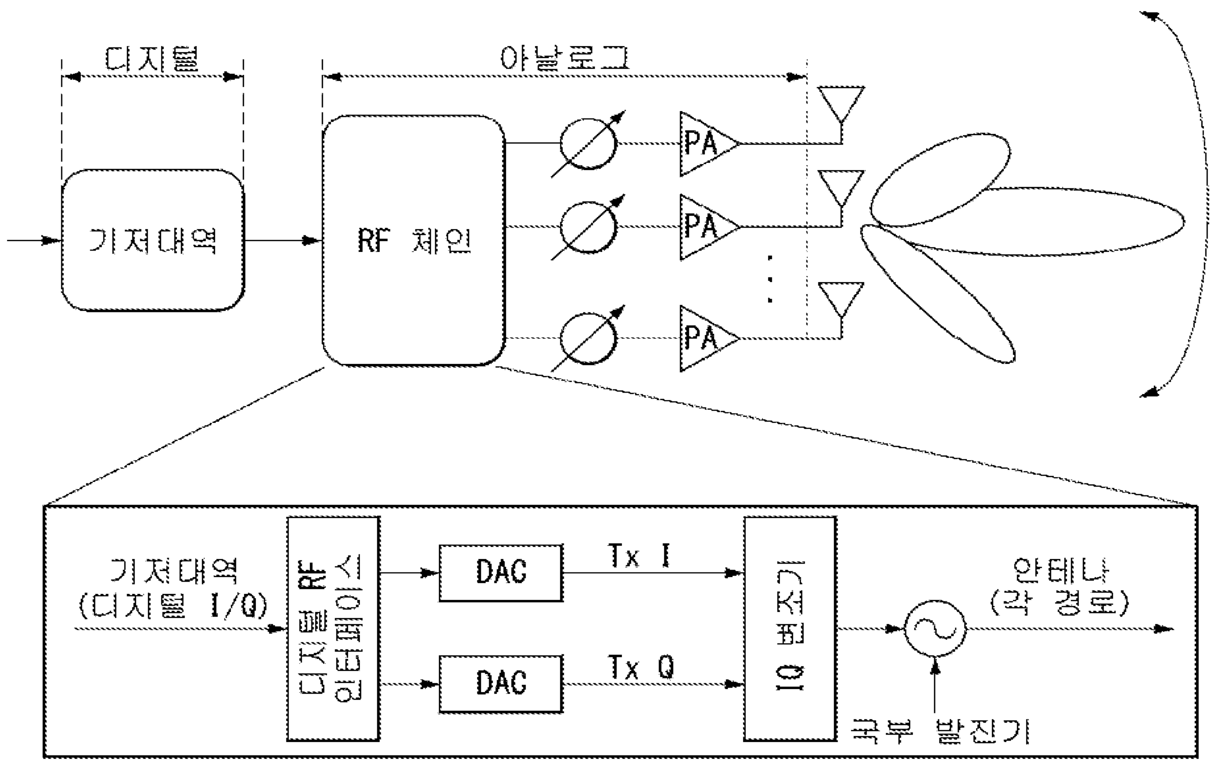
[도3]


한 서브프레임
$14 \cdot 2^{\mu}$ OFDM 심볼
$k = N_{RB}^{\mu} N_{SC}^{RB} - 1$
$N_{RB}^{\mu} N_{SC}^{RB} - 1$ 서브캐리어
N_{SC}^{RB} 서브캐리어
자원 블록
자원 요소
-자원 그리드의 경우, $(k, \bar{l})$
-자원 블록의 경우, (k, l)
$k = 0$
$l = 0$
$l = 14 \cdot 2^{\mu} - 1$

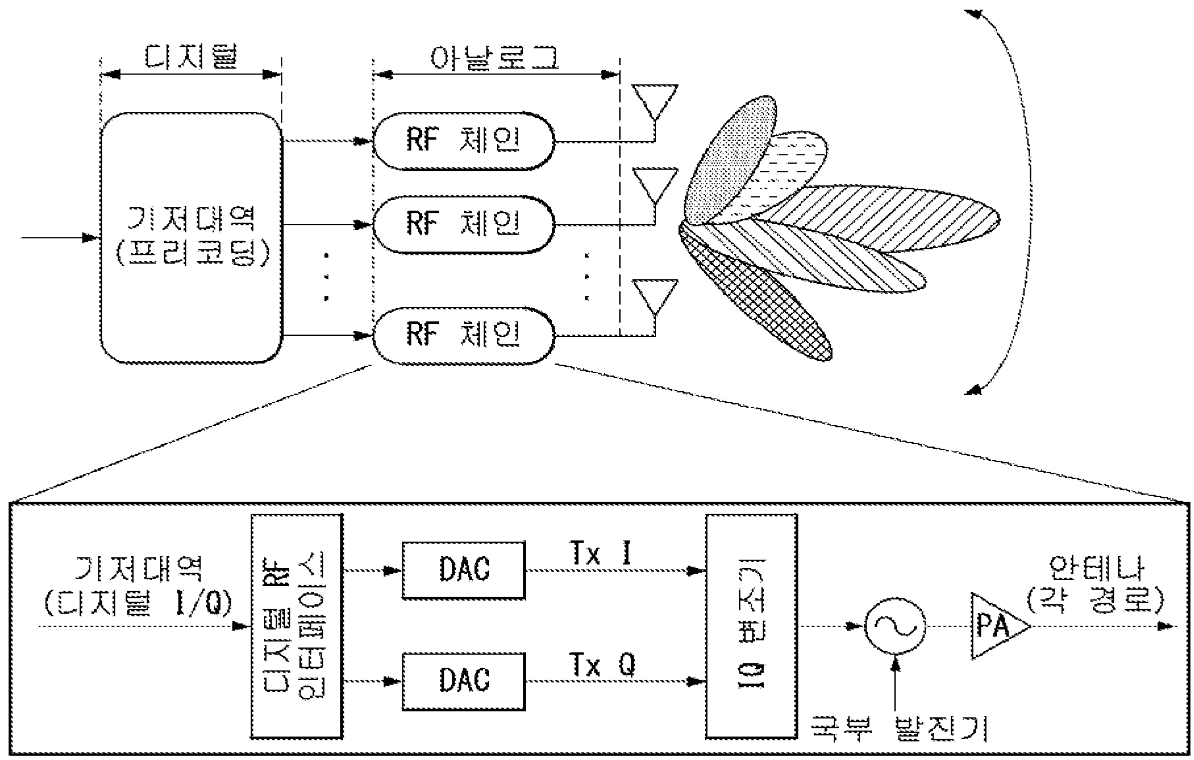
[도4]


안테나 포트 A
안테나 포트 B
뉴머롤로지 X
안테나 포트 A
안테나 포트 B
뉴머롤로지 Y

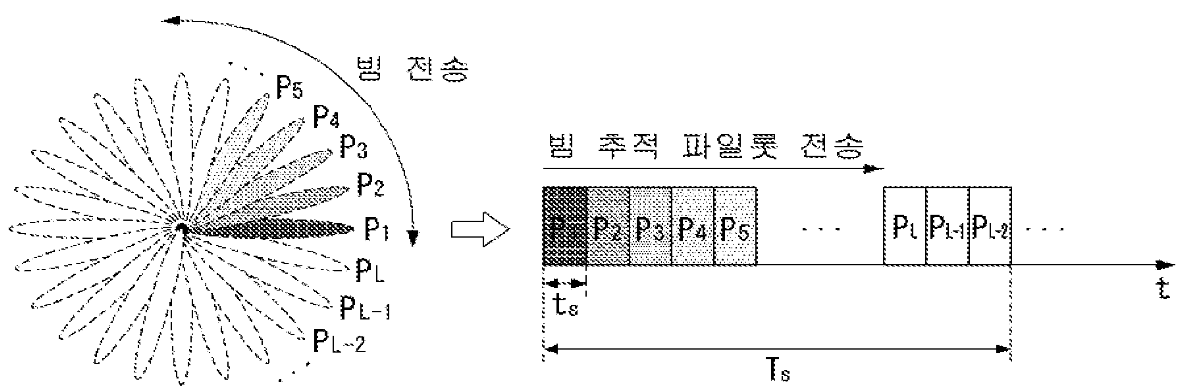
[도5]


디지털
아날로그
기저대역
RF 체인
PA
PA
PA
기저대역
(디지털 I/Q)
디지털 RF
인터페이스
DAC
DAC
Tx I
Tx Q
IQ 변조기
안테나
(각 경로)
국부 발진기

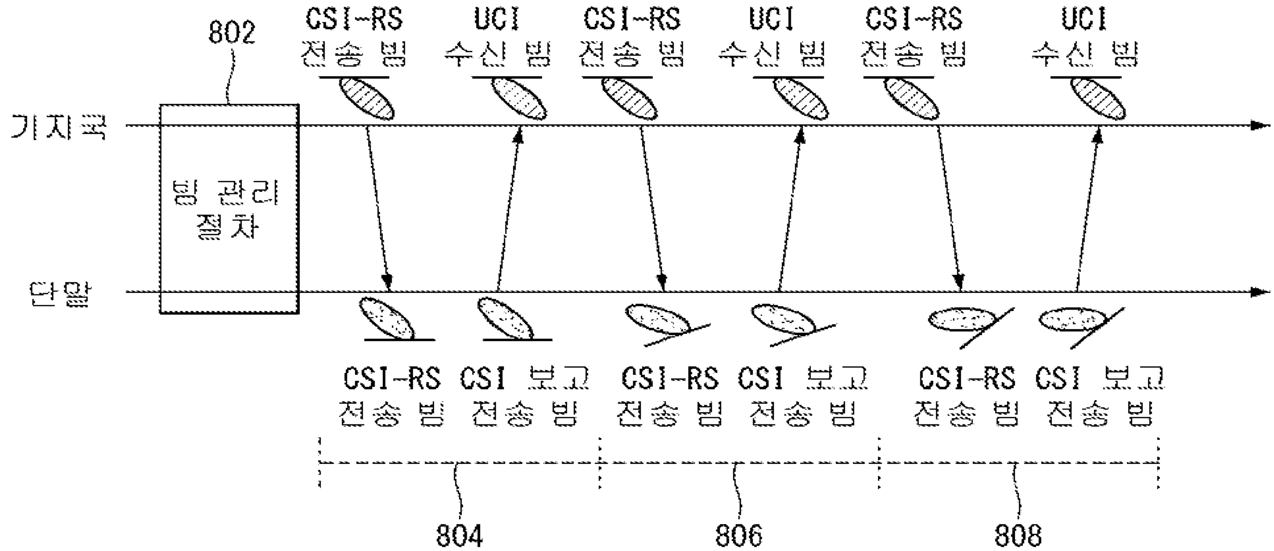
[도6]


디지털
아날로그
기저대역
(프리코딩)
RF 체인
RF 체인
RF 체인
기저대역
(디지털 I/Q)
디지털 RF
인터페이스
DAC
DAC
Tx I
Tx Q
IQ 변조기
국부 발진기
PA
안테나
(각 경로)

