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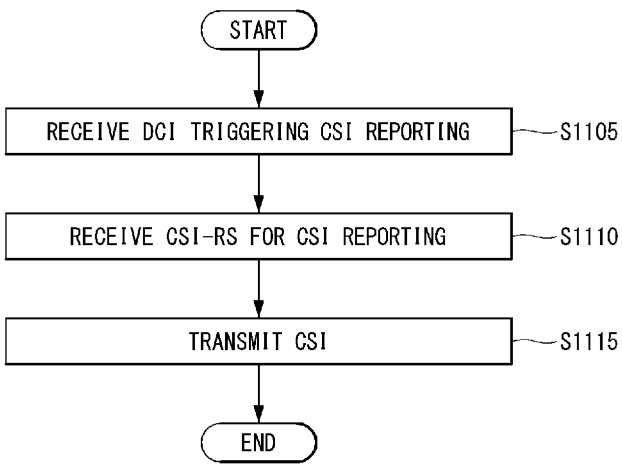
(54) **Title:** METHOD OF TRANSMITTING AND RECEIVING CHANNEL STATE INFORMATION IN WIRELESS COMMUNICATION SYSTEM AND APPARATUS THEREFOR



(57) **Abstract:** A method of performing channel state information (CSI) reporting by a terminal in a wireless communication system. The method includes: receiving downlink control information (DCI) that triggers the CSI reporting; receiving a CSI-reference signal (CSI-RS) for the CSI reporting; and transmitting, to a base station, CSI that is determined based on the CSI-RS that is received. A minimum required time for the CSI reporting is configured based on (i) a first minimum required time from a last timing of the CSI-RS to a transmission timing of the CSI reporting, and (ii) a second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS.

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Description

Title of Invention: METHOD OF TRANSMITTING AND RECEIVING CHANNEL STATE INFORMATION IN WIRELESS COMMUNICATION SYSTEM AND APPARATUS THEREFOR

Technical Field

[1] The present disclosure generally relates to a wireless communication system and, more particularly, to transmitting and receiving channel state information.

Background Art

[2] Mobile communication systems have been generally developed to provide voice services while guaranteeing user mobility. Such mobile communication systems have gradually expanded their coverage from voice services through data services up to high-speed data services. However, as current mobile communication systems suffer from resource shortages and increased user demand for even higher-speed services, development of more advanced mobile communication systems is needed.

[3] The requirements of the next-generation mobile communication system may include supporting increased data traffic, an increase in the transfer rate of each user, the accommodation of a significantly increased number of connection devices, very low end-to-end latency, and high energy efficiency. To this end, various techniques, such as small cell enhancement, dual connectivity, massive multiple input multiple output (MIMO), in-band full duplex, non-orthogonal multiple access (NOMA), supporting super-wide band, and device networking, have been researched.

Disclosure of Invention

Technical Problem

[4] Implementations of the present disclosure enable transmitting and receiving channel state information (CSI).

Solution to Problem

[5] One general aspect of the present disclosure includes a method of performing channel state information (CSI) reporting by a terminal in a wireless communication system, the method including: receiving downlink control information (DCI) that triggers the CSI reporting. The method of performing channel state information reporting also includes receiving a CSI-reference signal (CSI-RS) for the CSI reporting. The method of performing channel state information reporting also includes transmitting, to a base station, CSI that is determined based on the CSI-RS that is received. The method of performing channel state information reporting also includes where a minimum required time for the CSI reporting is configured based on (i) a first

minimum required time from a last timing of the CSI-RS to a transmission timing of the CSI reporting, and (ii) a second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[6] Implementations may include one or more of the following features. The method where reporting information for the CSI reporting includes any one of (i) a CSI-RS resource indicator (cri) and a reference signal received power (RSRP), (ii) a synchronization signal block (SSB) identifier and the RSRP, or (iii) no report. The method where the minimum required time for the CSI reporting is configured as a sum of (i) the first minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI reporting, and (ii) the second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS. The method where information for the first minimum required time is reported, by the terminal, to the base station as ue capability information. The method where the CSI-RS is configured to be aperiodically transmitted. The method may also include where the DCI that schedules the CSI-RS is triggering DCI for the CSI-RS. The method where information for the second minimum required time is reported, by the terminal, to the base station as ue capability information. The method where a number of processing units that are utilized by the terminal to perform the CSI reporting is equal to 1. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[7] Another general aspect of the present disclosure includes a terminal configured to perform channel state information (CSI) reporting in a wireless communication system, the terminal including: a radio frequency (RF) unit. The terminal also includes at least one processor; and at least one computer memory operably connectable to the at least one processor and storing instructions that, when executed by the at least one processor, perform operations including: receiving, through the RF unit, downlink control information (DCI) that triggers the CSI reporting. The operations also include receiving, through the RF unit, a CSI-reference signal (CSI-RS) for the CSI reporting. The operations also include transmitting, to a base station through the RF unit, CSI that is determined based on the CSI-RS that is received. A minimum required time for the CSI reporting is configured based on (i) a first minimum required time from a last timing of the CSI-RS to a transmission timing of the CSI reporting, and (ii) a second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices,

each configured to perform the actions of the methods.

[8] Implementations may include one or more of the following features. The terminal where reporting information for the CSI reporting includes any one of (i) a CSI-RS resource indicator (cri) and a reference signal received power (RSRP), (ii) a synchronization signal block (SSB) identifier and the RSRP, or (iii) no report. The terminal where the minimum required time for the CSI reporting is configured as a sum of (i) the first minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI reporting, and (ii) the second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS. The terminal where information for the first minimum required time is reported, by the terminal, to the base station as user equipment (UE) capability information. The terminal where the CSI-RS is configured to be aperiodically transmitted. The terminal may also include where the DCI that schedules the CSI-RS is triggering DCI for the CSI-RS. The terminal where information for the second minimum required time is reported, by the terminal, to the base station as UE capability information. The terminal where a number of processing units that are utilized by the terminal to perform the CSI reporting is equal to 1. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[9] Another general aspect of the present disclosure includes a base station configured to receive channel state information (CSI) in a wireless communication system, the base station including: a radio frequency (RF) unit. The base station also includes at least one processor; and at least one computer memory operably connectable to the at least one processor and storing instructions that, when executed by the at least one processor, perform operations including: transmitting, through the RF unit, downlink control information (DCI) that triggers the CSI reporting. The operations also include transmitting, through the RF unit, a CSI-reference signal (CSI-RS) for the CSI reporting. The operations also include receiving, from a terminal through the RF unit, CSI that is determined based on the CSI-RS that was transmitted. A minimum required time for the CSI reporting is configured based on (i) a first minimum required time from a last timing of the CSI-RS to a transmission timing of the CSI reporting by the terminal, and (ii) a second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[10] All or part of the features described throughout this disclosure can be implemented as a computer program product including instructions that are stored on one or more non-transitory machine-readable storage media, and that are executable on one or more processing devices. All or part of the features described throughout this disclosure can

be implemented as an apparatus, method, or electronic system that can include one or more processing devices and memory to store executable instructions to implement the stated functions.

[11] The details of one or more implementations of the subject matter of this disclosure are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages of the subject matter will become apparent from the description, the drawings, and the claims.

Advantageous Effects of Invention

[12] According to some implementations of the present disclosure, there is an effect in that CSI calculation and CSI reporting can be efficiently performed when the number of processing units utilized by a terminal for CSI reporting is smaller than the number of CSI reportings that are configured and/or indicated by a base station in CSI reporting.

[13] Furthermore, according to some implementations of the present disclosure, there is an effect that an efficient Z value setting and efficient processing unit utilization can be realized in the case of L1-RSRP report used for beam management and/or beam reporting use, in addition to normal CSI reporting.

[14] Effects which may be obtained by the present disclosure are not limited to the above-described effects, and various other effects may be evidently understood by those skilled in the art to which the present disclosure pertains from the following description.

Brief Description of Drawings

[15] FIG. 1 is a diagram illustrating an example of an overall structure of a new radio (NR) system according to some implementations of the present disclosure;

[16] FIG. 2 illustrates an example of a relationship between a uplink (UL) frame and a downlink (DL) frame in a wireless communication system according to some implementations of the present disclosure;

[17] FIG. 3 shows an example of a frame structure in an NR system;

[18] FIG. 4 shows an example of a resource grid supported in a wireless communication system according to implementations of the present disclosure;

[19] FIG. 5 shows examples of a resource grid for each antenna port and numerology according to some implementations of this disclosure;

[20] FIG. 6 shows an example of a self-contained structure according to some implementations of this disclosure;

[21] FIG. 7 shows an example of an operating flowchart of a terminal performing channel state information reporting according to some implementations of this disclosure;

[22] FIG. 8 shows an example of an operating flowchart of a base station receiving

channel state information reporting according to some implementations of this disclosure;

[23] FIG. 9 shows an example of an L1-RSRP report operation in a wireless communication system;

[24] FIG. 10 shows another example of an L1-RSRP report operation in a wireless communication system;

[25] FIG. 11 shows an example of an operating flowchart of a terminal reporting channel state information according to some implementations of this disclosure;

[26] FIG. 12 shows an example of an operating flowchart of a base station receiving channel state information according to some implementations of this disclosure;

[27] FIG. 13 shows an example of a wireless communication device according to some implementations of the present disclosure; and

[28] FIG. 14 shows another example of a block diagram of a wireless communication device according to some implementations of this disclosure.

Mode for the Invention

[29] Implementations of the present disclosure generally enable transmitting and receiving channel state information (CSI) in a wireless communication system.

[30] According to some implementations, techniques are disclosed for allocating and/or assigning one or more CSI reportings, configured and/or indicated by a base station, to one or more processing units that are utilized by a corresponding terminal when the terminal calculates CSI.

[31] Furthermore, according to some implementations, techniques are disclosed for allocating and/or assigning a minimum required time (e.g., Z value) and/or a minimum number of processing unit utilized by the terminal for the CSI reporting, which may be applied when CSI reporting for beam management and/or beam reporting use, that is, L1-RSRP report, is performed.

[32] Hereinafter, some implementations of the present disclosure are described in detail with reference to the accompanying drawings. A detailed description to be disclosed along with the accompanying drawings is intended to describe some exemplary implementations of the present disclosure and is not intended to describe a sole implementation of the present disclosure. The following detailed description includes more details in order to provide full understanding of the present disclosure. However, those skilled in the art will understand that the present disclosure may be implemented without such more details.

[33] In some cases, in order to avoid making the concept of the present disclosure vague, known structures and devices are omitted or may be shown in a block diagram form based on the core functions of each structure and device.

[34] Hereinafter, downlink (DL) means communication from a base station to a terminal, and uplink (UL) means communication from a terminal to a base station. In downlink, a transmitter may be part of a base station, and a receiver may be part of a terminal. In uplink, a transmitter may be part of a terminal, and a receiver may be part of a base station. A base station may be represented as a first communication device, and a terminal may be represented as a second communication device. A base station (BS) may be substituted with a term, such as a fixed station, an evolved-NodeB (eNB), a next generation NodeB (gNB), a base transceiver system (BTS), an access point (AP), a network (5G network), an AI system, a road side unit (RSU) or a robot. Furthermore, a terminal may be fixed or may have mobility, and may be substituted with a term, such as a user equipment (UE), a mobile station (MS), a user terminal (UT), a mobile subscriber station (MSS), a subscriber station (SS), an advanced mobile station (AMS), a wireless terminal (WT), a machine-type communication (MTC) device, a machine-to-machine (M2M) device, a device-to-device (D2D) device, a vehicle, a robot or an AI module.

[35] The following technology may be used for various radio access systems, such as CDMA, FDMA, TDMA, OFDMA, and SC-FDMA. CDMA may be implemented as a radio technology, such as universal terrestrial radio access (UTRA) or CDMA2000. TDMA may be implemented as radio technology, such as a global system for mobile communications (GSM)/general packet radio service (GPRS)/enhanced data rates for GSM evolution (EDGE). OFDMA may be implemented as a radio technology, such as IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802-20, or evolved UTRA (E-UTRA). UTRA is part of a universal mobile telecommunications system (UMTS). 3 rd generation partnership project (3GPP) long term evolution (LTE) is part of an evolved UMTS (E-UMTS) using E-UTRA, and LTE-Advanced (A)/LTE-A pro is an evolved version of 3GPP LTE. A 3GPP new radio or new radio access technology (NR) is an evolved version of 3GPP LTE/LTE-A/LTE-A pro.