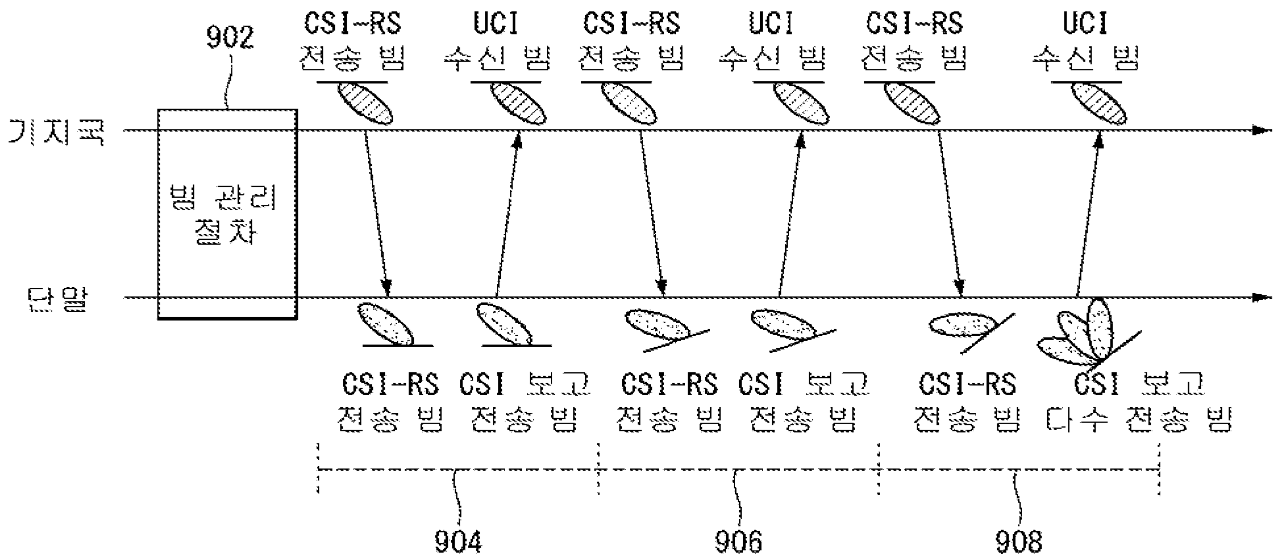
[도7]


빔 전송
P5
P4
P3
P2
P1
PL
PL-1
PL-2
빔 추적 파일롯 전송
P1
P2
P3
P4
P5
PL
PL-1
PL-2
t
ts
Ts

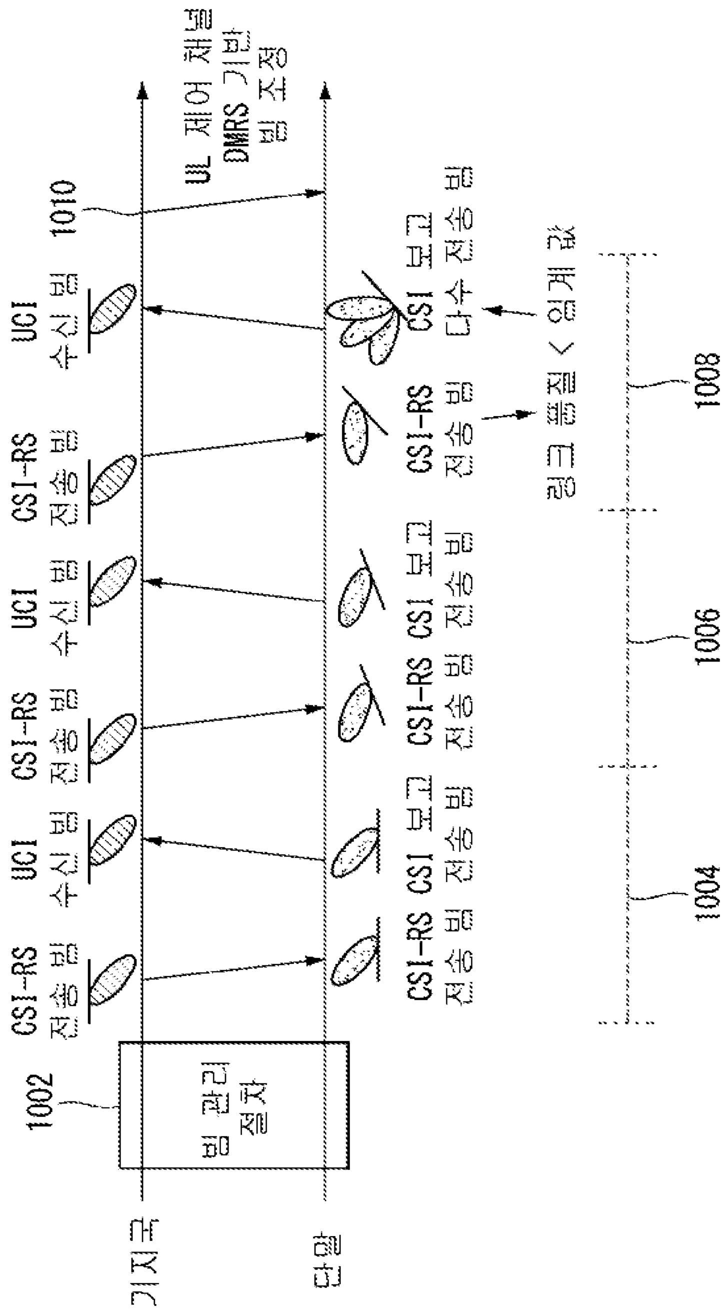
[도8]


802
CSI-RS 전송 빔
UCI 수신 빔
CSI-RS 전송 빔
UCI 수신 빔
CSI-RS 전송 빔
UCI 수신 빔
기지국
빔 관리 절차
단말
CSI-RS 전송 빔
CSI 보고 전송 빔
CSI-RS 전송 빔
CSI 보고 전송 빔
CSI-RS 전송 빔
CSI 보고 전송 빔
804
806
808

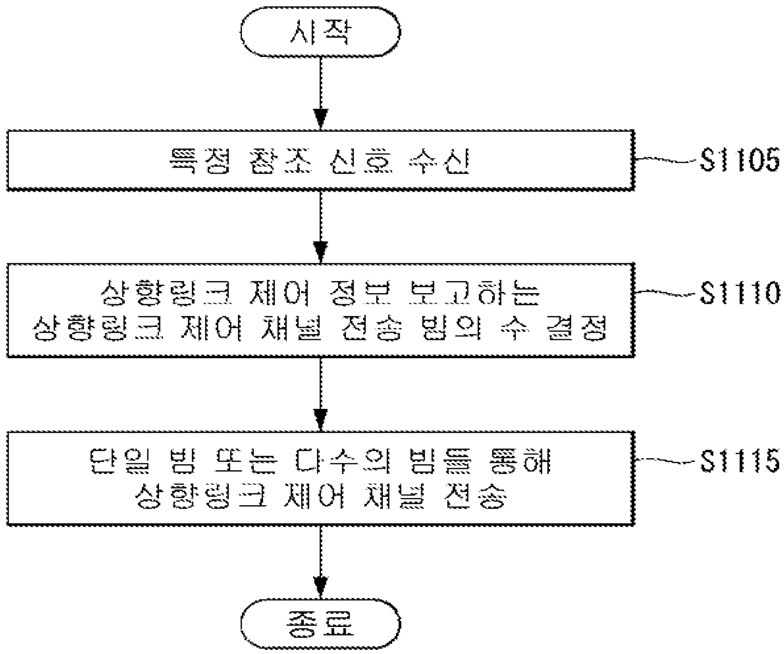
[도9]


902
CSI-RS 전송 빔
UCI 수신 빔
CSI-RS 전송 빔
UCI 수신 빔
CSI-RS 전송 빔
UCI 수신 빔
기지국
빔 관리 절차
단말
CSI-RS 전송 빔
CSI 보고 전송 빔
CSI-RS 전송 빔
CSI 보고 전송 빔
CSI-RS 전송 빔
CSI 보고 다수 전송 빔
904
906
908

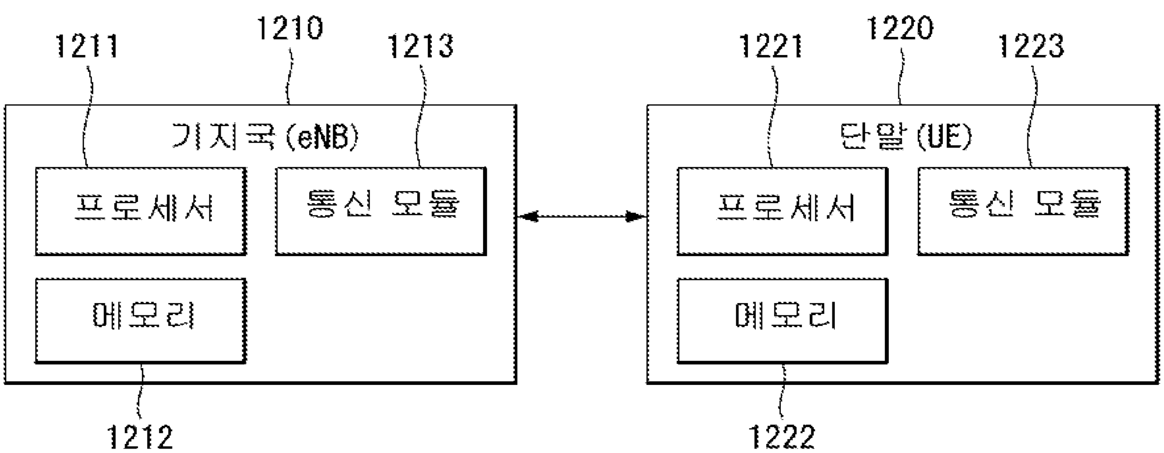
[도10]


기지국
단말
빔 관리 절차
1002
CSI-RS 전송 빔
UCI 수신 빔
CSI-RS 전송 빔
UCI 수신 빔
CSI-RS 전송 빔
UCI 수신 빔
1010
UL 제어 채널 DMRS 기반 빔 조정
CSI-RS 전송 빔
CSI 보고 전송 빔
CSI-RS 전송 빔
CSI 보고 전송 빔
CSI-RS 전송 빔
CSI 보고 다수 전송 빔
링크 품질 < 임계 값
1004
1006
1008

[도11]


시작
특정 참조 신호 수신
S1105
상향링크 제어 정보 보고하는
상향링크 제어 채널 전송 빔의 수 결정
S1110
단일 빔 또는 다수의 빔들 통해
상향링크 제어 채널 전송
S1115
종료

[도12]


1211
1210
1213
기지국 (eNB)
프로세서
통신 모듈
메모리
1212
1221
1220
1223
단말 (UE)
프로세서
통신 모듈
메모리
1222

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2018/000101

A. CLASSIFICATION OF SUBJECT MATTER

H04L 5/00(2006.01)i, H04W 72/08(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L 5/00; H04L 1/06; H04B 7/06; H04B 7/02; H04J 3/16; H04B 7/04; H04W 72/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: reference signal, uplink control information, report base station, terminal, interference cell information, number of beams, threshold value, channel quality indicator, single beam, multiple beams

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	KR 10-2014-0016854 A (SAMSUNG ELECTRONICS CO., LTD.) 10 February 2014 See paragraphs [0049], [0058], [0086]-[0095]; and figure 8.	1-5,8-15 6-7
Y	KR 10-1668709 B1 (LG ELECTRONICS INC.) 05 November 2016 See paragraphs [0019]-[0021]; and figure 15.	6
Y	CATT, "Discussion on Beam Reporting", R1-1611386, 3GPP TSG RAN WG1 Meeting #87, Reno, USA, 05 November 2016 (http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_87/Docs/) See section 2; and figure 2.	7
A	KR 10-2014-0049712 A (SAMSUNG ELECTRONICS CO., LTD.) 28 April 2014 See paragraphs [0037]-[0051]; and figure 3.	1-15
A	US 2016-0197659 A1 (SAMSUNG ELECTRONICS CO., LTD.) 07 July 2016 See paragraphs [0042]-[0054]; and figures 1-2.	1-15

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 APRIL 2018 (20.04.2018)	23 APRIL 2018 (23.04.2018)

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. +82-42-481-8578	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2018/000101

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10—2014—0016854 A	10/02/2014	AU 2013-297246 A1	05/03/2015
		AU 2013-297246 A1	06/02/2014
		AU 2013—297246 B2	10/11/2016
		CN 104521155 A	15/04/2015
		EP 2882110 A1	10/06/2015
		JP 2015-530018 A	08/10/2015
		RU 2015106981 A	20/09/2016
		RU 2636655 C2	27/11/2017
		US 2016—0006122 A1	07/01/2016
		WO 2014-021633 A1	06/02/2014
KR 10—1668709 B1	09/11/2016	CN 105009626 A	28/10/2015
		EP 2961216 A1	30/12/2015
		JP 2016—513430 A	12/05/2016
		US 2015-0341092 A1	26/11/2015
		US 9900068 B2	20/02/2018
		WO 2014—129858 A1	28/08/2014
KR 10-2014-0049712 A	28/04/2014	CN 104737461 A	24/06/2015
		CN 104737461 B	24/10/2017
		EP 2909950 A1	26/08/2015
		US 2014-0112269 A1	24/04/2014
		US 9882689 B2	30/01/2018
		WO 2014-062026 A1	24/04/2014
US 2016-0197659 A1	07/07/2016	CN 105453629 A	30/03/2016
		KR 10-2015-0016913 A	13/02/2015
		WO 2015-020404 A1	12/02/2015

Form PCT/ISA/210 (patent family annex) (January 2015)

국제조사보고서

국제출원번호 **PCT/KR2018/000101**

A. 발명이 속하는 기술분류 (국제특허분류(IPC))

H04L 5/00(2006.01)i, H04W 72/08(2009.01)i

B. 조사된 분야

조사된 최소문헌 (국제 특허분류를 기재)

H04L 5/00 ; H04L 1/06 ; H04B 7/06 ; H04B 7/02 ; H04J 3/16 ; H04B 7/04 ; H04W 72/08

조사된 기술분야에 속하는 최소문헌 이외의 문헌

한국등록 실용신안공보 및 한국공개실용신안공보 : 조사된 최소문헌란에 기재된 IPC

일본등록 실용신안공보 및 일본공개실용신안공보 : 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))

eKOMPASS (특허청 내부 검색시스템) & 키워드: 참조신호, 상향링크 제어 정보, 보고, 기지국, 단말, 측정 정보, 빔의 수, 임계 값, 채널 품질 지시자, 단일 빔, 다수의 빔

C. 관련문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
X	KR 10-2014-0016854 A (삼성전자주식회사) 2014.02.10 단락 [0049], [0058], [0086]—[0095]; 및 도면 8 참조.	1—5, 8—15
Y		6-7
Y	KR 10-1668709 B1 (엘지전자 주식회사) 2016.11.09 단락 [0019]-[0021]; 및 도면 15 참조.	6
Y	CATT, 'Discussion on beam reporting', R1—1611385, 3GPP TSG RAN WG1 Meeting #87, Reno, USA, 2016.11.05 (http://www.3gpp.org/ftp/tsg_ran/WG1—RL1/TSGR1—87/Docs/) 섹션 2; 및 도면 2 참조.	7
A	KR 10-2014-0049712 A (삼성전자주식회사) 2014.04.28 단락 [0037]-[0051]; 및 도면 3 참조.	1—15
A	US 2016-0197659 A1 (SAMSUNG ELECTRONICS CO., LTD.) 2016.07.07 단락 [0042]-[0054]; 및 도면 1-2 참조.	1—15

☐ 추가 문헌이 C(계속)에 기재되어 있습니다. ☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2018년 04월 20일 (20.04.2018)	2018년 04월 23일 (23.04.2018)

ISA/KR 의 명칭 및 우편주소

대한민국 특허청

(35208) 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사)

팩스 번호 +82-42-481-8578

심사관

강희곡

전화번호 +82-42-481-8264

서식 PCT/ISA/210 (두 번째 용지) (2015년 1월)

국제조사보고서 대응특허에 관한 정보	국제출원번호 PCT/KR2018/000101

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
KR 10-2014-0016854 A	2014/02/10	AU 2013-297246 A1	2015/03/05
		AU 2013-297246 A1	2014/02/06
		AU 2013-297246 B2	2016/11/10
		CN 104521155 A	2015/04/15
		EP 2882110 A1	2015/06/10
		JP 2015-530018 A	2015/10/08
		RU 2015106981 A	2016/09/20
		RU 2636655 C2	2017/11/27
		US 2016-0006122 A1	2016/01/07
		WO 2014-021633 A1	2014/02/06
KR 10-1668709 B1	2016/11/09	CN 105009626 A	2015/10/28
		EP 2961216 A1	2015/12/30
		JP 2016-513430 A	2016/05/12
		US 2015-0341092 A1	2015/11/26
		US 9900068 B2	2018/02/20
		WO 2014-129858 A1	2014/08/28
KR 10-2014-0049712 A	2014/04/28	CN 104737461 A	2015/06/24
		CN 104737461 B	2017/10/24
		EP 2909950 A1	2015/08/26
		US 2014-0112269 A1	2014/04/24
		US 9882689 B2	2018/01/30
		WO 2014-062026 A1	2014/04/24
US 2016-0197659 A1	2016/07/07	CN 105453629 A	2016/03/30
		KR 10-2015-0016913 A	2015/02/13
		WO 2015-020404 A1	2015/02/12

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/673,151

APPLICATION AS FILED - PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	16 minus 20=	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
			TOTAL			TOTAL	1720

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

AMENDMENT A

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/673,151	11/04/2019		1880	US78241	16	2

CONFIRMATION NO. 6936

UPDATED FILING RECEIPT

OC000000113240714

54000
ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

Date Mailed: 12/11/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

TSUNG-HUA TSAI, Hsinchu, TAIWAN;
CHIE-MING CHOU, Hsinchu, TAIWAN;

Applicant(s)

FG Innovation Company Limited, Tuen Mun, HONG KONG;

Power of Attorney: The patent practitioners associated with Customer Number 54000

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/754,706 11/02/2018

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 11/20/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/673,151**

Projected Publication Date: 05/07/2020

Non-Publication Request: No

Early Publication Request: No
Title

METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

Application No.:	**16/673151**
First Named Inventor:	**TSUNG-HUA TSAI**
Filing or 371(c) Date:	**11/04/2019**
Attorney Docket No.:	**US78241**

RE: Request to File Missing Parts of Nonprovisional Application under 37 CFR 1.53(b)

December 4, 2019

Dear Sir or Madam,

Responsive to the Notice dated 11/22/2019 for the above-identified non-provisional application, Applicant herein submits the fees set forth in 37 CFR 1.16(f).

Respectfully submitted,

By / Alvin S. Koan /

Alvin S. Koan
Registration No.: 68,468
ScienBiziP, P.C.
550 S. Hope Street, Suite 2825
Los Angeles, CA 90071
Phone: (213) 426-1771
Fax: (213) 426-1788

PTO/AIA/01 (06-12)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number ____________________

filed on ______________________________.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: TSUNG-HUA TSAI   Date (Optional) : 4-NOV-2019

Signature: Tsai, Tsung-Hua

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number ____________________ filed on ______________________________.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: CHIE-MING CHOU Date (Optional) : ____________________

Signature: Chie Ming Chou

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

Electronic Patent Application Fee Transmittal

Application Number:	16673151
Filing Date:	04-Nov-2019
Title of Invention:	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
Filer:	Alvin Sean Koan
Attorney Docket Number:	US78241

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	1051	1	160	160
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**160**

Electronic Acknowledgement Receipt

EFS ID:	37963339
Application Number:	16673151
International Application Number:	
Confirmation Number:	6936
Title of Invention:	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
Customer Number:	54000
Filer:	Alvin Sean Koan
Filer Authorized By:	
Attorney Docket Number:	US78241
Receipt Date:	09-DEC-2019
Filing Date:	04-NOV-2019
Time Stamp:	09:12:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$160
RAM confirmation Number	E2019B9013075792
Deposit Account	
Authorized User	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	US78241191209ANF.pdf	19149 e8098daf0c332dd8053840eefdaf22800210 9bc1	no	1
Warnings:					
Information:					
2	Oath or Declaration filed	US78241191209DEC.pdf	2422767 239addd0a3bdbb1ca70210c3aaf6fe76b7e 61d69	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30267 7a5cbfbb5dcd2f79cc0ee1e76cc9005528e1 2190	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2472183		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/673,151	11/04/2019		1720	US78241	16	2

CONFIRMATION NO. 6936

FILING RECEIPT

OC000000112793382

54000
ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

Date Mailed: 11/22/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

TSUNG-HUA TSAI, Hsinchu, TAIWAN;
CHIE-MING CHOU, Hsinchu, TAIWAN;

Applicant(s)

FG Innovation Company Limited, Tuen Mun, HONG KONG;

Power of Attorney: The patent practitioners associated with Customer Number 54000

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/754,706 11/02/2018

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 11/20/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/673,151**

Projected Publication Date: 05/07/2020

Non-Publication Request: No

Early Publication Request: No
Title

METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/673,151	11/04/2019	TSUNG-HUA TSAI	US78241

CONFIRMATION NO. 6936

FORMALITIES LETTER

54000
ScienBiziP, PC
550 South Hope Street
Suite 2825
Los Angeles, CA 90071

OC000000112793363

Date Mailed: 11/22/2019

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing.

Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.
  The surcharge is due for any one of:
  - late submission of the basic filing fee, search fee, or examination fee,
  - late submission of inventor's oath or declaration,
  - filing an application that does not contain at least one claim on filing, or
  - submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. No entity status discount is in effect. If applicant is qualified for small entity status, a written assertion of small entity status must be submitted to establish small entity status. (See 37 CFR 1.27). If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- $ **160** surcharge.
- $(**0**) previous unapplied payment amount.
- $ **160** TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

• A properly executed inventor's oath or declaration has not been received for the following inventor(s):
TSUNG-HUA TSAI
CHIE-MING CHOU

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/thaile/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/673,151

APPLICATION AS FILED - PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	16 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
			TOTAL			TOTAL	1720

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

AMENDMENT A

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	
First Named Inventor	TSUNG-HUA TSAI
Title	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
Art Unit	
Examiner Name	
Attorney Docket Number	US78241

SIGNATURE of Applicant or Patent Practitioner

Signature	/Alvin Koan/	Date (Optional)	2019-11-04
Name	Alvin Koan	Registration Number	68468
Title (if Applicant is a juristic entity)	Patent Practitioner		
Applicant Name (if Applicant is a juristic entity)	FG Innovation Company Limited		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of ___________ forms are submitted.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 54000

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

FG Innovation Company Limited

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	Chie-Ming Chou	Date (Optional)	2018-11-29
Name	CHIE-MING CHOU		
Title	CEO		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] The present application claims the benefit of and priority to a provisional U.S. Patent Application Serial No. 62/754,706 filed on November 2, 2018, entitled "Procedure for Multiple Transmit/Receive Point," with Attorney Docket No. US75391 (hereinafter referred to as "US75391 application"). The disclosure of the US75391 application is hereby incorporated fully by reference into the present application.

FIELD

[0002] The present disclosure generally relates to wireless communications, and more particularly, to methods and apparatuses for multiple Transmit/Receive Point (TRP) operations.

BACKGROUND

[0003] Various efforts have been made to improve different aspects of wireless communications (e.g., data rate, latency, reliability, mobility, etc.) for the next generation (e.g., Fifth Generation (5G) New Radio (NR)) wireless communication systems. Among the new concepts in the next generation wireless communication systems, leveraging multiple TRPs may be vital to improve coverage, reliability, and capacity performance of the system. For example, in order to support the growth in data traffic in 5G and to enhance the coverage, the wireless devices may be expected to access networks composed of multiple TRPs.