[36] In order to clarify the description, a 3GPP communication system (e.g., LTE-A, NR) is basically described, but the technical spirit of the present disclosure is not limited thereto. LTE means a technology after a 3GPP TS 36.xxx Release 8. Specifically, an LTE technology after 3GPP TS 36.xxx Release 10 is denoted as LTE-A, and an LTE technology after 3GPP TS 36.xxx Release 13 is denoted as LTE-A pro. 3GPP NR means a technology after TS 38.xxx Release 15. LTE/NR may be denoted as a 3GPP system. "xxx" means a detailed number of the standard document. LTE/NR may be commonly called a 3GPP system. For the background technology, terms, and abbreviations used in the description of the present disclosure, reference may be made to contents described in the standard document disclosed prior to the present disclosure. For example, reference may be made to the following documents.

[37] 3GPP LTE

[38] - 36.211: Physical channels and modulation

[39] - 36.212: Multiplexing and channel coding

[40] - 36.213: Physical layer procedures

[41] - 36.300: Overall description

[42] - 36.331: Radio Resource Control (RRC)

[43] 3GPP NR

[44] - 38.211: Physical channels and modulation

[45] - 38.212: Multiplexing and channel coding

[46] - 38.213: Physical layer procedures for control

[47] - 38.214: Physical layer procedures for data

[48] - 38.300: NR and NG-RAN Overall Description

[49] - 36.331: Radio Resource Control (RRC) protocol specification

[50] As more communication devices require a higher communication capacity, there emerges a need for enhanced mobile broadband communication compared to the existing radio access technology. Furthermore, massive machine type communications (MTC) that provides various services anywhere and at anytime by connecting multiple devices and things is also one of major issues that will be taken into consideration in next-generation communication. Furthermore, a communication system design in which service/terminal sensitive to reliability and latency is taken into consideration is discussed. As described above, the introduction of a next-generation radio access technology in which enhanced mobile broadband communication (eMBB), massive MTC (Mmtc), ultra-reliable and low latency communication (URLLC), etc. are taken into consideration is discussed. In this disclosure, the corresponding technology is called NR, for convenience sake. NR is an expression showing an example of a 5G radio access technology (RAT)).

[51] A new RAT system including NR uses an OFDM transmission technique or a transmission technique similar to OFDM transmission. The new RAT system may comply with OFDM parameters different from OFDM parameters of LTE. Alternatively, the new RAT system may comply with the numerology of the existing LTE/LTE-A or may have a greater system bandwidth (e.g., 100 MHz). Alternatively, one cell may support a plurality of numerologies. That is, terminals operating in different numerologies may coexist within one cell.

[52] Numerology corresponds to one subcarrier spacing in a frequency domain. A different numerology may be defined by scaling reference subcarrier spacing using an integer N.

[53] Three major requirement areas of 5G includes (1) an enhanced mobile broadband (eMBB) area, (2) a massive machine type communication (mMTC) area and (3) an

ultra-reliable and low latency communications (URLLC) area.

[54] Some use cases may require multiple areas for optimization, and other use cases may be focused on only one key performance indicator (KPI). 5G supports such various use cases in a flexible and reliable manner.

[55] eMBB enables basic mobile Internet access to be greatly surpassed, and covers abundant directional tasks and media and entertainment applications in cloud or augmented reality. Data is one of core power of 5G. Dedicated voice service may not be first seen in the 5G era. In 5G, it is expected that voice will be processed as an application program using a data connection simply provided by a communication system. Major causes of an increased traffic volume include an increase of a content size and an increase in the number of applications that require a high data transfer rate. Streaming service (audio and video), dialogue video, and a mobile Internet connection will be more widely used as more devices are connected to the Internet. Such many application programs require connectivity in which the programs are always turned on in order to push real-time information and notification to a user. Cloud storage and applications rapidly increase in mobile communication platforms, which may be applied to both business and entertainment. Furthermore, cloud storage is a special use case that pulls the growth of an uplink data transfer rate. 5G is also used for remote business of cloud, and requires much lower end-to-end latency in order to maintain excellent user experiences when a tactile interface is used. Entertainment, for example, cloud game and video streaming are other core elements that increase needs for a mobile wideband capability. Entertainment is essential for smartphones and tablets anywhere, including high mobility environments, such as a train, vehicle and airplane. Another use case is augmented reality and information search for entertainment. In this case, augmented reality requires very low latency and an instant data volume.

[56] Furthermore, one of 5G use cases that is most expected is related to a function capable of smoothly connecting embedded sensors in all the fields, that is, mMTC. It is expected that potential IoT devices will reach 20.4 billions until 2020. In industry IoT, 5G is one of regions performing major roles that enable a smart city, asset tracking, a smart utility, agriculture and security infra.

[57] URLLC includes a new service that will change the industry through a link having ultra-reliability/available low latency, such as remote control of major infra and a self-driven vehicle. A level of reliability and latency is essential for smart grid control, industry automation, robot engineering, drone control and adjustment.

[58] Multiple use cases are described more specifically.

[59] 5G is means for providing a stream evaluated as Giga bits per second in several hundreds of mega bits per second, and may supplement for fiber-to-the-home (FTTH) and cable-based wideband (or DOCSIS). Such a fast speed is necessary to deliver TV

with resolution of 4K or more (6K, 8K and more) in addition to virtual reality and augmented reality. Virtual reality (VR) and augmented reality (AR) applications include nearly immersive sports. A specific application program may require a special network configuration. For example, in the case of VR game, in order for game companies to minimize latency, a core server may need to be integrated with an edge network server of a network operator.

[60] It is expected that an automotive will become important new power in 5G along with many use cases for mobile communication for an automotive. For example, entertainment for a passenger requires both a high capacity and a high mobility mobile wideband. The reason for this is that a future user will continue to expect a connection of high quality regardless of his or her location and speed. Another use example of the automotive field is an augmented reality dashboard. The augmented reality dashboard enables a driver to identify an object in the dark on a thing reported through the front window, and overlaps and displays information spoken to the driver with respect to the distance and movement of the object. In the future, a wireless module enables communication between vehicles, information exchange between a vehicle and a supported infrastructure, and information exchange between a vehicle and other connected devices (e.g., devices accompanied by a pedestrian). A safety system shows alternative courses of a behavior so that a driver can drive more safely, thereby being capable of reducing a danger of an accident. A next step will be a remote-controlled or self-driven vehicle. This requires very reliable and very fast communication between different self-driven vehicles and between a vehicle and infra. In the future, a self-driven vehicle may perform all driving activities, and a driver will be focused on only traffic abnormality that cannot be identified by a vehicle itself. Technical requirements of a self-driven vehicle include ultra-low latency and ultra-high speed reliability so that traffic safety is increased up to a level of the extent that that cannot be achieved by a person.

[61] A smart city and a smart home mentioned as a smart society will be embedded as a high density wireless sensor network. A distributed network of intelligent sensors will identify a condition for the cost- and energy-efficient maintenance of a city or house. A similar configuration may be performed for each home. All of a temperature sensor, a window, a heating controller, a burglar alarm and home appliances are connected wirelessly. Many of such sensors are typically a low data transmission speed, low energy and a low cost. However, for example, real-time HD video may be necessary in a specific type of a device for surveillance.

[62] The consumption and distribution of energy including heat or gas require automated control of a distributed sensor network because they are highly distributed. A smart grid collects information, and interconnects such sensors using digital information and communication technologies so that the sensors behavior based on the information.

The information may include supplier and consumer behaviors, so the smart grid can improve the distribution of fuel, such as electricity, in manners, such as efficiency, reliability, economics, production sustainability and automation. The smart grid may be considered to be a different sensor network having low latency.

[63] A health sector includes many application programs that may reap the benefits of mobile communication. A communication system may support remote medical treatment that provides clinical medical treatment at a remote place. This may help to reduce a barrier for the distance and to improve access to medical services that are not continuously used at a remote farming area. This is also used to save life in medical treatment and an urgent situation. A mobile communication-based wireless sensor network may provide remote monitoring and sensors for parameters, such as a heart rate and blood pressure.

[64] Wireless and mobile communication becomes more important in the industry application field. An installation and maintenance cost for wires is high. Accordingly, the possibility that the wires are substituted with radio links capable of reconfiguring a cable is an attractive opportunity in many industry fields. However, to achieve the opportunity requires that a wireless connection operates with latency, reliability and capacity similar to those of the cable and that management thereof is simplified. A low latency and very low error probability is a new requirement that needs to be connected to 5G.

[65] Logistics and freight tracking are an important use case for mobile communication, which enables the tracking of an inventory and package anywhere using a location-based information system. A use case of logistics and freight tracking typically requires a low data speed, but requires a wide area and reliable location information.

[66] **Definition of terms**

[67] eLTE eNB: An eLTE eNB is an evolution of an eNB that supports a connection for an EPC and an NGC.

[68] gNB: A node for supporting NR in addition to a connection with an NGC

[69] New RAN: A radio access network that supports NR or E-UTRA or interacts with an NGC

[70] Network slice: A network slice is a network defined by an operator so as to provide a solution optimized for a specific market scenario that requires a specific requirement together with an inter-terminal range.

[71] Network function: A network function is a logical node in a network infra that has a well-defined external interface and a well-defined functional operation.

[72] NG-C: A control plane interface used for NG2 reference point between new RAN and an NGC

[73] NG-U: A user plane interface used for NG3 reference point between new RAN and

an NGC

[74] Non-standalone NR: A deployment configuration in which a gNB requires an LTE eNB as an anchor for a control plane connection to an EPC or requires an eLTE eNB as an anchor for a control plane connection to an NGC

[75] Non-standalone E-UTRA: A deployment configuration an eLTE eNB requires a gNB as an anchor for a control plane connection to an NGC.

[76] User plane gateway: A terminal point of NG-U interface

[77] **General system**

[78] FIG. 1 is a diagram illustrating an example of an overall structure of a new radio (NR) system according to some implementations of the present disclosure.

[79] Referring to FIG. 1, an NG-RAN is configured with gNBs that provide an NG-RA user plane (new AS sublayer/PDCP/RLC/MAC/PHY) and a control plane (RRC) protocol for a user equipment (UE).

[80] The gNBs are connected to each other via an Xn interface.

[81] The gNBs are also connected to an NGC via an NG interface.

[82] More specifically, the gNBs are connected to an access and mobility management function (AMF) via an N2 interface and a user plane function (UPF) via an N3 interface.

[83] **New Rat (NR) Numerology and frame structure**

[84] In the NR system, multiple numerologies may be supported. The numerologies may be defined by subcarrier spacing and a cyclic prefix (CP) overhead. Spacing between the plurality of subcarriers may be derived by scaling basic subcarrier spacing into an integer N (or μ). In addition, although a very low subcarrier spacing is assumed not to be used in a very high subcarrier frequency, a numerology to be used may be selected regardless of a frequency band.

[85] In addition, in the NR system, a variety of frame structures according to the multiple numerologies may be supported.

[86] Hereinafter, an orthogonal frequency division multiplexing (OFDM) numerology and a frame structure, which may be considered in the NR system, will be described.

[87] A plurality of OFDM numerologies supported in the NR system may be defined as in Table 1.

[88] [Table 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

[89] Regarding a frame structure in the NR system, the size of various fields in the time domain is expressed as a multiple of a time unit of $T_s = 1/(\Delta f_{max} \cdot N_f)$. In this case, $\Delta f_{max} = 480 \cdot 10^3$, and $N_f = 4096$. DL and UL transmission is configured as a radio frame having a section of $T_f = (\Delta f_{max} N_f / 100) \cdot T_s = 10\,\text{ms}$. The radio frame is composed of ten subframes each having a section of $T_{sf} = (\Delta f_{max} N_f / 1000) \cdot T_s = 1\,\text{ms}$. In this case, there may be a set of UL frames and a set of DL frames.

[90] FIG. 2 illustrates a relationship between a UL frame and a DL frame in a wireless communication system according to some implementations of the present disclosure.

[91] As illustrated in FIG. 2, an UL frame number I from a user equipment (UE) needs to be transmitted $T_{TA} = N_{TA} T_s$ before the start of a corresponding DL frame in the UE.

[92] Regarding the numerology μ, slots are numbered in ascending powers of $n_s^\mu \in \{0,\ldots,N_{subframe}^{slots,\mu} - 1\}$ in a subframe, and in ascending powers of $n_{s,f}^\mu \in \{0,\ldots,N_{frame}^{slots,\mu} - 1\}$ in a radio frame. One slot is composed of continuous OFDM symbols of N_{symb}^μ, and N_{symb}^μ is determined based on a used numerology and slot configuration. The start of slots n_s^μ in the subframe is temporally aligned with the start of OFDM symbols $n_s^\mu N_{symb}^\mu$ in the same subframe.

[93] All the terminals cannot perform transmission and reception at the same time, which means that all the OFDM symbols of a downlink slot or uplink slot cannot be used.