[0004] However, in the current multi-TRP environment, all TRPs in a cell may have the same cell Identity (ID), which means a User Equipment (UE) may not be able to distinguish these TRPs from each other if there is no further identification or information for each TRP.

[0005] Therefore, there is a need in the art for an improved communication mechanism for multiple TRP operations.

SUMMARY

[0006] The present disclosure is directed to methods and apparatuses for multi-TRP operations.

[0007] According to an aspect of the present disclosure, a UE is provided. The UE includes

one or more non-transitory computer-readable media having computer-executable instructions embodied thereon and at least one processor coupled to the one or more non-transitory computer-readable media. The at least one processor is configured to execute the computer-executable instructions to receive Transmission Configuration Indicator (TCI) state data in a Physical Download Control Channel (PDCCH) determining multiple Physical Downlink Shared Channels (PDSCHs), where the TCI state data is associated with multiple Demodulation Reference Signal (DMRS) port groups. The processor is further configured to obtain multiple Quasi Co-Location (QCL) assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

[0008] According to another aspect of the present disclosure, a method of wireless communications is provided. The method includes receiving, by a UE, TCI state data in a PDCCH determining multiple PDSCHs, where the TCI state data is associated with a multiple DMRS port groups. The method further includes obtaining, by the UE, multiple QCL assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. Various features are not drawn to scale. Dimensions of various features may be arbitrarily increased or reduced for clarity of discussion.

[0010] Fig. 1 is a schematic diagram illustrating a multi-TRP system, in accordance with example implementations of the present application.

[0011] Fig. 2 is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present application.

[0012] Fig. 3 is a schematic diagram illustrating multiple PDSCHs determined from a single PDCCH, in accordance with example implementations of the present application.

[0013] Fig. 4 is a flowchart for a process of identifying a secondary TRP (sTRP), in accordance with example implementations of the present application.

[0014] Fig. 5 is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present application.

[0015] Fig. 6 is a block diagram illustrating a node for wireless communication, in accordance with example implementations of the present application.

DETAILED DESCRIPTION

[0016] The following description contains specific information pertaining to example implementations in the present disclosure. The drawings in the present disclosure and their accompanying detailed description are directed to merely example implementations. However, the present disclosure is not limited to merely these example implementations. Other variations and implementations of the present disclosure will occur to those skilled in the art. Unless noted otherwise, like or corresponding elements among the figures may be indicated by like or corresponding reference numerals. Moreover, the drawings and illustrations in the present disclosure are generally not to scale and are not intended to correspond to actual relative dimensions.

[0017] For the purpose of consistency and ease of understanding, like features may be identified (although, in some examples, not shown) by the same numerals in the example figures. However, the features in different implementations may be differed in other respects, and thus shall not be narrowly confined to what is shown in the figures.

[0018] The description uses the phrases "in one implementation," or "in some implementations," which may each refer to one or more of the same or different implementations. The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The term "comprising," when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series and the equivalent. The expression "at least one of A, B and C" or "at least one of the following: A, B and C" means "only A, or only B, or only C, or any combination of A, B and C."

[0019] Additionally, for the purposes of explanation and non-limitation, specific details, such as functional entities, techniques, protocols, standard, and the like are set forth for providing an understanding of the described technology. In other examples, detailed description of well-known methods, technologies, systems, architectures, and the like are omitted so as not to obscure the description with unnecessary details.

[0020] Persons skilled in the art will immediately recognize that any network function(s) or algorithm(s) described in the present disclosure may be implemented by hardware, software or a combination of software and hardware. Described functions may correspond to modules which may be software, hardware, firmware, or any combination thereof. The software implementation may comprise computer executable instructions stored on computer readable medium such as memory or other type of storage devices. For example, one or more microprocessors or general-purpose computers with communication processing capability may be programmed with corresponding executable instructions and carry out the described network function(s) or algorithm(s). The microprocessors or general-purpose computers may be formed of Applications Specific Integrated Circuitry (ASIC), programmable logic arrays, and/or using one or more Digital Signal Processor (DSPs). Although some of the example implementations described in this specification are oriented to software installed and executing on computer hardware, nevertheless, alternative example implementations implemented as firmware or as hardware or combination of hardware and software are well within the scope of the present disclosure.

[0021] The computer readable medium includes but is not limited to Random Access Memory (RAM), Read Only Memory (ROM), Erasable Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM), flash memory, Compact Disc Read-Only Memory (CD-ROM), magnetic cassettes, magnetic tape, magnetic disk storage, or any other equivalent medium capable of storing computer-readable instructions.

[0022] A radio communication network architecture (e.g., a Long Term Evolution (LTE) system, an LTE-Advanced (LTE-A) system, an LTE-Advanced Pro system, or a 5G New Radio (NR) Radio Access Network (RAN)) typically includes at least one Base Station (BS), at least one User Equipment (UE), and one or more optional network elements that provide connection towards a network. The UE communicates with the network (e.g., a Core Network (CN), an Evolved Packet Core (EPC) network, an Evolved Universal Terrestrial Radio Access Network (E-UTRAN), a 5G Core (5GC), or an internet), through a RAN established by one or more BSs.

[0023] It should be noted that, in the present application, a UE may include, but is not limited to, a mobile station, a mobile terminal or device, a user communication radio terminal. For example, a UE may be a portable radio equipment, which includes, but is not limited to, a mobile phone, a tablet, a wearable device, a sensor, a vehicle, or a Personal Digital Assistant (PDA) with wireless communication capability. The UE is configured to receive and transmit signals over an air interface to one or more cells in a radio access network.

[0024] A BS may be configured to provide communication services according to at least one of the following Radio Access Technologies (RATs): Worldwide Interoperability for Microwave

Access (WiMAX), Global System for Mobile communications (GSM, often referred to as 2G), GSM Enhanced Data rates for GSM Evolution (EDGE) Radio Access Network (GERAN), General Packet Radio Service (GPRS), Universal Mobile Telecommunication System (UMTS, often referred to as 3G) based on basic Wideband-Code Division Multiple Access (W-CDMA), High-Speed Packet Access (HSPA), LTE, LTE-A, eLTE (evolved LTE, e.g., LTE connected to 5GC), NR (often referred to as 5G), and/or LTE-A Pro. However, the scope of the present application should not be limited to the above-mentioned protocols.

[0025] A BS may include, but is not limited to, a node B (NB) as in the UMTS, an evolved Node B (eNB) as in the LTE or LTE-A, a Radio Network Controller (RNC) as in the UMTS, a Base Station Controller (BSC) as in the GSM/GERAN, a ng-eNB as in an Evolved Universal Terrestrial Radio Access (E-UTRA) BS in connection with the 5GC, a next generation Node B (gNB) as in the 5G-RAN, and any other apparatus capable of controlling radio communication and managing radio resources within a cell. The BS may serve one or more UEs through a radio interface.

[0026] The BS is operable to provide radio coverage to a specific geographical area using a plurality of cells forming the radio access network. The BS supports the operations of the cells. Each cell is operable to provide services to at least one UE within its radio coverage. More specifically, each cell (often referred to as a serving cell) provides services to serve one or more UEs within its radio coverage (e.g., each cell schedules the downlink and optionally uplink resources to at least one UE within its radio coverage for downlink and optionally uplink packet transmissions). The BS can communicate with one or more UEs in the radio communication system through the plurality of cells. A cell may allocate Sidelink (SL) resources for supporting Proximity Service (ProSe) or Vehicle to Everything (V2X) service. Each cell may have overlapped coverage areas with other cells.

[0027] As discussed above, the frame structure for NR is to support flexible configurations for accommodating various next generation (e.g., 5G) communication requirements, such as Enhanced Mobile Broadband (eMBB), Massive Machine Type Communication (mMTC), Ultra-Reliable and Low-Latency Communication (URLLC), while fulfilling high reliability, high data rate and low latency requirements. The Orthogonal Frequency-Division Multiplexing (OFDM) technology as agreed in the 3rd Generation Partnership Project (3GPP) may serve as a baseline for NR waveform. The scalable OFDM numerology, such as the adaptive sub-carrier spacing, the channel bandwidth, and the Cyclic Prefix (CP) may also be used. Additionally, two coding schemes are considered for NR: (1) Low-Density Parity-Check (LDPC) code and (2) Polar Code. The coding scheme adaption may be configured based on the channel conditions and/or the service applications.

[0028] Moreover, it is also considered that in a transmission time interval TX of a single NR frame, a Downlink (DL) transmission data, a guard period, and an Uplink (UL) transmission data should at least be included, where the respective portions of the DL transmission data, the guard period, the UL transmission data should also be configurable, for example, based on the network dynamics of NR. In addition, SL resources may also be provided in an NR frame to support ProSe services or V2X services.

[0029] In addition, the terms “system” and “network” herein may be used interchangeably. The term “and/or” herein is only an association relationship for describing associated objects, and represents that three relationships may exist. For example, A and/or B may indicate that: A exists alone, A and B exist at the same time, or B exists alone. In addition, the character “/” herein generally represents that the former and latter associated objects are in an “or” relationship.

[0030] Fig. 1 is a schematic diagram illustrating a multi-TRP system 100, in accordance with example implementations of the present application. As shown in Fig. 1, the multi-TRP system 100 includes a UE 102, a BS 104, and TRPs 106 and 108. It should be noted that even though two TRPs are included in the example implementation illustrated in Fig. 1, any number of TRPs may communicate with the UE in some other implementations. In addition, each TRP may communicate with the BS 104 through a wired or wireless connection.

[0031] The TRPs 106 and 108 may be macro-cells, small-cells, pico-cells, femto-cells, Remote Radio Heads (RRHs), relay nodes or antenna panels, which may be deployed anywhere such as in the interior of a room, in/on a building, on top of a house or streetlamps. The UE 102 may connect to the BS 104 through the TRPs 106 and 108.

[0032] Each of the TRPs 106 and 108 may have one or more antenna panels to provide directional beams towards the UE 102. The antenna panels distributed on the TRPs may be jointly used in the data transmissions to the UE, thereby forming a Multi-Input Multi-Output (MIMO) system.

[0033] Fig. 2 is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present application.

[0034] In action 202, the UE may receive TCI state data in a PDCCH determining multiple PDSCHs. The TCI state data may be associated with multiple DMRS port groups. In action 204, the UE may obtain multiple QCL assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

[0035] The QCL assumptions may include different parameters, such as the spatial-domain QCL parameters (e.g., QCL TypeD parameter), or other QCL parameters such as, at least one of the average delay, the delay spread, the Doppler shift, and the Doppler spread. For example, each QCL assumption may include at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

[0036] In some of the present implementations, the UE may identify different TRPs (e.g., the TRPs 106 and 108 in Fig. 1) based on the QCL assumptions.

[0037] In some of the present implementations, each QCL assumption may correspond to one of the DMRS port groups associated with the TCI state data. For example, the QCL assumptions and the DMRS port groups may have a one-to-one mapping relationship. In some of the present implementations, the UE may receive the DMRS port groups corresponding to the PDSCHs via a Radio Resource Control (RRC)signaling.

[0038] In some of the present implementations, the mapping relationship between the QCL assumptions and the DMRS port groups may be modified. For example, the UE may receive an instruction for indicating a relationship (e.g., a mapping relationship) between the QCL assumptions and the DMRS port groups via a Medium Access Control (MAC) Control Element (CE), Downlink Control Information (DCI), or an RRC signaling. In some of the present implementations, indicating the relationship between the QCL assumptions and the DMRS port groups may include at least one of modifying, adding, deleting, and selecting the relationship between the QCL assumptions and the DMRS port groups. In some other implementations, the UE may be configured with a timer, and the mapping relationship between the QCL assumptions and the DMRS port groups may be modified when the timer expires.