[94] Table 2 shows the number of OFDM symbols (N_{symb}^{slot}) for each slot, the number of slots ($N_{slot}^{frame,\mu}$) for each radio frame, and the number of slots ($N_{slot}^{subframe,\mu}$) for each subframe in a normal CP. Table 3 shows the number of OFDM symbols for each slot, the number of slots for each radio frame, and the number of slots for each subframe in an extended CP.

[95] [Table 2]

μ	N_{symb}^{slot}	$N_{slot}^{frame,\mu}$	$N_{slot}^{subframe,\mu}$
0	14	10	1
1	14	20	2
2	14	40	4
3	14	80	8
4	14	160	16

[96] [Table 3]

μ	N_{symb}^{slot}	$N_{slot}^{frame,\mu}$	$N_{slot}^{subframe,\mu}$
2	12	40	4

[97] FIG. 3 shows an example of a frame structure in an NR system. FIG. 3 is merely for

convenience of description and does not limit the scope of the present disclosure.

[98] Table 3 is an example in which μ=2, that is, subcarrier spacing (SCS) is 60 kHz. Referring to Table 2, 1 subframe (or frame) may include 4 slots. A 1 subframe={1,2,4} slots shown in FIG. 3 is an example, and the number of slots that may be included in 1 subframe may be defined like Table 2.

[99] Furthermore, a mini-slot may be configured with 2, 4 or 7 symbols and may be configured with symbols more or less symbols than the 2, 4 or 7 symbols.

[100] In relation to a physical resource in the NR system, an antenna port, a resource grid, a resource element, a resource block, a carrier part may be taken into consideration.

[101] Hereinafter, the above physical resources possible to be considered in the NR system will be described in more detail.

[102] First, regarding an antenna port, the antenna port is defined such that a channel over which a symbol on one antenna port is transmitted can be inferred from another channel over which a symbol on the same antenna port is transmitted. When large-scale properties of a channel received over which a symbol on one antenna port can be inferred from another channel over which a symbol on another antenna port is transmitted, the two antenna ports may be in a quasi co-located or quasi co-location (QC/QCL) relationship. In this case, the large-scale properties may include at least one of delay spread, Doppler spread, Doppler shift, average gain, and average delay.

[103] FIG. 4 illustrates an example of a resource grid supported in a wireless communication system according to some implementations of the present disclosure.

[104] Referring to FIG. 4, a resource grid is composed of $N_{\mathrm{RB}}^{\mu} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers in a frequency domain, each subframe composed of 14x2^μ OFDM symbols, but the present disclosure is not limited thereto.

[105] In the NR system, a transmitted signal is described by one or more resource grids, composed of $N_{\mathrm{RB}}^{\mu} N_{\mathrm{sc}}^{\mathrm{RB}}$ subcarriers, and $2^{\mu} N_{\mathrm{symb}}^{(\mu)}$ OFDM symbols, wherein $N_{\mathrm{RB}}^{\mu} \leq N_{\mathrm{RB}}^{\max,\mu}$. The above $N_{\mathrm{RB}}^{\max,\mu}$ indicates the maximum transmission bandwidth, and it may change not just between numerologies, but between UL and DL.

[106] In this case, as illustrated in FIG. 5, one resource grid may be configured for the numerology μ and an antenna port p.

[107] FIG. 5 illustrates examples of resource grids for each antenna port and numerology according to some implementations of this disclosure.

[108] Each element of the resource grid for the numerology μ and the antenna port p is indicated as a resource element, and may be uniquely identified by an index pair $(k,\bar{l})$. In this case, $k = 0,\ldots,N_{\mathrm{RB}}^{\mu} N_{\mathrm{sc}}^{\mathrm{RB}} - 1$ is an index in the frequency domain, and $\bar{l} = 0,\ldots,2^{\mu} N_{\mathrm{symb}}^{(\mu)} - 1$ indicates a location of a symbol in a subframe. To indicate a resource element in a slot, the index pair (k,l) is used. In this case, $l = 0,\ldots,N_{\mathrm{symb}}^{\mu} - 1$.

[109] A resource element $(k,\bar{l})$ for a numerology μ and an antenna port p corresponds to a complex value $a_{k,\bar{l}}^{(p,\mu)}$. If there is no danger of confusion or if a specific antenna port or numerology is not specified, indices p and μ may be dropped. As a result, a complex value may be $a_{k,\bar{l}}^{(p)}$ or $a_{k,\bar{l}}$.

[110] Furthermore, a physical resource block is defined as $N_{sc}^{RB}=12$ contiguous subcarriers on the frequency domain.

[111] A point A plays a role as a common reference point of a resource block grid and may be obtained as follows.

[112] - offsetToPointA for PCell downlink indicates a frequency offset between the lowest subcarrier of the lowest resource block, overlapping an SS/PBCH block used for a UE for initial cell selection, and the point A, and is represented as a resource block units assuming a 15 kHz subcarrier spacing for FR1 and a 60 kHz subcarrier spacing for FR2;

[113] - absoluteFrequencyPointA indicates the frequency-location of the point A represented as in an absolute radio-frequency channel number (ARFCN).

[114] Common resource blocks are numbered from 0 to the upper side in the frequency domain for the subcarrier spacing configuration μ.

[115] The center of the subcarrier 0 of a common resource block 0 for the subcarrier spacing configuration μ is identical with the 'point A.' A resource element (k,l) for a common resource block number n_{CRB}^{μ} and the subcarrier spacing configuration μ in the frequency domain may be given like Equation 1 below.

[116] [Equation 1]

[117] $$n_{CRB}^{\mu}=\left\lfloor \frac{k}{N_{sc}^{RB}} \right\rfloor$$

[118] In this case, k may be relatively defined at the point A so that $k=0$ corresponds to a subcarrier having the point A as the center. Physical resource blocks are numbered from 0 to $N_{BWP,i}^{size}-1$ within a bandwidth part (BWP). i is the number of a BWP. In the BWP i, the relation between the physical resource block n_{PRB} and the common resource block n_{CRB} may be given by Equation 2 below.

[119] [Equation 2]

[120] $$n_{CRB}=n_{PRB}+N_{BWP,i}^{start}$$

[121] In this case, $N_{BWP,i}^{start}$ may be a common resource block in which the BWP relatively starts in the common resource block 0.

[122] **Bandwidth part (BWP)**

[123] An NR system may be supported up to a maximum of 400 MHz per one component carrier (CC). If a terminal operating in such a wideband CC operates with its RF for all CCs being turned on, terminal battery consumption may be increased. Alternatively, if

several use cases (e.g., eMBB, URLLC, Mmtc, V2X) operating within one wideband CC are taken into consideration, a different numerology (e.g., sub-carrier spacing) for each frequency band within the corresponding CC may be supported. Alternatively, the capability of a maximum bandwidth may be different for each terminal. A base station may indicate that the terminal operates only in some bandwidth not the full bandwidth of the wideband CC by taking the capacity into consideration. The corresponding some bandwidth is defined as a bandwidth part (BWP), for convenience sake. The BWP may be configured with resource blocks (RBs) contiguous on a frequency axis, and may correspond to one numerology (e.g., sub-carrier spacing, CP length, slot/mini-slot duration).

[124] Meanwhile, a base station may configure multiple BWPs within one CC configure in a terminal. For example, in a PDCCH monitoring slot, a BWP occupying a relatively small frequency domain may be configured, and a PDSCH indicated in a PDCCH may be scheduled on a BWP greater than the configured BWP. Alternatively, if UEs are crowded in a specific BWP, some UEs may be configured in other BWP for load balancing. Alternatively, some spectrum at the center of a full bandwidth may be excluded by taking into consideration frequency domain inter-cell interference cancellation between neighbor cells, and BWPs on both sides may be configured in the same slot. That is, the base station may configure at least one DL/UL BWP in a terminal associated with a wideband CC, may activate at least one DL/UL BWP of DL/UL BWP(s) (by L1 signaling or MAC CE or RRC signaling) configured in a specific time. Switching to another configured DL/UL BWP (by L1 signaling or MAC CE or RRC signaling) may be indicated or switching to a predetermined DL/UL BWP may be performed when a timer value expires based on a timer. In this case, the activated DL/UL BWP is defined as an active DL/UL BWP. However, if a terminal is in an initial access process or in a situation before an RRC connection is set up, the terminal may not receive a configuration for a DL/UL BWP. In such a situation, a DL/UL BWP assumed by the terminal is defined as an initial active DL/UL BWP.

[125] **Self-contained structure**

[126] A time division duplexing (TDD) structure taken into consideration in an NR system is a structure in which both uplink (UL) and downlink (DL) are processed in one slot (or subframe). This is for minimizing latency of data transmission in the TDD system. The structure may be referred to as a self-contained structure or a self-contained slot.

[127] FIG. 6 shows an example of a self-contained structure according to some implementations of this disclosure. FIG. 6 is merely for convenience of description and does not limit the scope of the present disclosure.

[128] Referring to FIG. 6, as in the case of legacy LTE, a case where one transmission unit (e.g., slot, subframe) is configured with 14 orthogonal frequency division multiplexing

(OFDM) symbols is assumed.

[129] In FIG. 6, a region 602 means a downlink control region, and a region 604 means an uplink control region. Furthermore, regions (i.e., regions not having separate indication) except the region 602 and the region 604 may be used for the transmission of downlink data or uplink data.

[130] That is, uplink control information and downlink control information may be transmitted in one self-contained slot. In contrast, in the case of data, uplink data or downlink data may be transmitted in one self-contained slot.

[131] If the structure shown in FIG. 6 is used, downlink transmission and uplink transmission are sequentially performed and the transmission of downlink data and the reception of uplink ACK/NACK may be performed within one self-contained slot.

[132] Consequently, when an error occurs in data transmission, the time consumed up to the retransmission of data can be reduced. Accordingly, latency related to data forwarding can be minimized.

[133] In a self-contained slot structure, such as FIG. 6, there is a need for a time gap for a process of a base station (eNodeB, eNB, gNB) and/or a terminal (user equipment (UE)) changing from a transmission mode to a reception mode or of the base station and/or the terminal changing from a reception mode to a transmission mode. In relation to the time gap, when uplink transmission is performed after downlink transmission in a self-contained slot, some OFDM symbol(s) may be configured as a guard period (GP).

[134] The following contents are discussed in relation to CSI measurement and/or reporting.

[135] As used herein, the parameter Z refers to a minimum required time for a terminal to perform CSI reporting, e.g., a minimum time duration (or time gap) starting from a timing at which a terminal receives DCI that schedules the CSI reporting until a timing at which the terminal performs actual CSI reporting.

[136] Furthermore, a time offset of a CSI reference resource may be derived based on a minimum time duration starting from a timing at which a terminal receives a measurement resource (e.g., CSI-RS) related to CSI reporting until a timing at which the terminal performs actual CSI reporting (referred to herein as Z') and based on a numerology (e.g., subcarrier spacing) for CSI latency.

[137] Specifically, in relation to the calculation (or computation) of CSI, Z and Z' values may be defined as in the examples of Table 4 to Table 7. In this case, Z is related to only aperiodic CSI reporting. For example, the Z value may be represented as the sum of a decoding time for DCI (scheduling CSI reporting) and a CSI processing time (e.g., Z' to be described later). Furthermore, in the case of a Z value of a normal terminal, a channel state information-reference signal (CSI-RS) may be assumed to be positioned

after the last symbol of a PDCCH symbol (i.e., the symbol of a PDCCH in which DCI is transmitted).

[138] Furthermore, as discussed above, the parameter Z' may refer to a minimum duration (or time gap) from a timing at which a terminal receives a measurement resource (i.e., CMR, IMR) (e.g., CSI-RS) related to CSI reporting to a timing at which the terminals performs actual CSI reporting. In general, a relation may be described between (Z, Z') and numerology and CSI latency, as shown in the example of Table 4.

[139] [Table 4]

CSI latency	Units	15kHz SCS	30kHz SCS	60kHz SCS	120kHz SCS
Low latency	Symbols	$(Z_{1,1}, Z'_{1,1})$	$(Z_{1,2}, Z'_{1,2})$	$(Z_{1,3}, Z'_{1,3})$	$(Z_{1,4}, Z'_{1,4})$
High latency	Symbols	$(Z_{2,1}, Z'_{2,1})$	$(Z_{2,2}, Z'_{2,2})$	$(Z_{2,3}, Z'_{2,3})$	$(Z_{2,4}, Z'_{2,4})$

[140] Furthermore, Table 5 and Table 6 show examples of CSI calculation times for a normal UE and CSI calculation times for an advanced UE, respectively. Table 5 and Table 6 are merely examples and are not limiting.