[0039] In some of the present implementations, the TCI state of a DL channel (e.g., a PDCCH or a PDSCH) may include multiple QCL Reference Signal (RS) sets, and each QCL RS set may correspond to one DMRS port group. For example, the TCI state data may correspond to a TCI state configuration that includes multiple QCL RS sets, and each of the QCL RS sets may correspond to one of the DMRS port groups associated with the TCI state data.

[0040] Fig. 3 is a schematic diagram illustrating multiple PDSCHs determined from a single PDCCH, in accordance with example implementations of the present application. As shown in Fig. 3, the UE may receive DCI that contains a TCI state data (e.g., a TCI code point) from the PDCCH 302. After successfully decoding the TCI code point, the UE may obtain multiple TCI states each being associated with one DMRS port group. For example, each TCI state may contain parameters for configuring the QCL relationship between the DL/UL RS(s) and the DM-RS port(s) of a corresponding PDSCH. The QCL relationship may be configured by higher layer parameters, such as qcl-Type1 and qcl-Type2. In addition, the QCL type (e.g., QCL-TypeA, QCL-TypeB, QCL-TypeC and QCL-TypeD) corresponding to each DL RS may be given by a higher layer parameter (e.g., qcl-Type) in the QCL assumption/information. In some other implementations, the TCI state data may be a TRP index that is configured per a cell/Component Carrier (CC), or Bandwidth Part (BWP) basis.

[0041] In the example implementation, the UE may derive multiple PDSCHs based on the DMRS port groups associated with the TCI state data in the DCI, because each DMRS port group may correspond to one PDSCH. As shown in Fig. 3, if the TCI state data is associated with DMRS port group#1 and DMRS port group#2, which are configured by the BS via an RRC signaling, the UE may then determine the QCL assumptions for PDSCH#1 304 and PDSCH#2 306 based on the DMRS port group#1 and DMRS port group#2, respectively. Each of the PDSCHs (e.g., PDSCH#1 304 and PDSCH#2 306) derived from the PDCCH 302 may correspond to a TRP. As shown in Fig. 3, the PDSCH#1 304 and PDSCH#2 306 may be associated with TRPs 308 and 310, respectively. In some of the present implementations, after determining the QCL assumptions for the PDSCH#1 304 and the PDSCH#2 306, the UE may use them to identify the TRPs 308 and 310.

[0042] In some other implementations, the DCI in the PDCCH 302 may schedule a single PDSCH (not illustrated in Fig. 3), and the TRPs 308 and 310 may correspond to different transmission layers of this PDSCH. Each transmission layer may correspond to a data stream from a TRP.

[0043] In some of the present implementations, when a UE performs an initial access procedure successfully, the UE may obtain the resource(s) of a Downlink (DL)/Uplink (UL) channel/beam for communicating with the BS through a certain TRP. This TRP may be referred to as an initial access TRP. In some of the present implementations, the resource of a DL channel/beam may be a Synchronization Signal (SS)/Physical Broadcast Channel (PBCH) Block

(SSB), and the UL channel/beam may be a Physical Random Access Channel (PRACH). The UE may select the SSB through a random access procedure, and use the corresponding resources (e.g., which are configured with the same spatial QCL (sQCL) assumption as the selected SSB) to perform channel/beam measurements.

[0044] In some of the present implementations, the UE may be configured with resources that are orthonormal to the SSB to perform the channel/beam measurements.

[0045] In some of the present implementations, a TRP may be classified as a primary TRP (pTRP) or a secondary TRP (sTRP) for further operations. For example, the UE may adopt different time-domain behaviors (e.g., the aperiodic/semi-persistent/periodic reporting behavior) to report Channel State Information (CSI)/beam measurement results to the pTRP(s) and sTRP(s). For example, the UE may adopt a periodic or semi-persistent reporting process with respect to the RS resource(s) coming from the pTRP, and apply an aperiodic reporting process with respect to the RS resource(s) coming from the sTRP.

[0046] In some of the present implementations, the UE may perform Beam Management (BM) procedures based on the network-configured resources. The UE may report the measurement results to the BS to help the BS to determine the primary communication link (e.g., including the pTRP) to the UE. For example, the BS may schedule a qualified resource (e.g., a beam/channel with a quality value exceeding a predetermined threshold) as the primary communication link to the UE. In this case, the TRP transmitting the qualified resource may be deemed as the pTRP.

[0047] In some of the present implementations, the UE may be notified to change its pTRP if the quality of the resource from the original pTRP changes. It should be noted that the number of the qualified resources and the pTRPs may be arbitrary.

[0048] In some of the present implementations, one or more antenna panels may be embedded in a single TRP. Each antenna panel may transmit at least one resource (beam/channel) in a time unit.

[0049] In some of the present implementations, the pTRP may be determined in an implicit way. For example, a TRP at which a specific resource is transmitted may be determined as a pTRP. The specific resource may include at least one of an SSB, a Channel State Information Reference Signal (CSI-RS), a Sounding Reference Signal (SRS), a PDCCH, a PDCCH that Control Resource Set (CORESET)#0 or search space#0 is located, a broadcast signal (e.g., a PBCH), a PDSCH of Remaining Minimum System Information (RMSI), and a beam/channel having a quality that exceeds a predetermined threshold. In some other implementations, the pTRP for the UE may be determined in an explicit way. For example, the BS may indicate one or more pTRPs to the UE via an RRC signaling, a MAC-CE or DCI.

[0050] In some of the present implementations, for those TRPs that are not selected as the pTRP(s), they may be determined as sTRPs for the UE if these TRPs satisfy certain condition(s), as shown in Fig. 4.

[0051] Fig. 4 is a flowchart for a process of identifying an sTRP, in accordance with example implementations of the present application. In action 402, the UE may obtain a first signal quality value (Q1) for a first resource from a pTRP. In action 404, the UE may obtain a second signal quality value (Q2) for a second resource from a candidate sTRP. The values, Q1 and Q2, may be (but not limited to) Layer 1 (L1)-Reference Signals Received Power (RSRP) values, L1-Reference Signals Received Quality (RSRQ) values, L1-Signal to Interference plus Noise Ratio (SINR) values, RSRP values, RSRQ values, SINR values, or any combination thereof.

[0052] In action 406, the UE may determine whether the difference between Q1 and Q2 is less than, or equal to, a predetermined threshold (TH). In some of the present implementations, the predetermined threshold TH may be configured by the BS.

[0053] If the outcome of action 406 is "yes", the UE, in action 408, may transmit a first report to inform the BS that the candidate sTRP associated with the second resource is qualified to pair with the pTRP. In response to the first report, the BS may add this candidate sTRP as an sTRP for the UE, and inform the UE of the information of the pTRP(s) and/or sTRP(s). Conversely, if the outcome of action 406 is "no", the UE, in action 410, may transmit a second report to inform the BS that the candidate sTRP associated with the second resource is not qualified to pair with the pTRP. In this case, the BS may decide not to add this candidate sTRP as an sTRP for the UE.

[0054] In some of the present implementations, the first and second resources described in actions 402 and 404 may be composite resources. A composite resource may be the first one (or a predetermined one) of the resources in a resource set that is configured for the TRP, or a union resource among all the resource(s) in the resource set, or a resource corresponding to a statistical average beam direction of the TRP. The UE may receive the composite resource of a composite beam/channel from each TRP based on a corresponding QCL assumption. In some of the present implementations, the composite resource may be a TRP-specific resource or a cell-specific resource if the composite resource is composited by at least one SSB resource. Conversely, if the composite resource is not composited by any SSB resource, the composite resource may be a UE-specific resource. In some of the present implementations, the composite resource may be transmitted in a broadcast manner, and compared to a resource that is used in a single-TRP BM procedure, the composite resource may correspond to a wider beam.

[0055] Using the composite resources may help the UE perform multi-TRP measurements more efficiently, because the UE may only need to measure one resource (composite resource) for each TRP at the beginning of the measurement.

[0056] In some of the present implementations, when several TRPs are distributed around the UE, the UE may be configured with a composite resource set. Each composite resource in the composite resource set may represent an average beam direction of an individual TRP. In this manner, the UE may report suitable TRP pairs to the BS quickly.

[0057] In some of the present implementations, once the pTRP(s) and sTRP(s) are determined, the BS may collect these pTRP(s) and sTRP(s) in a serving TRP set, and inform the UE of this serving TRP set via RRC signaling, a MAC CE, DCI, or any combination thereof.

[0058] In some of the present implementations, a variation in beam/channel quality may lead to a change in the configuration of the pTRP(s) and/or sTRP(s). For example, when the BS detects that the TRP with the best/qualified beam quality has changed, the BS may instruct the UE to modify/select the related configurations of the pTRP(s) and/or sTRP(s) to change the pTRP(s) and/or sTRP(s).

[0059] In some of the present implementations, the UE may receive a trigger event with a predetermined offset from the BS. The UE may determine whether the difference between the beam/channel quality of the pTRP and that of the sTRP exceeds this predetermined offset. If the determination's result is positive, the UE may transmit a report to request the BS to modify/select the related configurations of the pTRP(s) and/or sTRP(s).

[0060] In some of the present implementations, the UE may monitor the CORESET of a TRP based on a QCL assumption that is made for monitoring a PDCCH that schedules multiple PDSCHs. In this case, each PDSCH may be transmitted from a separate TRP. In some other implementations, the UE may monitor the CORESET of a TRP based on a QCL assumption that is made for monitoring a PDCCH that schedules a single PDSCH. In this case, different transmission layers of this PDSCH may be transmitted by the respective TRPs. In some other implementations, the UE may monitor the CORESET of a TRP based on multiple QCL assumptions that are made for monitoring multiple PDCCHs, each scheduling a PDSCH, and each NR-PDSCH may be transmitted from a separate TRP. In some other implementations, the UE may monitor the CORESET of a TRP based on multiple QCL assumptions that are made for monitoring multiple PDCCHs, each scheduling a PDSCH, and each NR-PDSCH may be transmitted from a separate TRP.

[0061] Fig. 5 is a flowchart for a process of multi-TRP operations, in accordance with example implementations of the present disclosure.

[0062] In action 502, an initial access TRP is setup after the UE successfully performs an initial access procedure. For example, after successfully performing the initial access procedure, the UE may get a DL/UL resource (e.g., channel/beam) to communicate with the BS through a TRP. This TRP may be set as the initial access TRP for the UE. The initial access TRP may be used as a pTRP from the UE's perspective.

[0063] In action 504, the UE may receive configuration(s) for channel/beam measurement(s). For example, the UE may receive the configurations of K (e.g., K=0, 1, 2, …) resource(s) and/or L (e.g., L=0, 1, 2, …) resource for channel/beam measurements. The UE may apply the same QCL assumption as the SSB on which the UE camps during the random access procedure to receive the K resource(s). In addition, the L resource(s) may be orthonormal to the SSB on which the UE camps during the random access procedure. In some of the present implementations, the resources in the same resource set may have the same time-domain behavior, and each RS may correspond to a channel/beam of a TRP.

[0064] In action 506, the UE may perform channel/beam measurement(s) according to the configuration. For example, the UE may perform the channel/beam measurement(s) according to the configuration(s) of the K and/or L resource(s). The UE may obtain the channel/beam statues/quality information (e.g. L1-RSRP, L1-RSRQ, L1-SINR, RSRP, RSRQ, SINR, or any combination thereof) from the channel/beam measurement. In some of the present implementations, the spatial domain filter information for receiving each DL resource may be obtained from the measurement. The spatial domain information may include at least one Receive (RX) radiation pattern and/or RX panel.