[141] [Table 5]

CSI latency	Units	15kHz SCS ($\mu = 0$)	30kHz SCS ($\mu = 1$)	60kHz SCS ($\mu = 2$)	120kHz SCS ($\mu = 3$)
Low latency	Symbols	(22, 15)	(25, 16)	(33, 19)	(49, 25)
High latency	Symbols	(29, 22)	(32, 23)	(40, 26)	(56, 32)

[142] [Table 6]

CSI latency	Units	15kHz SCS ($\mu = 0$)	30kHz SCS ($\mu = 1$)	60kHz SCS ($\mu = 2$)	120kHz SCS ($\mu = 3$)
Low latency	Symbols	(12, 7)	(12, 7)	(12, 7)	(12, 7)
High latency	Symbols	(19, 14)	(19, 14)	(19, 14)	(19, 14)

[143] Furthermore, in relation to the above-described CSI latency, it may be assumed that when N CSI reportings are triggered, up to X CSI reportings will be calculated in a given time. In this case, X may be based on UE capability information. Furthermore, in relation to the above-described Z (and/or Z'), a terminal may be configured to ignore DCI scheduling CSI reporting that does not satisfy a condition related to the Z value.

[144] Furthermore, information (i.e., information for (Z, Z')) related to CSI latency, such as that described above, may be reported (to the base station) as UE capability information by a terminal.

[145] For example, if aperiodic CSI reporting through only a PUSCH configured as single CSI reporting is triggered, a terminal may not expect that it will receive scheduling downlink control information (DCI) having a symbol offset, such as 'M-L-N < Z.' Furthermore, if an aperiodic channel state information-reference signal (CSI-RS) is used for channel measurement and has a symbol offset, such as 'M-O-N < Z', a terminal may not expect that it will receive scheduling DCI.

[146] In the above description, L may indicate the last symbol of a PDCCH triggering aperiodic reporting, M may indicate the starting symbol of a PUSCH, and N may indicate a timing advanced (TA) value of a symbol unit. Furthermore, O may mean the

latest symbol of the last symbol of an aperiodic CSI-RS for a channel measurement resource (CMR), the last symbol (if present) of an aperiodic non zero power (MZP) CSI-RS for an interference measurement resource (IMR), and the last symbol (if present) of aperiodic channel state information-interference measurement (CSI-IM). The CMR may mean an RS and/or resource for channel measurement, and the IMR may mean an RS and/or resource for interference measurement.

[147] In relation to the above-described CSI reporting, a case where CSI reportings collide against each other may occur. In this case, the collision of the CSI reportings may mean that the time occupancies of physical channels scheduled to transmit CSI reportings overlap in at least one symbol and are transmitted in the same carrier. For example, if 2 or more CSI reportings collide against each other, one CSI reporting may be performed according to the following rule. In this case, priority of CSI reporting may be determined using a sequential technique of first applying Rule #1 and then applying Rule #2. Rule #2, Rule #3, and Rule #4 of the following rules may be applied to only all periodic reporting and semi-persistently reporting aimed at a PUCCH.

[148] - Rule #1: in the operating viewpoint on a time domain, aperiodic (AP) CSI > PUSCH-based semi-persistent (SP) CSI > PUCCH-based semi-persistent CSI > periodic (P) CSI

[149] - Rule #2: in the CSI content viewpoint, beam management (e.g., beam reporting)-related CSI > CSI acquisition-related CSI

[150] - Rule #3: in the cell ID (cellID) viewpoint, a primary cell (PCell) > a primary secondary cell (PSCell) > different IDs (in increasing order)

[151] - Rule #4: in the CSI reporting-related ID (e.g., csiReportID) viewpoint, in order that the indices of IDs increase

[152] Furthermore, in relation to the above-described CSI reporting, a processing unit (e.g., CPU) may be defined. For example, a terminal supporting X CSI calculations (e.g., based on UE capability information 2-35) may mean that the terminal utilizes X processing units to report CSI. In this case, the number of CSI processing units may be represented as K_s.

[153] For example, in the case of aperiodic CSI reporting using an aperiodic CSI-RS (configured with a single CSI-RS resource in a resource set for channel measurement), a CSI processing unit may be maintained in the state in which symbols from the first OFDM symbol to the last symbol of a PUSCH carrying CSI reporting after PDCCH triggering have been occupied.

[154] For another example, if N CSI reportings (each one being configured with a single CSI-RS resource in a resource set for channel measurement) are triggered in a slot, but a terminal has only M un-occupied CSI processing units, the corresponding terminal may be configured to update (i.e., report) only M of the N CSI reportings.

[155] Furthermore, in relation to the above-described X CSI calculations, the UE capability may be configured to support any one of a Type CSI processing capability or a Type B CSI processing capability.

[156] For example, it is assumed that an aperiodic CSI trigger state (A-CSI trigger state triggers N CSI reportings (in this case, each CSI reporting is associated with (Z_n, Z'_n)) and has un-occupied CSI processing units.

[157] In the case of the Type CSI processing capability, if a time gap between the first symbol of a PUSCH and the last symbol related to aperiodic CSI-RS/aperiodic CSI-IM does not have a sufficient CSI calculation time according to $Z'_{TOT} = \sum_{n-1}^{M} Z'_n$, a terminal may not expect that any one of triggered CSI reportings will be updated. Furthermore, the terminal may ignore DCI scheduling a PUSCH having a scheduling offset smaller than $Z'_{TOT} = \sum_{n-1}^{M} Z'_n$.

[158] In the case of the Type B CSI processing capability, if a PUSCH scheduling offset does not have a sufficient a CSI calculation time according to a corresponding Z' value in corresponding reporting, a terminal may not expect that CSI reporting will be updated. Furthermore, the terminal may ignore DCI scheduling a PUSCH having a scheduling offset smaller than any one of Z values for other reportings.

[159] For another example, CSI reporting based on a periodic and/or semi-persistent CSI-RS may be assigned to a CSI processing unit depending on a Type A method or a Type B method. The Type A method may assume a serial CSI processing implementation, and the Type B method may assume a parallel CSI processing implementation.

[160] In the Type A method, in the case of periodic and/or semi-persistent CSI reporting, a CSI processing unit may occupy symbols from the first symbol of a CSI reference resource of periodic and/or semi-persistent CSI reporting to the first symbol of a physical channel carrying corresponding CSI reporting. In the case of aperiodic CSI reporting, a CSI processing unit may occupy symbols from the first symbol after a PDCCH triggering corresponding CSI reporting to the first symbol of a physical channel carrying corresponding CSI reporting.

[161] In the Type B method, periodic or aperiodic CSI reporting setting based on a periodic and/or semi-persistent CSI-RS may be allocated to one or K_s CSI processing units, and may always occupy one or K_s CSI processing units. Furthermore, activated semi-persistent CSI reporting setting may be allocated to one or K_s CSI processing units, and may occupy one or K_s CSI processing units until it is deactivated. When semi-persistent CSI reporting is activated, a CSI processing unit may be used for other CSI reporting.

[162] Furthermore, in the case of the above-described Type CSI processing capability, when the number of CSI processing units occupied by periodic and/or semi-persistent

CSI reporting exceeds the number of simultaneous CSI calculations (X) according to UE capability, a terminal may not expect that the periodic and/or semi-persistent CSI reporting will be updated.

[163] **First implementation**

[164] In the present implementation, examples of configuring the assignment, allocation and/or occupancy of a CSI processing unit for one or more CSI reportings are described.

[165] In relation to the above-described processing unit (e.g., CPU), a rule for determining which CSI will use a CSI processing unit, that is, which CSI will be allocated to a CSI processing unit, needs to be taken into consideration. In this disclosure, in relation to a CSI processing unit, CSI will mean or denote CSI reporting.

[166] For convenience of description, in the present implementation, a case where a terminal has X CSI processing units, X-M CSI processing units of the X CSI processing units are occupied (i.e., used) for CSI calculation, and M CSI processing units are not occupied is assumed. That is, M may mean the number of CSI processing units not occupied by CSI reporting.

[167] In this case, at specific timing (e.g., a specific OFDM symbol), N CSI reportings greater than M may start the occupancy of a CSI processing unit.

[168] For example, when the occupancy (i.e., use) of a CSI processing unit starts with respect to 3 CSI reportings in the state in which M is 2 in an n-th OFDM symbol, only two of 3 CSI reportings occupy the CSI processing unit. In this case, a CSI processing unit is not allocated (or assigned) to the remaining one CSI reporting, and CSI for the corresponding CSI reporting cannot be calculated. With respect to the not-calculated CSI, a technique of defining (or agreeing) that the most recently calculated and/or reported CSI is reported again or defining (or agreeing) that a preset specific CSI value is reported or defining (or agreeing that reporting is not performed regarding the corresponding CSI reporting may be taken into consideration.

[169] Hereinafter, the present implementation utilizes the following example techniques for priority regarding which CSI reporting will be first assigned to a CSI processing unit (hereinafter priority for CSI processing unit occupancy) when contention for the occupancy of the CSI processing unit occurs. Furthermore, the priority for the occupancy of a CSI processing unit may be configured identically or similarly in the above-described CSI collision in addition to the examples to be described hereinafter.

[170] **Example 1)**

[171] Priority for the occupancy of a CSI processing unit may be determined based on a latency requirement.

[172] In an NR system, all types of CSI may be determined as any one of low latency CSI or high latency CSI. In this case, the low latency CSI may mean CSI in which the

complexity of a terminal is low in CSI calculation, and the high latency CSI may mean CSI in which the complexity of a terminal is high in CSI calculation. For example, when CSI is low latency CSI, the corresponding CSI occupies a CSI processing unit for a time shorter than that of high latency CSI because the amount of CSI calculation is small.

[173] Low latency CSI may be configured to preferentially occupy a CSI processing unit over high latency CSI. In this case, there are advantages in that when low latency CSI and high latency CSI collide against each other, the occupancy time of a CSI processing unit can be minimized by giving priority to the low latency CSI and a corresponding CSI processing unit can be rapidly used for other CSI calculation.

[174] Alternatively, high latency CSI may be configured to preferentially occupy a CSI processing unit over low latency CSI. The reason for this is that high latency CSI has greater calculation complexity than low latency CSI and can provide more and/or accurate channel information.

[175] **Example 2)**

[176] Priority for the occupancy of a CSI processing unit may be determined based on the occupancy end time of a CSI processing unit.

[177] CSI having a short occupancy end time of a CSI processing unit may be configured to preferentially occupy a CSI processing unit.

[178] Although occupancy starting times for a CSI processing unit are the same for multiple pieces of CSI (reporting), occupancy end times may be different. For example, although low latency CSI or high latency CSI are the same, an occupancy end time for each CSI reporting may be different depending on a channel for CSI calculation and/or a CSI-RS whose interference is measured and/or a time domain behavior (e.g., periodic, semi-persistently, aperiodic) on a CSI-Imdml time domain. There are advantages in that the occupancy time of a CSI processing unit can be minimized and a corresponding CSI processing unit can be rapidly used for CSI calculation because CSI having a short occupancy end time is given priority.

[179] Alternatively, CSI having a long (i.e., late) occupancy end time of a CSI processing unit may be configured to preferentially occupy a CSI processing unit. The reason for this is that CSI having a long occupancy end time requires a long calculation time and can provide more and/or accurate channel information.

[180] **Example 3)**

[181] Priority for the occupancy of a CSI processing unit may be determined based on a time domain behavior for a reference signal (e.g., CSI-RS) used for channel measurement and/or a reference signal (e.g., CSI-IM) used for interference measurement.

[182] For convenience of description, in this example, in relation to CSI reporting, a case where a reference signal used for channel measurement is a CSI-RS and a reference

signal used for interference measurement is CSI-IM is assumed.

[183] The CSI-RS and/or the CSI-IM may be transmitted and received in three types, such as periodic, semi-persistent, or aperiodic. CSI calculated based on a periodic CSI-RS and/or CSI-IM has many opportunities to measure a channel and/or interference. Accordingly, CSI calculated based on an aperiodic CSI-RS and/or CSI-IM rather than CSI based on a periodic CSI-RS and/or CSI-IM may be preferred to preferentially occupy a CSI processing unit.

[184] Accordingly, priority may be determined in order of CSI based on aperiodic CSI-RS and/or CSI-IM, CSI based on a semi-persistent CSI-RS and/or CSI-IM, and CSI based on a periodic CSI-RS and/or CSI-IM. That is, priority for the occupancy of a CSI processing unit may be determined in order of 'CSI based on aperiodic CSI-RS and/or CSI-IM > CSI based on a semi-persistent CSI-RS and/or CSI-IM > CSI based on a periodic CSI-RS and/or CSI-IM.' Such priority may be extended and applied to the above-described CSI collision rule in addition to priority for the occupancy of a CSI processing unit.

[185] Alternatively, priority may be determined in order of CSI based on a periodic CSI-RS and/or CSI-IM, CSI based on a semi-persistent CSI-RS and/or CSI-IM, and CSI based on aperiodic CSI-RS and/or CSI-IM.