[0065] In some of the present implementations, the UE may report at least one of the resource indicator (or beam index), the measurement metric information, and the correlation information according to the configuration(s) obtained in action 504. The resource indicator may be, but not limited to, an SSB resource indicator (if the resource is an SSB), a CSI-RS resource indicator (if the resource is a CSI-RS), a DMRS resource indicator (if the resource is a DMRS), or an SRS resource indicator. The measurement metric information may be, but not limited to, an L1-RSRP, an L1-RSRQ, an L1-SINR, a RSRP, a RSRQ, an SINR, or any combination thereof. In some of the present implementations, the measurement metric information that is related to a resource may be differentially encoded with respective to another resource. For example, a differential L1-RSRP offset level for the 2nd measured resource may be obtained by subtracting L1-RSRP#1 from L1-RSRP#2, where L1-RSRP#1 is an L1-RSRP obtained from the 1st resource measurement, and L1-RSRP#2 is an L1-RSRP obtained from the 2nd resource measurement. The correlation information may include a correlation factor/indicator that indicates the spatial correlation between two or more observed resources. In some of the present implementations, the UE may compare the spatial correlation factor/indicator with a correlation threshold to determine whether the spatial correlation between the observed resources is high or not. The correlation threshold may be configured by the BS or determined based on the UE's implementations. The UE may be instructed to report the highest and/or lowest spatial correlation factor/indicator. In some of the present implementations, the correlation information may include at least one of a high/low correlation indicator and the indicators of the observed resources. The high/low correlation indicator may be used for indicating that the spatial correlation between the observed resources is high/low.

[0066] In some of the present implementations, the BS may determine compatible resources for serving the TRPs, based on the correlation information received from the UE, to improve the spatial diversity/multiplexing performance. In some of the present implementations, the correlation factor/indicator may be obtained by calculating the Angle-of-Arrival (AoA) related parameters for the channel/beams of the RS resources from the TRPs.

[0067] In action 508, the UE may receive a message of a multi-TRP indication (e.g., indicating the information of pTRP(s) and/or sTRP(s)). For example, the message for indicating the information of pTRP(s) may contain at least one TCI-state indication that indicates a reference RS resource for a DL control channel and/or an SSB selected through the random access procedure. In this case, CORESET#0 or search space#0 may be located in the reference RS resource. In addition, the message for indicating the information of sTRP(s) may include at least one TCI-state indication that indicates at least one reference resource(s) for the DL shared channel(s). In this case, the UE may know that the TRP transmitting the indicated reference resource is an sTRP. In some of the present implementations, the TCI-state indication may correspond to one or more DMRS port groups, and each DMRS port group ID may correspond to a TRP ID.

[0068] In some of the present implementations, the target RS port/resource group (e.g., the DMRS port group of a PDSCH/PDCCH) may have the same QCL assumption as that of the source TRP-RS resource, which means the UE may assume that all ports/resources in the same target RS port/resource group may be from the same TRP, while the ports/resources in different target RS port/resource groups may be from different TRPs.

[0069] In action 510, the UE may receive a message to terminate the multi-TRP operation and/or reset the multi-TRP configuration. For example, after receiving the message, the UE may terminate, cancel, or reset at least one of the correlation information of the reference RS resources among the TRPs, the TRP setting (e.g., including the resource setting and /or reporting setting), and the correspondence among the DMRS ports, DMRS port groups, TCI states, and QCL assumptions. In some of the present implementations, if there is no UE-specific scheduling for a while (e.g., before a timer expires), or a BWP switching happens, the UE may release the previous setting/configuration.

[0070] In some of the present implementations, the configuration that the UE receives in action 504 may be the composite resource configuration for the composite beam/channel from each TRP. The UE may perform channel/beam measurements on the composite resources of the respective TRPs. In this manner, the channel/beam measurements may be performed more efficiently, because the UE may only need to measure one resource (composite resource) for each TRP.

[0071] In some of the present implementations, the BS may indicate at least one pTRP resource set to the UE through at least one of the configuration of the pTRP, the predetermined resource(s) associated with the pTRP ID, and the best channel quality determined by the BS or UE.

[0072] In some of the present implementations, the BS may indicate at least one sTRP resource set to the UE through at least one of the configuration of the sTRP, the predetermined resource(s) associated with the sTRP ID, and the best compatible channel quality in terms of the pTRP determined by the BS or UE.

[0073] In some of the present implementations, the UE may identify different resource(s)/resource set(s) from different TRPs via at least one of the information of QCL assumption(s), the target RS port group(s), and reference RS correlation indication.

[0074] For example, the network/BS may indicate target RSs to the UE in terms of two reference RS resource sets. According to the TCI state configuration, the target DMRS may be spatially quasi co-located with the reference RS from a TRP. The DMRS ports may be in different target DMRS port groups. In some other implementations, the UE may be configured with an information element of correlation information, and the UE may use it to determine whether two or more resources are from the same TRP. In this case, a low correlation means that the reference RS resources may have a rich spatial multiplexing/diversity and come from different TRPs, and a high correlation may mean that the reference RS resources may come from the same TRP.

[0075] Fig. 6 is a block diagram illustrating a node for wireless communication, in accordance with various aspects of the present disclosure. As shown in Fig. 6, a node 600 may include a transceiver 620, a processor 628, a memory 634, one or more presentation components 638, and at least one antenna 636. The node 600 may also include an RF spectrum band module, a BS communications module, a network communications module, and a system communications management module, Input/Output (I/O) ports, I/O components, and power supply (not explicitly shown in FIG. 6). Each of these components may be in communication with each other, directly or indirectly, over one or more buses 640. In one implementation, the node 600 may be a UE or a BS that performs various functions described herein, for example, with reference to Figs. 1 through 5.

[0076] The transceiver 620 having a transmitter 622 (e.g., transmitting/transmission circuitry) and a receiver 624 (e.g., receiving/reception circuitry) may be configured to transmit and/or receive time and/or frequency resource partitioning information. In some implementations, the transceiver 620 may be configured to transmit in different types of subframes and slots including, but not limited to, usable, non-usable and flexibly usable subframes and slot formats. The transceiver 620 may be configured to receive data and control channels.

[0077] The node 600 may include a variety of computer-readable media. Computer-readable media may be any available media that may be accessed by the node 600 and include both volatile and non-volatile media, removable and non-removable media. By way of example, and not limitation, computer-readable media may comprise computer storage media and communication media. Computer storage media includes both volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules or data.

[0078] Computer storage media includes RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, Digital Versatile Disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices. Computer storage media does not comprise a propagated data signal. Communication media typically embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless media. Combinations of any of the above should also be included within the scope of computer-readable media.

[0079] The memory 634 may include computer-storage media in the form of volatile and/or non-volatile memory. The memory 634 may be removable, non-removable, or a combination thereof. Example memory includes solid-state memory, hard drives, optical-disc drives, and etc. As illustrated in Fig. 6, The memory 634 may store computer-readable, computer-executable instructions 632 (e.g., software codes) that are configured to, when executed, cause the processor 628 to perform various functions described herein, for example, with reference to Figs. 1 through 5. Alternatively, the instructions 632 may not be directly executable by the processor 628 but be configured to cause the node 600 (e.g., when compiled and executed) to perform various functions described herein.

[0080] The processor 628 (e.g., having processing circuitry) may include an intelligent hardware device, e.g., a Central Processing Unit (CPU), a microcontroller, an ASIC, and etc. The processor 628 may include memory. The processor 628 may process the data 630 and the instructions 632 received from the memory 634, and information through the transceiver 620, the base band communications module, and/or the network communications module. The processor 628 may also process information to be sent to the transceiver 620 for transmission through the antenna 636, to the network communications module for transmission to a core network.

[0081] One or more presentation components 638 presents data indications to a person or other device. Examples of presentation components 638 may include a display device, speaker, printing component, vibrating component, etc.

[0082] From the above description, it is manifested that various techniques may be used for implementing the concepts described in the present application without departing from the scope of those concepts. Moreover, while the concepts have been described with specific reference to certain implementations, a person of ordinary skill in the art may recognize that changes may be made in form and detail without departing from the scope of those concepts. As such, the described implementations are to be considered in all respects as illustrative and not restrictive. It should also be understood that the present application is not limited to the particular implementations described above, but many rearrangements, modifications, and substitutions are possible without departing from the scope of the present disclosure.

CLAIMS

WHAT IS CLAIMED IS:

1. A user equipment (UE) comprising:

one or more non-transitory computer-readable media having computer-executable instructions embodied thereon; and

at least one processor coupled to the one or more non-transitory computer-readable media, and configured to execute the computer-executable instructions to:

receive, in a Physical Download Control Channel (PDCCH), Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtain a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data.

2. The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

identify a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

3. The UE of claim 1, wherein each of the plurality of QCL assumptions corresponds to one of the plurality of DMRS port groups.

4. The UE of claim 3, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium Access Control (MAC) Control Element (CE) signaling.

5. The UE of claim 1, wherein the at least one processor is further configured to execute

the computer-executable instructions to:

indicate a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

6. The UE of claim 1, wherein the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

7. The UE of claim 1, wherein the at least one processor is further configured to execute the computer-executable instructions to:

receive the plurality of DMRS port groups corresponding to the plurality of PDSCHs via RRC signaling.

8. The UE of claim 1, wherein each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

9. A method of wireless communications comprising:

receiving in a Physical Download Control Channel (PDCCH), by a user equipment (UE), Transmission Configuration Indicator (TCI) state data for determining a plurality of Physical Downlink Shared Channels (PDSCHs), the TCI state data being associated with a plurality of Demodulation Reference Signal (DMRS) port groups; and

obtaining, by the UE, a plurality of Quasi Co-Location (QCL) assumptions for receiving the plurality of PDSCHs based on the plurality of DMRS port groups associated with the TCI state data.

10. The method of claim 9, further comprising:

identifying, by the UE, a plurality of Transmit/Receive Points (TRPs) based on the plurality of QCL assumptions.

11. The method of claim 9, wherein each of the plurality of QCL assumptions corresponds

to one of the plurality of DMRS port groups.

12. The method of claim 11, further comprising:

receiving, by the UE, an instruction for indicating a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups via Medium Access Control (MAC) Control Element (CE) signaling.

13. The method of claim 9, further comprising:

indicating, by the UE, a relationship between the plurality of QCL assumptions and the plurality of DMRS port groups when a timer configured for the UE expires.

14. The method of claim 9, wherein the TCI state data corresponds to a TCI state configuration that includes a plurality of QCL Reference Signal (RS) sets, and each of the plurality of QCL RS sets corresponds to one of the plurality of DMRS port groups.

15. The method of claim 9, further comprising:

receiving, by the UE, the plurality of DMRS port groups corresponding to the plurality of PDSCHs via RRC signaling.

16. The method of claim 9, wherein each of the plurality of QCL assumptions includes at least one of a time-domain QCL parameter, a frequency-domain QCL parameter, and a spatial-domain QCL parameter.

ABSTRACT

A method includes receiving, by a User Equipment (UE), Transmission Configuration Indicator (TCI) state data in a Physical Download Control Channel (PDCCH) determining multiple Physical Downlink Shared Channels (PDSCHs), where the TCI state data is associated with multiple Demodulation Reference Signal (DMRS) port groups, and obtaining, by the UE, multiple Quasi Co-Location (QCL) assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data.

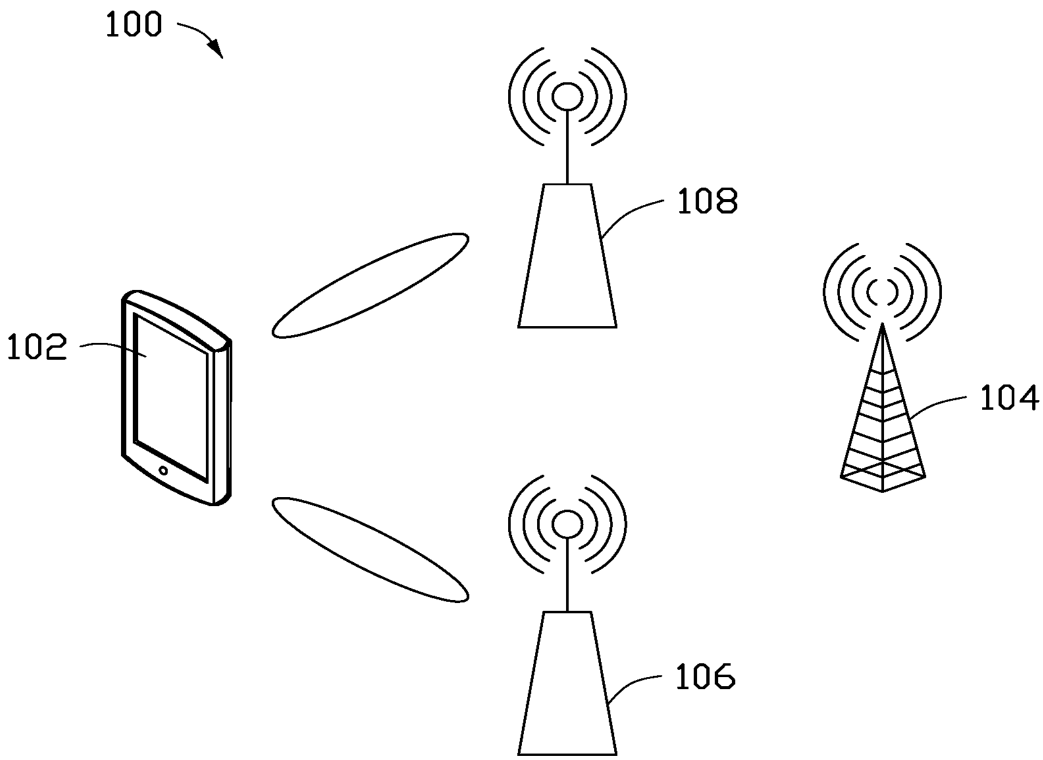

FIG. 1

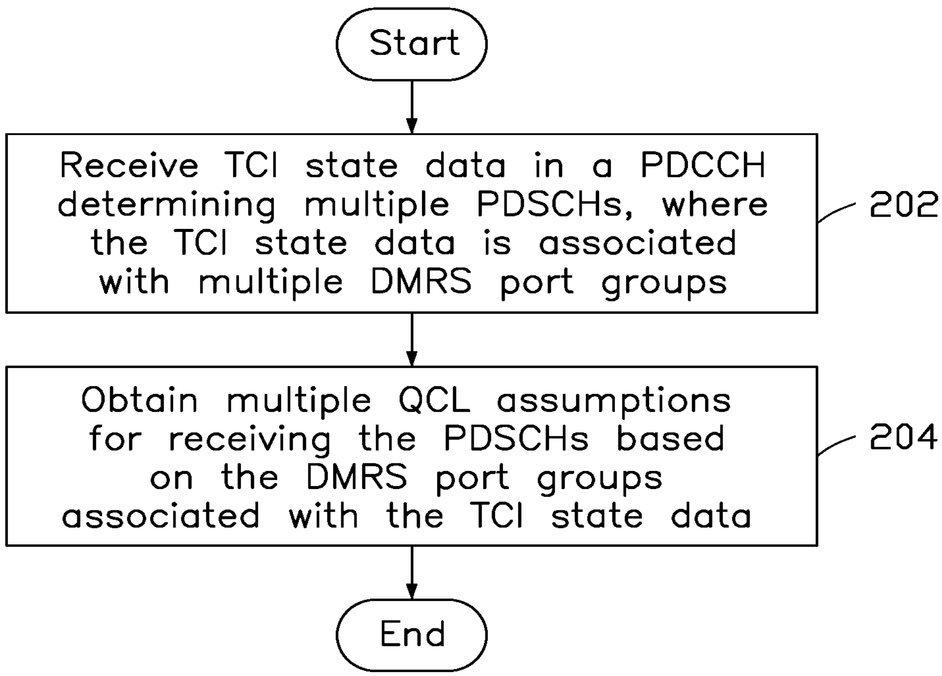
Start
Receive TCI state data in a PDCCH determining multiple PDSCHs, where the TCI state data is associated with multiple DMRS port groups
202
Obtain multiple QCL assumptions for receiving the PDSCHs based on the DMRS port groups associated with the TCI state data
204
End

FIG. 2

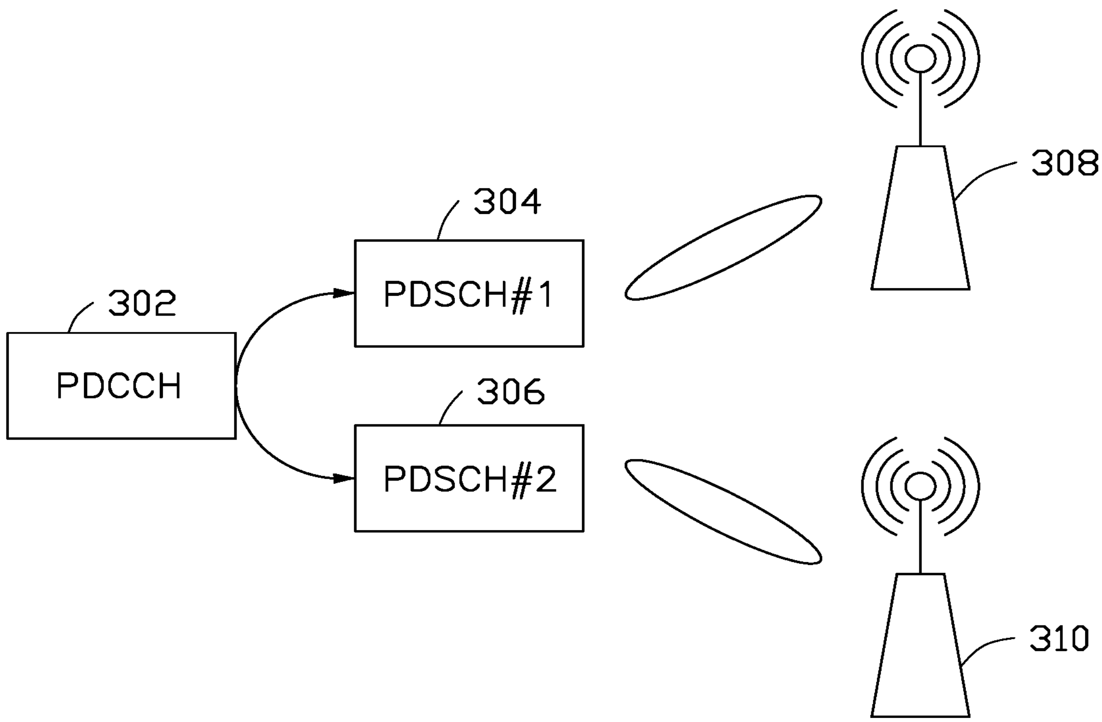

FIG. 3

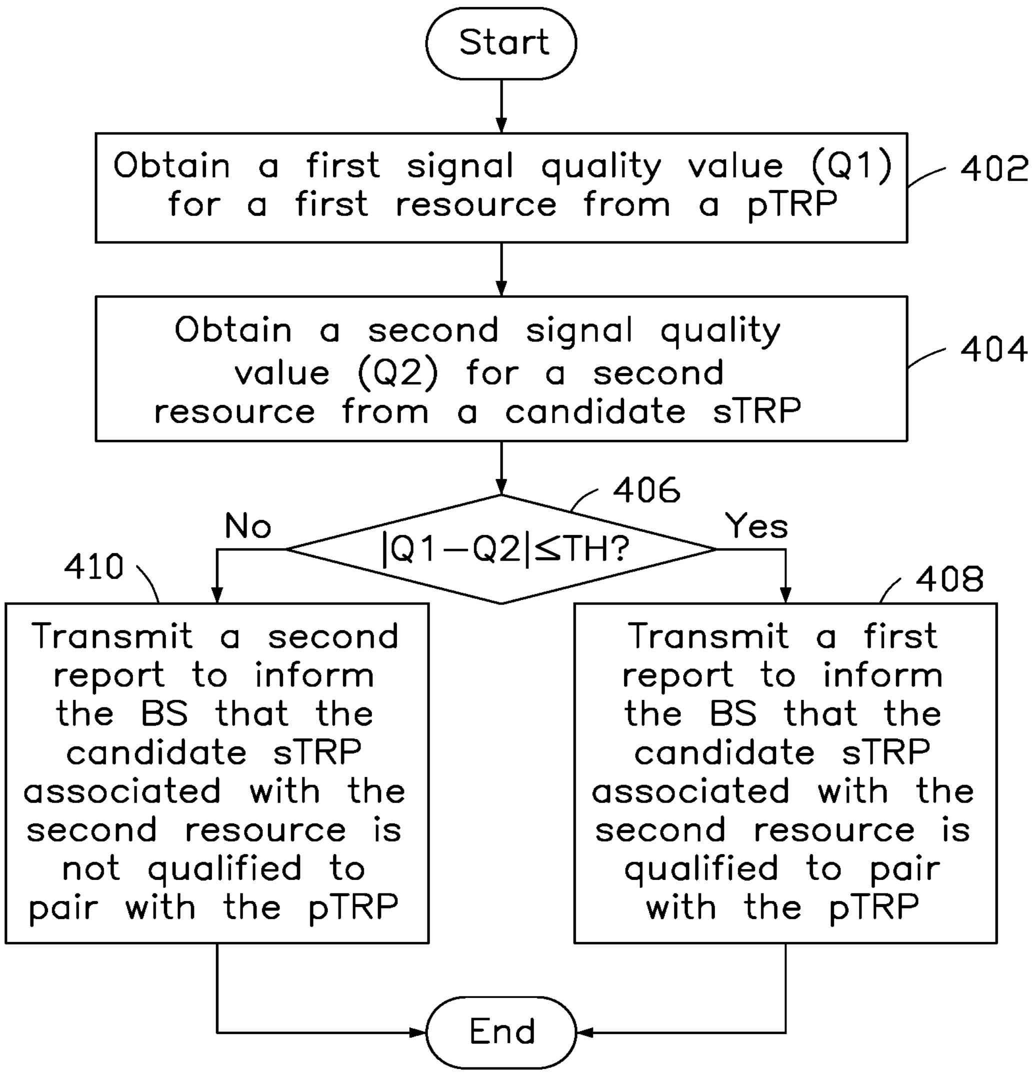
Start
Obtain a first signal quality value (Q1) for a first resource from a pTRP
402
Obtain a second signal quality value (Q2) for a second resource from a candidate sTRP
404
406
No
|Q1−Q2|≤TH?
Yes
410
Transmit a second report to inform the BS that the candidate sTRP associated with the second resource is not qualified to pair with the pTRP
408
Transmit a first report to inform the BS that the candidate sTRP associated with the second resource is qualified to pair with the pTRP
End