[186] **Example 4)**

[187] Priority for the occupancy of a CSI processing unit may be determined based on a time domain measurement behavior.

[188] For example, priority for the occupancy of a CSI processing unit may be determined based on whether restriction related to CSI measurement, that is, measurement restriction, has been configured.

[189] When a terminal receives a CSI-RS and/or CSI-IM in a specific time when the measurement restriction becomes ON and generates CSI by measuring the CSI-RS and/or CSI-IM, the corresponding CSI may be configured to preferentially occupy a CSI processing unit over CSI measured when the measurement restriction becomes OFF. Such priority may be extended and applied to the above-described CSI collision rule in addition to priority for the occupancy of a CSI processing unit.

[190] Alternatively, when a terminal generates CSI in the state in which the measurement restriction has been OFF, the corresponding CSI may be configured to preferentially occupy a CSI processing unit over CSI measured when the measurement restriction becomes ON.

[191] **Example 5)**

[192] Priority for the occupancy of a CSI processing unit may be determined based on the above-described Z value and/or Z' value. In this case, Z is related to only aperiodic CSI reporting, and may mean a minimum time (or time gap) from timing at which a

terminal receives DCI scheduling CSI reporting to timing at which the terminal performs actual CSI reporting. Furthermore, Z' may mean a minimum time (or time gap) from timing at which a terminal receives a measurement resource (i.e., CMR, IMR) (e.g., CSI-RS) related to CSI reporting to timing at which the terminal performs actual CSI reporting.

[193] A subcarrier spacing (SCS) and latency-related configuration may be different for each CSI. Accordingly, a Z value and/or a Z' value may be differently set for each CSI.

[194] For example, when M (i.e., M CSI reportings to be assigned to a CSI processing unit) of N CSI reportings scheduled in a terminal are selected, CSI having a small Z value and/or Z' value may be configured to preferentially occupy a CSI processing unit (hereinafter example 5-1). CSI reporting having a small Z value and/or Z' value occupies a CSI processing unit for a short time, and may be efficient because a corresponding CSI processing unit may be used to calculate new CSI.

[195] In general, CSI having a small subcarrier spacing may have higher priority in terms of CSI processing unit occupancy because a Z value and/or Z' value is smaller as the subcarrier spacing is smaller. Furthermore, low CSI may have higher priority in terms of CSI processing unit occupancy because a Z value and/or Z' value is smaller as latency is small. Furthermore, a configuration may be performed so that the occupancy sequence of CSI processing units is determined through a comparison between pieces of latency and a CSI processing unit is occupied in order of smaller subcarrier spacing when latency is the same. In contrast, a configuration may be performed so that the occupancy sequence of CSI processing units is determined through a comparison between subcarrier spacings and a CSI processing unit is occupied in order of lower latency when the subcarrier spacing is the same.

[196] For another example, when M (i.e., M CSI reportings to be assigned to a CSI processing unit) of N CSI reportings scheduled in a terminal are selected, CSI having a great Z value and/or Z' value may be configured to preferentially occupy a CSI processing unit (hereinafter example 5-2). CSI reporting having a great Z value and/or Z' value occupies a CSI processing unit for a long time, but may be assumed to be more important CSI although it has a long calculation time in that the corresponding CSI has a more accurate and more channel information.

[197] In relation to the example 5, a technique of selectively applying example 5-1) and example 5-2 based on a given condition may be taken into consideration.

[198] First, a terminal selects pieces of M CSI by giving priority to CSI having a great Z value. If CSI calculation is not performed because a Z value is greater than a processing time given by a scheduler, the terminal may select pieces of M CSI, assuming that CSI having a small Z value preferentially occupies a CSI processing unit. Otherwise, the terminal may select pieces of M CSI, assuming that CSI having a

great Z value preferentially occupies a CSI processing unit. In this case, the processing time may mean the time when actual CSI reporting is performed from the triggering timing of CSI reporting, the time until actual CSI reporting is performed from a CSI reference resource, or the time until actual CSI reporting is performed from the last symbol of a CSI-RS and/or CSI-IM.

[199] Alternatively, after a terminal determines CSI satisfying a given processing time among N pieces of CSI, it may configure the determined CSI as a valid CSI set, and may first select pieces of M CSI having a great Z value within the configured valid CSI set. Alternatively, the terminal may first select pieces of M CSI having a small Z value within the configured valid CSI set. Since CSI not included in the valid CSI set is not-calculated or -reported CSI, it may be effective that the terminal excludes not-calculated or -reported CSI of the pieces of N CSI from a contention target.

[200] **Example 6)**

[201] Priority for the occupancy of a CSI processing unit may be determined based on whether a CSI-RS resource indicator (CRI) is reported.

[202] In the case of CSI reported together with a CRI (i.e., if a CRI is included as a CSI reporting quantity), although the corresponding CSI is one piece of CSI, a CSI processing unit corresponding to the number of CSI-RSs used for measurement may be occupied. For example, when a terminal reports a CRI to select one of 8 CSI-RSs by performing channel measurement using the 8 CSI-RSs, 8 CSI processing units are occupied. In this case, a problem in that a single piece of CSI occupies many CSI processing units may occur. In order to solve this problem, in the state in which contention for the occupancy of a CSI processing unit has occurred, priority of CSI reported together with a CRI may be configured to be lower than that of CSI not reported together with a CRI.

[203] Alternatively, priority of CSI reported together with a CRI may be configured to be higher than that of CSI not reported together with a CRI. This may be more important because CSI reported together with a CRI has a larger amount of channel information than CSI not reported together with a CRI.

[204] Furthermore, the examples 1) to 6) may be combined with the above-described priority rules related to CSI collision and may be used to determine priority for the occupancy of a CSI processing unit.

[205] For example, in relation to the occupancy of a CSI processing unit, the example 1) may be preferentially applied over Rules #1 to #4. This may mean that the occupancy rule of a CSI processing unit is applied by giving priority to CSI (reporting) having low latency and priority for the occupancy of a CSI processing unit is determined based on the above-described priority rule related to CSI collision when latency is the same. Alternatively, the example 1) may be applied after Rule #1 is applied and Rules

#2 to #4 may be sequentially applied. Alternatively, the example 1) may be applied after Rules #1 and #2 are applied, and Rules #3 and #4 may be sequentially applied.

[206] In the examples 1) to 6), pieces of CSI (or CSI reportings) (hereinafter prior CSI) that have already occupied a CSI processing unit at specific timing (e.g., n-th OFDM symbol) are maintained, and contention and priority between pieces of CSI (hereinafter post CSI) trying to start the occupancy of a CSI processing unit at the specific timing have been described. If this is expanded, the examples 1) to 5) may be applied to priority and contention between pieces of CSI that have already occupied a CSI processing unit at specific timing and pieces of new CSI trying to occupy a CSI processing unit.

[207] If an M or less number of pieces of CSI try to start the occupancy of a CSI processing unit at specific timing, all the pieces of CSI may occupy the CSI processing unit without contention. In this case, if CSI exceeding the M CSI try to start the occupancy of a CSI processing unit, pieces of X-M CSI already occupying the CSI processing unit and pieces of N CSI trying to occupy the CSI processing unit may content with each other. In this case, the contention may be performed according to any one of the following two scheme.

[208] The first scheme is a technique in which the pieces of X-M CSI and the pieces of N CSI trying to occupy the CSI processing unit equally contend with each other again. Prior CSI is CSI that has already occupied a CSI processing unit and that has vested rights, but is configured to contend with N pieces of post CSI again without an advantage.

[209] The second scheme is a technique in which pieces of post CSI first contend with each other and an opportunity to contend with prior CSI is given to post CSI that has lost in the contention. That is, the post CSI that has lost in the contention and the prior CSI may be configured to contend with each other according to a specific rule. As a result, if priority is given to the post CSI, a CSI processing unit occupied by the prior CSI may be used for the post CSI.

[210] If post CSI has higher priority than prior CSI by applying a specific rule, the prior CSI gives the occupancy of a CSI processing unit to the post CSI, and the corresponding CSI processing unit is used for post CSI calculation. In this case, calculation for the prior CSI has not been completed. Accordingly, with respect to reporting for corresponding CSI, a technique of defining (or agreeing) that the recently calculated or reported CSI is reported again, defining (or agreeing) that a preset specific CSI value is reported, or defining (or agreeing) that reporting is not performed may be taken into consideration.

[211] For example, a case where the example 2) is applied to contention between post CSI and prior CSI is assumed.

[212] If pieces of post CSI include CSI whose occupancy is terminated earlier than that of prior CSI, the post CSI may take a CSI processing unit occupied by the prior CSI. Alternatively, if the example 1) is applied, post CSI of low latency may take a CSI processing unit occupied by prior CSI of high latency.

[213] Furthermore, as described above, CSI calculated through channel measurement based on a periodic and/or semi-persistent CSI-RS may be configured to always occupy a CSI processing unit. A technique of permitting contention between prior CSI and post CSI and configuring a CSI processing unit so that it is redistributed based on priority by being limited to the case may be taken into consideration. Furthermore, a technique of configuring prior CSI, calculated through channel measurement based on a periodic and/or semi-persistent CSI-RS, so that the prior CSI exclusively occupies a CSI processing unit without contenting with post CSI may also be taken into consideration. In this case, contention between the remaining CSI and the post CSI may be permitted.

[214] Furthermore, as described above, in the case of the Type CSI processing capability, if a time gap between the first symbol of a PUSCH and the last symbol related to aperiodic CSI-RS/aperiodic CSI-IM has an insufficient CSI calculation time according to $Z'_{TOT} = \sum_{n=1}^{M} Z'_n$, a terminal may not expect that any one of triggered CSI reportings will be updated. In this case, in relation to un-occupied M CSI processing units, a technique of selecting pieces of M CSI (reportings) to be assigned to a CSI processing unit, among pieces of N CSI (reportings) scheduled in the terminal, needs to be taken into consideration.

[215] In relation to this, the examples 1) to 6) described in this disclosure and the priority rules related to CSI collision may be used as the technique for selecting the pieces of M CSI (reportings).

[216] Furthermore, as the technique for selecting the pieces of M CSI (reporting), M CSI that most minimizes Z_TOT and/or Z'_TOT among the pieces of N CSI may be configured to be selected. In this case, Z_TOT and/or Z'_TOT may mean an added value of Z values for CSI reportings to be reported (or updated) by a terminal and/or an added value of Z' values. If pieces of M CSI (set) that most minimize Z'_TOT and pieces of M CSI (set) that most minimize Z_TOT are different, one of the two may be finally selected. Alternatively, M CSI that most increase Z_TOT and/or Z'_TOT among the pieces of N CSI may be configured to be selected.

[217] Furthermore, as the technique for selecting the pieces of M CSI (reportings), M CSI that makes the last symbol of an aperiodic CSI-RS and/or aperiodic CSI-IM associated with CSI reporting, among the pieces of N CSI, received at the earliest timing may be configured to be selected. Alternatively, M CSI that makes the last symbol of an aperiodic CSI-RS and/or aperiodic CSI-IM associated with CSI reporting, among the

pieces of N CSI, received at the latest timing may be configured to be selected.

[218] For example, a case where N is 3, the last symbol of an aperiodic CSI-RS and/or aperiodic CSI-IM for CSI 1 is positioned in the fifth symbol of a k-th slot, the last symbol of an aperiodic CSI-RS and/or aperiodic CSI-IM for CSI 2 is positioned in the fifth symbol of a (k-1)-th slot, and the last symbol of an aperiodic CSI-RS and/or aperiodic CSI-IM for CSI 3 is positioned in the sixth symbol of the k-th slot is assumed. In this case, if M is set as 2, the CSI 1 and the CSI 2 may be selected so that they will occupy a CSI processing unit. The reason for this is that at the moment when the CSI 3 is selected, timing at which a corresponding CSI-RS and/or CSI-IM is received is late because the last symbol of the aperiodic CSI-RS and/or aperiodic CSI-IM is positioned in the sixth symbol of the k-th slot.

[219] CSI reporting configured and/or indicated in a terminal by a base station based on the above-described examples may be assigned and/or occupied to and/or by a CSI processing unit supported by the corresponding terminal.

[220] FIG. 7 shows an example of an operating flowchart of a terminal performing channel state information reporting according to some implementations of this disclosure. FIG. 7 is merely for convenience of description and does not limit the scope of the present disclosure.

[221] Referring to FIG. 7, a case where the terminal supports one or more CSI processing units for CSI reporting execution and/or CSI calculation is assumed.

[222] The terminal may receive a channel state information-reference signal (CSI-RS) for (one or more) CSI reportings from a base station (S705). For example, the CSI-RS may be a non-zero-power (NZP) CSI-RS and/or a zero-power (ZP) CSI-RS. Furthermore, in the case of interference measurement, the CSI-RS may be substituted with CSI-IM.

[223] The terminal may transmit, to the base station, CSI calculated based on the CSI-RS (S710).

[224] In this case, when the number of CSI reportings configured in the terminal is greater than the number of CSI processing units not occupied by the terminal, the calculation of the CSI may be performed based on predetermined priority. In this case, the predetermined priority may be configured and/or defined as in the examples 1) to 6) described in this disclosure.

[225] For example, the pre-configured priority may be configured based on a processing time for the CSI. The processing time may be i) a first processing time, that is, the time from the triggering timing of the CSI reporting to the execution timing of the CSI reporting (e.g., the above-described Z), or ii) a second processing time, that is, the time from the reception timing of the CSI-RS to the execution timing of the CSI reporting (e.g., the above-described Z').

[226] Furthermore, when the number of CSI processing units not occupied by the terminal

is M, M CSI reportings that minimize the sum of the first processing times or the sum of the second processing times, among one or more CSI reportings configured in the terminal, may be allocated to an M CSI processing units.

[227] Furthermore, a CSI processing unit not occupied by the terminal may be allocated with respect to CSI that satisfies the first processing time or the second processing time, among one or more CSI reportings configured in the terminal.

[228] For another example, the pre-configured priority may be configured based on a latency requirement for the CSI.

[229] For yet another example, the pre-configured priority is configured based on a time domain behavior of the CSI-RS, and the time domain behavior may be one of periodic, semi-persistent, or aperiodic.

[230] For yet another example, the pre-configured priority may be configured based on whether measurement restriction to the calculation of the CSI has been configured (e.g., ON or OFF).

[231] For yet another example, if the CSI-RS is an aperiodic CSI-RS, the pre-configured priority may be configured based on the timing of the last symbol of the CSI-RS.

[232] In relation to this, in an implementation aspect, the operation of the above-described terminal may be specifically implemented by a terminal device 1320, 1420 shown in FIG. 13, 14 of this disclosure. For example, the operation of the above-described terminal may be performed by a processor 1321, 1421 and/or a radio frequency (RF) unit (or module) 1323, 1425.

[233] In a wireless communication system, a terminal that receives a data channel (e.g., PDSCH) may include a transmitter for transmitting radio signals, a receiver for receiving radio signals, and a processor functionally connected to the transmitter and the receiver. In this case, the transmitter and the receiver (or transceiver) may be denoted as an RF unit (or module) for transmitting and receiving radio signals.

[234] For example, the processor may control the RF unit to receive a channel state information-reference signal (CSI-RS) for (one or more) CSI reportings from a base station. Furthermore, the processor may control the RF unit to transmit CSI, calculated based on the CSI-RS, to the base station.

[235] FIG. 8 shows an example of an operating flowchart of a base station receiving channel state information reporting according to some implementations of this disclosure. FIG. 8 is merely for convenience of description and does not limit the scope of the present disclosure.

[236] Referring to FIG. 8, a case where a terminal supports one or more CSI processing units for CSI reporting execution and/or CSI calculation is assumed.

[237] The base station may transmit, to the terminal, a channel state information-reference signal (CSI-RS) for (one or more) CSI reportings (S805). For example, the CSI-RS

may be a non-zero-power (NZP) CSI-RS and/or a zero-power (ZP) CSI-RS. Furthermore, in the case of interference measurement, the CSI-RS may be substituted with CSI-IM.

[238] The base station may receive, from the terminal, CSI calculated based on the CSI-RS (S810).

[239] In this case, when the number of CSI reportings configured in the terminal is greater than the number of CSI processing units not occupied by the terminal, the calculation of the CSI may be performed based on predetermined priority. In this case, the predetermined priority may be configured and/or defined as in the examples 1) to 6) described in this disclosure.

[240] For example, the pre-configured priority may be configured based on a processing time for the CSI. The processing time may be i) a first processing time, that is, the time from the triggering timing of the CSI reporting to the execution timing of the CSI reporting (e.g., the above-described Z), or ii) a second processing time, that is, the time from the reception timing of the CSI-RS to the execution timing of the CSI reporting (e.g., the above-described Z').

[241] Furthermore, when the number of CSI processing units not occupied by the terminal is M, M CSI reportings that minimize the sum of the first processing times or the sum of the second processing times, among one or more CSI reportings configured in the terminal, may be allocated to an M CSI processing units.

[242] Furthermore, a CSI processing unit not occupied by the terminal may be allocated with respect to CSI that satisfies the first processing time or the second processing time, among one or more CSI reportings configured in the terminal.

[243] For another example, the pre-configured priority may be configured based on a latency requirement for the CSI.

[244] For yet another example, the pre-configured priority is configured based on a time domain behavior of the CSI-RS, and the time domain behavior may be one of periodic, semi-persistent, or aperiodic.

[245] For yet another example, the pre-configured priority may be configured based on whether measurement restriction to the calculation of the CSI has been configured (e.g., ON or OFF).

[246] For yet another example, if the CSI-RS is an aperiodic CSI-RS, the pre-configured priority may be configured based on the timing of the last symbol of the CSI-RS.

[247] In relation to this, in an implementation aspect, the operation of the above-described base station may be specifically implemented by a base station device 1310, 1410 shown in FIG. 13, 14 of this disclosure. For example, the operation of the above-described terminal may be performed by a processor 1311, 1411 and/or a radio frequency (RF) unit (or module) 1313, 1415.

[248] In a wireless communication system, the base station that transmits a data channel (e.g., PDSCH) may include a transmitter for transmitting radio signals, a receiver for receiving radio signals, and a processor functionally connected to the transmitter and the receiver. In this case, the transmitter and the receiver (or transceiver) may be denoted as an RF unit (or module) for transmitting and receiving radio signals.

[249] For example, the processor may control the RF unit to transmit a channel state information-reference signal (CSI-RS) for (one or more) CSI reportings to a terminal. Furthermore, the processor may control the RF unit to receive CSI, calculated based on the CSI-RS, from the terminal.

[250] **Second implementation**

[251] In the present implementation, examples of setting and/or determining the above-described Z value in relation to CSI reporting (e.g., Layer1-reference signal received power reporting (L1-RSRP report)) related to beam management and/or beam reporting in addition to the above-described CSI reporting is described. In this case, the Z value is related to aperiodic CSI reporting as described above, and may mean a minimum time (or time gap) from timing at which a terminal receives DCI scheduling CSI reporting to timing at which the terminal performs actual CSI reporting.

[252] In the present implementation, the case of L1-RSRP report is basically described, but this is only for convenience of description and the examples described in the present implementation may be applied to CSI reporting (i.e., CSI reporting configured for beam management and/or beam reporting use) related to beam management and/or beam reporting. Furthermore, in the CSI reporting related to beam management and/or beam reporting, reporting information (e.g., report(ing) quantity, report(ing) contents) may mean CSI reporting configured as at least one of i) a CSI-RS resource indicator (CRI) and reference signal received power (RSRP), ii) a synchronization signal block (SSB) and RSRP, or iii) no report (e.g., no report, none).

[253] In addition to (normal) CSI reporting, such as that described above, in the case of L1-RSRP report, a minimum (required) time (i.e., a minimum required time related to a CSI calculation time) necessary for a terminal may be defined using the above-described Z value and/or Z' value. If a base station schedules time smaller than a corresponding time, a terminal ignores L1-RSRP triggering DCI or may not report a valid 1-RSRP value to the base station.

[254] Hereinafter, in the present implementation, i) a case where a channel state information-reference signal (CSI-RS) and/or a synchronization signal block (SSB) used for L1-RSRP calculation is present between aperiodic L1-RSRP triggering DCI and a reporting time (i.e., L1-RSRP reporting timing) and ii) a case where a CSI-RS and/or an SSB is present prior to aperiodic triggering DCI are described, and a technique of setting a Z value in relation to L1-RSRP is described.

[255] In this case, the aperiodic L1-RSRP triggering DCI may mean DCI for triggering aperiodic L1-RSRP report, and the CSI-RS used for L1-RSRP calculation may mean a CSI-RS used for the calculation of CSI to be used for L1-RSRP report.

[256] FIG. 9 shows an example of an L1-RSRP report operation in a wireless communication system. FIG. 9 is merely for convenience of description and does not limit the scope of the present disclosure.

[257] Referring to FIG. 9, a case where a CSI-RS and/or an SSB used for L1-RSRP calculation is present between timing at which aperiodic L1-RSRP triggering DCI is received and L1-RSRP reporting timing is assumed. FIG. 9 is described by taking the case of a periodic (P) CSI-RS as an example, but may be extended and applied to an aperiodic and/or semi-persistent CSI-RS and SSB.

[258] In FIG. 9, 4 CSI-RSs may be transmitted in 4 OFDM symbols 905, and such 4 CSI-RSs may be periodically transmitted.

[259] The reporting of L1-RSRP is aperiodically triggered through at least one piece of DCI. A terminal may calculate L1-RSRP using a CSI-RS(s) present in a time prior to Z' from reporting timing, and may report calculated CSI to a base station.

[260] In the case of FIG. 9, the terminal may receive DCI triggering L1-RSRP report (905), and may calculate CSI to be used for L1-RSRP report using (one or more) CSI-RSs received prior to a Z' value (i.e., a minimum time necessary for the above-described terminal to receive a CSI-RS and to perform CSI calculation) from a reporting time 915 indicated and/or configured by the corresponding DCI.

[261] FIG. 10 shows another example of an L1-RSRP report operation in a wireless communication system. FIG. 10 is merely for convenience of description and does not limit the scope of the present disclosure.

[262] Referring to FIG. 10, a case where a CSI-RS and/or an SSB used for L1-RSRP calculation is not present between timing at which aperiodic L1-RSRP triggering DCI is received and L1-RSRP reporting timing and a CSI-RS and/or an SSB is present prior to aperiodic L1-RSRP triggering DCI is assumed. FIG. 10 is described by taking the case of a periodic (P) CSI-RS as an example, but may be extended and applied to an aperiodic and/or semi-persistent CSI-RS and SSB.

[263] In FIG. 10, 4 CSI-RSs may be transmitted in 4 OFDM symbols 1005, and such 4 CSI-RSs may be periodically transmitted.

[264] The reporting of L1-RSRP is aperiodically triggered through at least one DCI. A terminal may calculate L1-RSRP using a CSI-RS(s) present in a time prior to Z' from reporting timing, and may report calculated CSI to a base station.

[265] In the case of FIG. 10, the terminal may need to store a measured channel and/or channel information (e.g., L1-RSRP value) based on the possibility that measurement based on a received CSI-RS will be reported because the terminal is unaware whether

the received CSI-RS is reported until the terminal receives DCI triggering CSI reporting. In this case, the terminal may need to store the above-described information until timing at which the decoding of the DCI is completed, that is, the time when CSI reporting becomes clear. In this case, there may be a disadvantage in that a terminal price rises because additional memory is required.

[266] Accordingly, a technique of restricting scheduling so that a CSI-RS and/or an SSB used for L1-RSRP calculation is present between periodic L1-RSRP triggering DCI and L1-RSRP reporting timing as in FIG. 9 may be taken into consideration. In this case, a Z value (i.e., a minimum required time for the (aperiodic) CSI reporting of a terminal) may be determined to be greater than a Z' value, and may be determined to be equal to or greater than the sum of the Z' value and the number of symbols in which the CSI-RS and/or the SSB is transmitted.

[267] A Z value is not greatly increased because a CSI-RS is transmitted in 14 symbols or less, but a Z value may be greatly set because an SSB is transmitted in several slots (e.g., 5ms). If the Z value increases, it may be inefficient because delay from timing at which CSI reporting is triggered to the time when actual CSI reporting is performed increases.

[268] By taking this fact into consideration, the following examples may be taken into consideration when the Z value is determined.

[269] **Example 1)**

[270] In the case of CSI reporting based on a CSI-RS, assuming that a CSI-RS and/or SSB used for L1-RSRP calculation is present between aperiodic L1-RSRP triggering DCI and reporting timing (e.g., the case of FIG. 9), a Z value may be configured to be defined as a value greater than a Z' value. Furthermore, in the case of CSI reporting based on an SSB, assuming that a CSI-RS and/or an SSB used for L1-RSRP calculation is present prior to aperiodic L1-RSRP triggering DCI (e.g., the case of FIG. 10), a Z value may be configured to be defined as a value smaller than a Z value used for the case of CSI reporting based on a CSI-RS.

[271] **Example 2)**

[272] Alternatively, whether a smaller Z value will be used or a larger Z value will be used may be determined based on the time characteristic of a resource used for L1-RSRP calculation (i.e., a behavior characteristic on a time domain) (e.g., aperiodic, periodic, semi-persistently).