FIG. 4

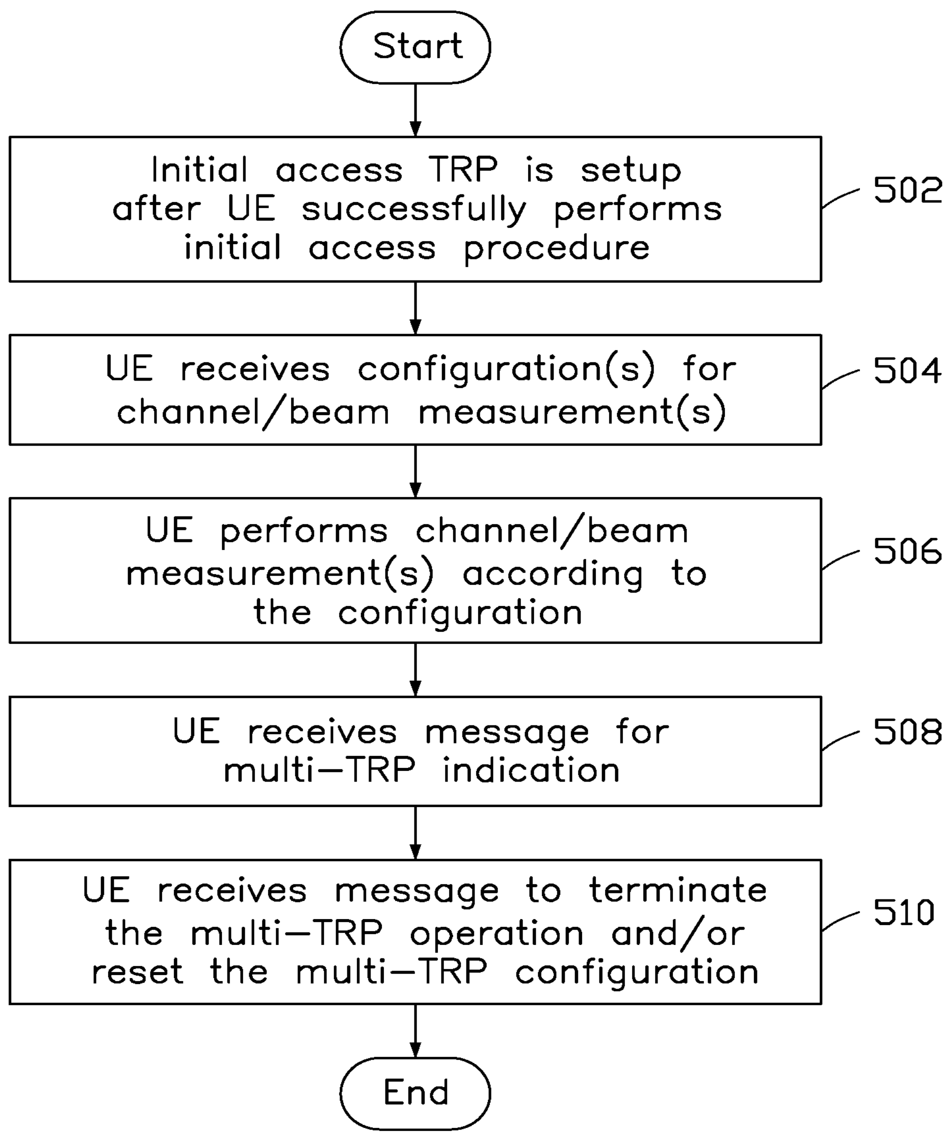
Start
Initial access TRP is setup after UE successfully performs initial access procedure
502
UE receives configuration(s) for channel/beam measurement(s)
504
UE performs channel/beam measurement(s) according to the configuration
506
UE receives message for multi–TRP indication
508
UE receives message to terminate the multi–TRP operation and/or reset the multi–TRP configuration
510
End

FIG. 5

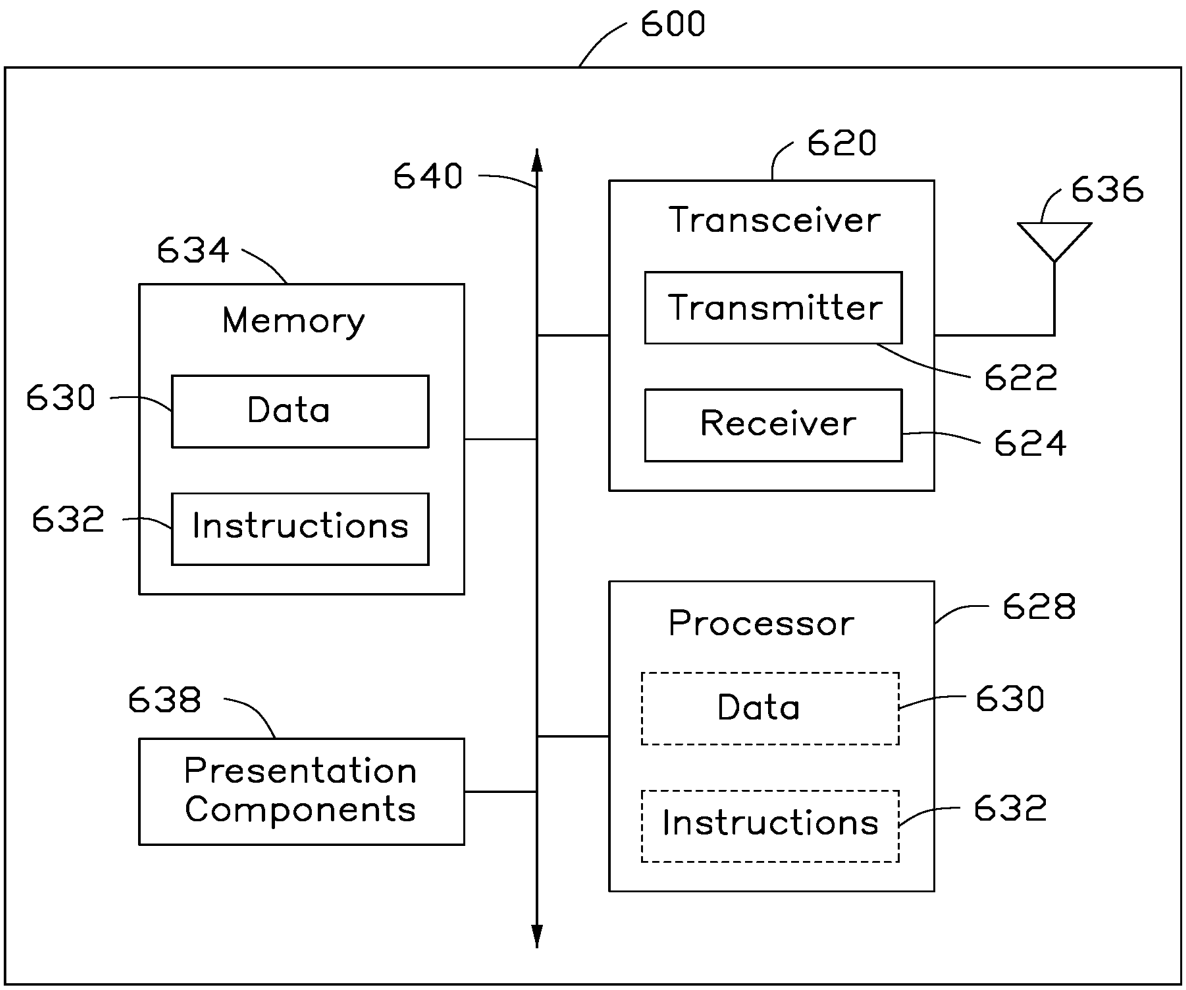
600
640
620
636
634
Transceiver
Transmitter
Memory
622
630
Data
Receiver
624
632
Instructions
Processor
628
638
Data
630
Presentation
Components
Instructions
632

FIG. 6

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	US78241
	Application Number	

Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	**Given Name**	**Middle Name**	**Family Name**	**Suffix**
	TSUNG-HUA		TSAI	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Hsinchu	Country of Residence [i]	TW

Mailing Address of Inventor:

Address 1	12F.-7, No.135, Ciyun Rd., East Dist.		
Address 2			
City	Hsinchu	**State/Province**	
Postal Code	30072	**Country** [i]	TW

Inventor 2 Remove

Legal Name

Prefix	**Given Name**	**Middle Name**	**Family Name**	**Suffix**
	CHIE-MING		CHOU	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Hsinchu	Country of Residence [i]	TW

Mailing Address of Inventor:

Address 1	5F-1, NO. 5, HSIN-AN RD.		
Address 2	HSINCHU SCIENCE-BASED INDUSTRIAL PARK, TAIWAN		
City	Hsinchu	**State/Province**	
Postal Code	300	**Country** [i]	TW

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	US78241
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS	

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	54000		
Email Address	eoa-proce@scienbizip.com	Add Email	Remove Email
Email Address	eoa-cbd@scienbizip.com	Add Email	Remove Email
Email Address	eoa-procc@scienbizippc.com		Remove Email

Application Information:

Title of the Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS		
Attorney Docket Number	US78241	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	2

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	US78241
	Application Number	

Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	54000		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the “Application Number” field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Claims benefit of provisional	62/754706	2018-11-02

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Remove Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	US78241
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	US78241
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	
If the Applicant is an Organization check here.	☒
Organization Name	FG Innovation Company Limited

Mailing Address Information For Applicant:

Address 1	Flat 2623, 26/F Tuen Mun Central Square		
Address 2	22 Hoi Wing Road, Tuen Mun, New Territories		
City	Tuen Mun	**State/Province**	
Country	HK	Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	US78241
	Application Number	
Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Alvin Koan/			Date (YYYY-MM-DD)	2019-11-04
First Name	Alvin	Last Name	Koan	Registration Number	68468

Additional Signature may be generated within this form by selecting the Add button. Add

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	US78241
	Application Number	

Title of Invention	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
Filer:	Alvin Sean Koan
Attorney Docket Number:	US78241

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1720**

Electronic Acknowledgement Receipt

EFS ID:	37648443
Application Number:	16673151
International Application Number:	
Confirmation Number:	6936
Title of Invention:	METHOD AND APPARATUS FOR MULTIPLE TRANSMIT/RECEIVE POINT (TRP) OPERATIONS
First Named Inventor/Applicant Name:	TSUNG-HUA TSAI
Customer Number:	54000
Filer:	Alvin Sean Koan
Filer Authorized By:	
Attorney Docket Number:	US78241
Receipt Date:	04-NOV-2019
Filing Date:	
Time Stamp:	15:45:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1720
RAM confirmation Number	E2019A4F46119468
Deposit Account	
Authorized User	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	US78241191104POA.pdf	1138481 1224d0d683746053ed5293a2fcdf5345c105f0c8	no	2
Warnings:					
Information:					
2	Specification	US78241191104_Spec.pdf	121263 02b4145867aa8c94b518d313e40d665116846476	no	17
Warnings:					
Information:					
3	Claims	US78241191104_Clms.pdf	31293 88a6eddfbe3da50b1caa4854d8b59595768ff299	no	3
Warnings:					
Information:					
4	Abstract	US78241191104_Abst.pdf	17248 5fe7eaed602d3945eac1059ebad5ec8da4cbd0d7	no	1
Warnings:					
Information:					
5	Drawings-only black and white line drawings	US78241191104_draw.pdf	72224 34e3603965cf7ad6712cd3635aed429bb993d60a	no	6
Warnings:					
Information:					
6	Application Data Sheet	US78241__ADS.pdf	1792808 0f12c2bbce28fe0c66fdd87c8e8a2cafeaccb1eb	no	8
Warnings:					
Information:					

7	Fee Worksheet (SB06)	fee-info.pdf	34731 706162947ee4e476b747947f5a6cd722f65dc71a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3208048		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.