[273] For example, a technique of configuring and/or defining that a CSI-RS and/or SSB having a periodic characteristic or a semi-persistently characteristic uses a smaller Z value and a CSI-RS (i.e., aperiodic CSI-RS) having an aperiodic characteristic separately uses a larger Z value may be taken into consideration.

[274] **Example 3)**

[275] Consider the scenario where reporting setting related to CSI (e.g., CSI reporting setting) is configured for beam management and/or beam reporting use (i.e., if reporting information is configured as any one of i) CRI and RSRP, ii) SSB ID and RSRP, or iii) no report) and an aperiodic CSI-RS is used for the reporting setting.

[276] In this scenario, a base station may need to drop a triggering DCI and an aperiodic CSI-RS at least by a minimum time (e.g., m, KB) or more, based on the corresponding minimum time between the triggering DCI and an aperiodic CSI-RS previously reported by a terminal as UE capability information, and to perform transmission. In this case, the triggering DCI means DCI for triggering (or scheduling) the aperiodic CSI-RS. That is, the m value may be determined by taking a DCI decoding time into consideration. As such, the base station may need to schedule a CSI-RS by taking into consideration a DCI decoding time related to the reception of the CSI-RS that will be reported by the terminal.

[277] Again, a certain amount of minimum time may be required by the terminal for the CSI reporting (referred to as the Z value) when aperiodic L1-RSRP is reported using the above-described CSI-RS (e.g., periodic, semi-persistent, or aperiodic CSI-RS) and/or SSB. In such scenarios, the Z value may be determined using the m value. For example, 'Z = m' may be configured so that reporting is guaranteed to be performed after decoding of the DCI is completed.

[278] In this case, during the time duration from a timing at which the terminal receives the DCI to a timing when the terminal performs CSI reporting, an L1-RSRP encoding time and the Tx preparation time of the terminal may be additionally necessary in addition to the DCI decoding time for the terminal.

[279] Accordingly, a Z value may need to be set greater than the m value. For example, the Z values may be simply set as m + c (e.g., where c is a constant, such as c = 1).

[280] Alternatively, a Z value may be determined to be the sum of the m value and a Z' value. For example, the Z value may be set as a value obtained by adding, to a Z' value, the time required to decode the DCI triggering an aperiodic CSI-RS. As a specific example, the Z value may be set based on a minimum required time from the last timing at which the CSI-RS of the terminal is received to CSI reporting timing and a decoding time for DCI that schedules the corresponding CSI-RS.

[281] In relation to the examples described in the present implementation, a technique of configuring the number of processing units (e.g., CPUs) used for L-RSRP report may also be taken into consideration.

[282] In the case of normal CSI reporting, the number of CSI processing units to be utilized or occupied may be different based on the number of CSI-RS resources (i.e., the number of CSI-RS indices) configured and/or allocated to CSI reporting. For example, as the number of CSI-RSs increases, CSI calculation complexity may increase,

resulting in an increased number of processing units being utilized for the CSI reporting. In contrast, in some scenarios, the number of CSI processing units used (or configured, occupied) for L1-RSRP report may be fixed to 1. For example, L1-RSRP may be calculated by measuring each received power with respect to N CSI-RS resources or N SSBs, but L1-RSRP may be calculated as 1 CSI processing unit because a computation load is small compared to normal CSI calculation complexity.

[283] Consequently, in normal CSI calculation, a CSI processing unit is linearly increased and used as many as the number of CSI-RS resources used for channel measurement. In the case of L1-RSRP calculation, only one CSI processing unit may be configured to be used.

[284] Alternatively, in the case of L1-RSRP calculation, a technique of non-linearly increasing the number of CSI processing units based on the number of resources of a CSI-RS and/or SSB without fixing a used CSI processing unit may be used. For example, a technique of configuring that the number of CSI processing units is assumed to be 1 if a terminal performs L1-RSRP calculation through 16 or less CSI-RS resources and the number of CSI processing units is assumed to be 2 if a terminal performs L1-RSRP calculation on other cases may be taken into consideration.

[285] FIG. 11 shows an example of an operating flowchart of a terminal reporting channel state information according to some implementations of this disclosure. FIG. 11 is merely for convenience of description and does not limit the scope of the present disclosure.

[286] Referring to FIG. 11, a case where the terminal uses the examples described in the second implementation in performing L1-RSRP report is assumed. Particularly, a Z value and/or Z' value reported as UE capability information may be determined and/or configured based on the examples described in the second implementation (e.g., example 3 of the second implementation).

[287] The terminal may receive DCI triggering CSI reporting (from a base station) (S1105). In this case, the CSI reporting may be aperiodic CSI reporting.

[288] Furthermore, the CSI reporting may be CSI reporting for beam management and/or beam reporting use. For example, reporting information of the CSI reporting may be any one of i) a CSI-RS resource indicator (CRI) and reference signal received power (RSRP), ii) a synchronization signal block (SSB) identifier and RSRP, or iii) no report.

[289] The terminal may receive at least one CSI-RS (i.e., configured and/or indicated for the CSI reporting) for the CSI reporting (from the base station) (S1110). For example, as shown in FIG. 9, the CSI-RS may be a CSI-RS received after DCI in step S1105 and prior to CSI reporting timing.

[290] The terminal may transmit, to the base station, CSI calculated based on the CSI-RS (S1115). For example, the terminal may perform L1-RSRP report, measured based on

the CSI-RS, on the base station.

[291] In this case, a minimum required time for the CSI reporting (e.g., a Z value in the example 3 of the second implementation) may be configured based on i) a minimum required time (e.g., a Z' value in the example 3 of the second implementation) from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a decoding time for DCI scheduling the CSI-RS (e.g., an m value in the example 3 of the second implementation). For example, the minimum required time for the CSI reporting may be configured as the sum of i) a minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a minimum required time between a DCI triggering the CSI-RS and a reception (or transmission) of the CSI-RS (i.e. a decoding time for DCI scheduling the CSI-RS) (e.g., Z = Z' + m).

[292] Furthermore, as described above, information for the minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI may be reported, by the terminal, to the base station as UE capability information.

[293] Furthermore, as described above, the CSI-RS is configured to be aperiodically transmitted, that is, an aperiodic CSI-RS, and the DCI scheduling the CSI-RS may be triggering DCI for the CSI-RS. In this case, information for the minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS (i.e. the decoding time for the DCI scheduling the CSI-RS) may be reported, by the terminal, to the base station as UE capability information.

[294] Furthermore, as described above, the number of CSI processing units occupied for the CSI reporting (e.g., CSI reporting configured for beam management and/or beam reporting use, that is, L1-RSRP report) may be set to 1.

[295] In relation to this, in an implementation aspect, the operation of the above-described terminal may be specifically implemented by the terminal device 1320, 1420 shown in FIG. 13, 14 of this disclosure. For example, the operation of the above-described terminal may be performed by the processor 1321, 1421 and/or the radio frequency (RF) unit (or module) 1323, 1425.

[296] In a wireless communication system, a terminal that receives a data channel (e.g., PDSCH) may include a transmitter for transmitting radio signals, a receiver for receiving radio signals, and a processor functionally connected to the transmitter and the receiver. In this case, the transmitter and the receiver (or transceiver) may be denoted as an RF unit (or module) for transmitting and receiving radio signals.

[297] For example, the processor may control the RF unit to receive DCI triggering CSI reporting (from a base station). In this case, the CSI reporting may be aperiodic CSI reporting.

[298] Furthermore, the CSI reporting may be CSI reporting for beam management and/or beam reporting use. For example, reporting information of the CSI reporting may be

any one of i) a CSI-RS resource indicator (CRI) and reference signal received power (RSRP), ii) a synchronization signal block (SSB) identifier and RSRP, or iii) no report.

[299] The processor may control the RF unit to receive at least one CSI-RS (i.e., configured and/or indicated for the CSI reporting) for the CSI reporting (from the base station). For example, as shown in FIG. 9, the CSI-RS may be a CSI-RS received after timing at which the DCI triggering CSI reporting is received and prior to CSI reporting timing.

[300] The processor may control the RF unit to transmit, to the base station, CSI calculated based on the CSI-RS. For example, the processor may control L1-RSRP report measured based on the CSI-RS so that the L1-RSRP report is performed on the base station.

[301] In this case, a minimum required time for the CSI reporting (e.g., a Z value in the example 3 of the second implementation) may be configured based on i) a minimum required time (e.g., a Z' value in the example 3 of the second implementation) from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a decoding time for DCI scheduling the CSI-RS (e.g., an m value in the example 3 of the second implementation). For example, the minimum required time for the CSI reporting may be configured as the sum of i) a minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS (i.e. a decoding time for DCI scheduling the CSI-RS) (e.g., $Z = Z' + m$).

[302] Furthermore, as described above, information for the minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI may be reported, by the terminal, to the base station as UE capability information.

[303] Furthermore, as described above, the CSI-RS is configured to be aperiodically transmitted, that is, an aperiodic CSI-RS, and the DCI scheduling the CSI-RS may be triggering DCI for the CSI-RS. In this case, information for the minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS (i.e. the decoding time for the DCI scheduling the CSI-RS) may be reported, by the terminal, to the base station as UE capability information.

[304] Furthermore, as described above, the number of CSI processing units occupied for the CSI reporting (e.g., CSI reporting configured for beam management and/or beam reporting use, that is, L1-RSRP report) may be set to 1.

[305] As an operation is performed as described above, unlike normal CSI reporting, in the case of L1-RSRP report used for beam management and/or beam reporting use, efficient Z value setting and CSI processing unit occupancy may be performed.

[306] FIG. 12 shows an example of an operating flowchart of a base station receiving channel state information according to some implementations of this disclosure. FIG.

12 is merely for convenience of description and does not limit the scope of the present disclosure.

[307] Referring to FIG. 12, a case where a terminal uses the examples described in the second implementation in performing L1-RSRP report is assumed. Particularly, a Z value and/or Z' value reported as UE capability information may be determined and/or configured based on the examples described in the second implementation (e.g., the example 3 of the second implementation).

[308] The base station may transmit DCI triggering CSI reporting (to the terminal) (S1205). In this case, the CSI reporting may be aperiodic CSI reporting.

[309] Furthermore, the CSI reporting may be CSI reporting for beam management and/or beam reporting use. For example, reporting information of the CSI reporting may be any one of i) a CSI-RS resource indicator (CRI) and reference signal received power (RSRP), ii) a synchronization signal block (SSB) identifier and RSRP, or iii) no report.

[310] The base station may transmit at least one CSI-RS (i.e., configured and/or indicated for the CSI reporting) for the CSI reporting (to the terminal) (S1210). For example, as shown in FIG. 9, the CSI-RS may be a CSI-RS transmitted after the DCI in step S1205 and prior to CSI reporting timing.

[311] The base station may receive CSI calculated based on the CSI-RS from the terminal (S1215). For example, the terminal may perform L1-RSRP report, measured based on the CSI-RS, on the base station.

[312] In this case, a minimum required time for the CSI reporting (e.g., a Z value in the example 3 of the second implementation) may be configured based on i) a minimum required time (e.g., a Z' value in the example 3 of the second implementation) from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a decoding time for DCI scheduling the CSI-RS (e.g., an m value in the example 3 of the second implementation). For example, the minimum required time for the CSI reporting may be configured as the sum of i) a minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS (i.e. a decoding time for DCI scheduling the CSI-RS) (e.g., $Z = Z' + m$).

[313] Furthermore, as described above, information for the minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI may be reported, by the terminal, to the base station as UE capability information.

[314] Furthermore, as described above, the CSI-RS is configured to be aperiodically transmitted, that is, an aperiodic CSI-RS, and the DCI scheduling the CSI-RS may be triggering DCI for the CSI-RS. In this case, information for the decoding time for the DCI scheduling the CSI-RS may be reported, by the terminal, to the base station as UE capability information.

[315] Furthermore, as described above, the number of CSI processing units occupied for the CSI reporting (e.g., CSI reporting configured for beam management and/or beam reporting use, that is, L1-RSRP report) may be set to 1.

[316] As an operation is performed as described above, unlike normal CSI reporting, in the case of L1-RSRP report used for beam management and/or beam reporting use, efficient Z value setting and CSI processing unit occupancy may be performed.

[317] In relation to this, in an implementation aspect, the operation of the above-described base station may be specifically implemented by the base station device 1310, 1410 shown in FIG. 13, 14 of this disclosure. For example, the operation of the above-described base station may be performed by the processor 1311, 1411 and/or the radio frequency (RF) unit (or module) 1313, 1415.

[318] In a wireless communication system, the base station that transmits a data channel (e.g., PDSCH) may include a transmitter for transmitting radio signals, a receiver for receiving radio signals, and a processor functionally connected to the transmitter and the receiver. In this case, the transmitter and the receiver (or transceiver) may be denoted as an RF unit (or module) for transmitting and receiving radio signals.

[319] For example, the processor may control the RF unit to transmit DCI triggering CSI reporting (to a terminal). In this case, the CSI reporting may be aperiodic CSI reporting.

[320] Furthermore, the CSI reporting may be CSI reporting for beam management and/or beam reporting use. For example, reporting information of the CSI reporting may be any one of i) a CSI-RS resource indicator (CRI) and reference signal received power (RSRP), ii) a synchronization signal block (SSB) identifier and RSRP, or iii) no report.

[321] The processor may control the RF unit to transmit at least one CSI-RS for CSI reporting (i.e., configured and/or indicated for the CSI reporting) (to the terminal). For example, as shown in FIG. 9, the CSI-RS may be a CSI-RS transmitted after timing the DCI triggering CSI reporting is received and prior to CSI reporting timing.

[322] The processor may control the RF unit to receive CSI, calculated based on the CSI-RS, from the terminal. For example, the terminal may perform L1-RSRP report, measured based on the CSI-RS, on a base station.

[323] In this case, a minimum required time for the CSI reporting (e.g., a Z value in the example 3 of the second implementation) may be configured based on i) a minimum required time (e.g., a Z' value in the example 3 of the second implementation) from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a decoding time for DCI scheduling the CSI-RS (e.g., an m value in the example 3 of the second implementation). For example, the minimum required time for the CSI reporting may be configured as the sum of i) a minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI and ii) a minimum required time between a

DCI triggering the CSI-RS and a reception of the CSI-RS (i.e. a decoding time for DCI scheduling the CSI-RS) (e.g., Z = Z' + m).

[324] Furthermore, as described above, information for the minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI may be reported, by the terminal, to the base station as UE capability information.

[325] Furthermore, as described above, the CSI-RS is configured to be aperiodically transmitted, that is, an aperiodic CSI-RS, and the DCI scheduling the CSI-RS may be triggering DCI for the CSI-RS. In this case, information for the decoding time for the DCI scheduling the CSI-RS may be reported, by the terminal, to the base station as UE capability information.

[326] Furthermore, as described above, the number of CSI processing units occupied for the CSI reporting (e.g., CSI reporting configured for beam management and/or beam reporting use, that is, L1-RSRP report) may be set to 1.

[327] As an operation is performed as described above, unlike normal CSI reporting, in the case of L1-RSRP report used for beam management and/or beam reporting use, efficient Z value setting and CSI processing unit occupancy may be performed.

[328] **General device to which the present disclosure may be applied**

[329] FIG. 13 shows a wireless communication device according to some implementations of the present disclosure.

[330] Referring to FIG. 13, a wireless communication system may include a first device 1310 and a second device 1320.

[331] The first device 1310 may be a base station, a network node, a transmission terminal, a reception terminal, a wireless device, a wireless communication device, a vehicle, a vehicle on which an automatic driving function has been mounted, a connected car, a drone (or unmanned aerial vehicle (UAV)), an artificial intelligence (AI) module, a robot, an augmented reality (AR) device, a virtual reality (VR) device, a mixed reality (MR) device, a hologram device, a public safety device, an MTC device, an IoT device, a medical device, a FinTech device (or financial device), a security device, a climate/environment device, a device related to 5G service or a device related to the fourth industrial revolution field.

[332] The second device 1320 may be a base station, a network node, a transmission terminal, a reception terminal, a wireless device, a wireless communication device, a vehicle, a vehicle on which an automatic driving function has been mounted, a connected car, a drone (or unmanned aerial vehicle (UAV)), an artificial intelligence (AI) module, a robot, an augmented reality (AR) device, a virtual reality (VR) device, a mixed reality (MR) device, a hologram device, a public safety device, an MTC device, an IoT device, a medical device, a FinTech device (or financial device), a security device, a climate/environment device, a device related to 5G service or a

device related to the fourth industrial revolution field.

[333] For example, the terminal may include a portable phone, a smart phone, a laptop computer, a terminal for digital broadcasting, a personal digital assistants (PDA), a portable multimedia player (PMP), a navigator, a slate PC, a tablet PC, an ultrabook, a wearable device (e.g., a watch type terminal (smartwatch), a glass type terminal (smart glass), a head mounted display (HMD)), and so on. For example, the HMD may be a display device of a form, which is worn on the head. For example, the HMD may be used to implement VR, AR or MR.

[334] For example, the drone may be a flight vehicle that flies by a wireless control signal without a person being on the flight vehicle. For example, the VR device may include a device implementing the object or background of a virtual world. For example, the AR device may include a device implementing the object or background of a virtual world by connecting it to the object or background of the real world. For example, the MR device may include a device implementing the object or background of a virtual world by merging it with the object or background of the real world. For example, the hologram device may include a device implementing a 360-degree stereographic image by recording and playing back stereographic information using the interference phenomenon of a light beam generated when two lasers called holography are met. For example, the public safety device may include a video relay device or an imaging device capable of being worn on a user's body. For example, the MTC device and the IoT device may be a device that does not require a person's direct intervention or manipulation. For example, the MTC device and the IoT device may include a smart meter, a vending machine, a thermometer, a smart bulb, a door lock or a variety of sensors. For example, the medical device may be a device used for the purpose of diagnosing, treating, reducing, handling or preventing a disease. For example, the medical device may be a device used for the purpose of diagnosing, treating, reducing or correcting an injury or obstacle. For example, the medical device may be a device used for the purpose of testing, substituting or modifying a structure or function. For example, the medical device may be a device used for the purpose of controlling pregnancy. For example, the medical device may include a device for medical treatment, a device for operation, a device for (external) diagnosis, a hearing aid or a device for a surgical procedure. For example, the security device may be a device installed to prevent a possible danger and to maintain safety. For example, the security device may be a camera, CCTV, a recorder or a blackbox. For example, the FinTech device may be a device capable of providing financial services, such as mobile payment. For example, the FinTech device may include a payment device or point of sales (POS). For example, the climate/environment device may include a device for monitoring or predicting the climate/environment.

[335] The first device 1310 may include at least one processor such as a processor 1311, at least one piece of memory such as memory 1312, and at least one or more transceiver such as a transceiver 1313. The processor 1311 may perform the above-described functions, procedures, and/or methods. The processor 1311 may perform one or more protocols. For example, the processor 1311 may perform one or more layers of a radio interface protocol. The memory 1312 is connected to the processor 1311, and may store various forms of information and/or instructions. The transceiver 1313 is connected to the processor 1311, and may be controlled to transmit and receive radio signals.

[336] The second device 1320 may include at least one processor such as a processor 1321, at least one piece of memory device such as memory 1322, and at least one transceiver such as a transceiver 1323. The processor 1321 may perform the above-described functions, procedures and/or methods. The processor 1321 may implement one or more protocols. For example, the processor 1321 may implement one or more layers of a radio interface protocol. The memory 1322 is connected to the processor 1321, and may store various forms of information and/or instructions. The transceiver 1323 is connected to the processor 1321 and may be controlled transmit and receive radio signals.

[337] The memory 1312 and/or the memory 1322 may be connected inside or outside the processor 1311 and/or the processor 1321, respectively, and may be connected to another processor through various technologies, such as a wired or wireless connection.

[338] The first device 1310 and/or the second device 1320 may have one or more antennas. For example, the antenna 1314 and/or the antenna 1324 may be configured to transmit and receive radio signals.

[339] FIG. 14 shows another example of a block diagram of a wireless communication device according to some implementations of this disclosure.

[340] Referring to FIG. 14, the wireless communication system includes a base station 1410 and multiple terminals 1420 disposed within the base station region. The base station may be represented as a transmission device, and the terminal may be represented as a reception device, and vice versa. The base station and the terminal include processors 1411 and 1421, memory 1414 and 1424, one or more Tx/Rx radio frequency (RF) modules 1415 and 1425, Tx processors 1412 and 1422, Rx processors 1413 and 1423, and antennas 1416 and 1426, respectively. The processor implements the above-described functions, processes and/or methods. More specifically, in DL (communication from the base station to the terminal), a higher layer packet from a core network is provided to the processor 1411. The processor implements the function of the L2 layer. In DL, the processor provides the terminal 1420 with multiplexing

between a logical channel and a transport channel and radio resource allocation, and is responsible for signaling toward the terminal. The TX processor 1412 implements various signal processing functions for the L1 layer (i.e., physical layer). The signal processing function facilitates forward error correction (FEC) in the terminal, and includes coding and interleaving. A coded and modulated symbol is split into parallel streams. Each stream is mapped to an OFDM subcarrier and multiplexed with a reference signal (RS) in the time and/or frequency domain. The streams are combined using inverse fast Fourier transform (IFFT) to generate a physical channel that carries a time domain OFDMA symbol stream. The OFDM stream is spatially precoded in order to generate multiple space streams. Each space stream may be provided to a different antenna 1416 through an individual Tx/Rx module (or transmitter and receiver 1415). Each Tx/Rx module may modulate an RF carrier into each space stream for transmission. In the terminal, each Tx/Rx module (or transmitter and receiver 1425) receives a signal through each antenna 1426 of each Tx/Rx module. Each Tx/Rx module restores information modulated in an RF carrier and provides it to the RX processor 1423. The RX processor implements various signal processing functions of the layer 1. The RX processor may perform space processing on information in order to restore a given space stream toward the terminal. If multiple space streams are directed toward the terminal, they may be combined into a single OFDMA symbol stream by multiple RX processors. The RX processor converts the OFDMA symbol stream from the time domain to the frequency domain using fast Fourier transform (FFT). The frequency domain signal includes an individual OFDMA symbol stream for each subcarrier of an OFDM signal. Symbols on each subcarrier and a reference signal are restored and demodulated by determining signal deployment points having the best possibility, which have been transmitted by the base station. Such soft decisions may be based on channel estimation values. The soft decisions are decoded and deinterleaved in order to restore data and a control signal originally transmitted by the base station on a physical channel. A corresponding data and control signal are provided to the processor 1421.

[341] UL (communication from the terminal to the base station) is processed by the base station 1410 in a manner similar to that described in relation to the receiver function in the terminal 1420. Each Tx/Rx module 1425 receives a signal through each antenna 1426. Each Tx/Rx module provides an RF carrier and information to the RX processor 1423. The processor 1421 may be related to the memory 1424 storing a program code and data. The memory may be referred to as a computer-readable medium.

[342] In this disclosure, the wireless device may be a base station, a network node, a transmission terminal, a reception terminal, a wireless device, a wireless communication device, a vehicle, a vehicle on which an automatic driving function has been

mounted, a connected car, a drone (or unmanned aerial vehicle (UAV)), an artificial intelligence (AI) module, a robot, an augmented reality (AR) device, a virtual reality (VR) device, a mixed reality (MR) device, a hologram device, a public safety device, an MTC device, an IoT device, a medical device, a FinTech device (or financial device), a security device, a climate/environment device, a device related to 5G service or a device related to the fourth industrial revolution field. For example, the drone may be a flight vehicle that flies by a wireless control signal without a person being on the flight vehicle. For example, the MTC device and the IoT device may be a device that does not require a person's direct intervention or manipulation, and may include a smart meter, a vending machine, a thermometer, a smart bulb, a door lock or a variety of sensors. For example, the medical device may be a device used for the purpose of diagnosing, treating, reducing, handling or preventing a disease and a device used for the purpose of testing, substituting or modifying a structure or function, and may include a device for medical treatment, a device for operation, a device for (external) diagnosis, a hearing aid or a device for a surgical procedure. For example, the security device may be a device installed to prevent a possible danger and to maintain safety, and may be a camera, CCTV, a recorder or a blackbox. For example, the FinTech device may be a device capable of providing financial services, such as mobile payment, and may be a payment device, point of sales (POS), etc. For example, the climate/environment device may include a device for monitoring or predicting the climate/environment.

[343] In this disclosure, the terminal include a portable phone, a smart phone, a laptop computer, a terminal for digital broadcasting, a personal digital assistants (PDA), a portable multimedia player (PMP), a navigator, a slate PC, a tablet PC, an ultrabook, a wearable device (e.g., a watch type terminal (smartwatch), a glass type terminal (smart glass), a head mounted display (HMD)), a foldable device, and so on. For example, the HMD may be a display device of a form, which is worn on the head, and may be used to implement VR or AR.

[344] The aforementioned implementations are achieved by a combination of structural elements and features of the present disclosure in a predetermined manner. Each of the structural elements or features should be considered selectively unless specified separately. Each of the structural elements or features may be carried out without being combined with other structural elements or features. In addition, some structural elements and/or features may be combined with one another to constitute the implementations of the present disclosure. The order of operations described in the implementations of the present disclosure may be changed. Some structural elements or features of one implementation may be included in another implementation, or may be replaced with corresponding structural elements or features of another implementation.

Moreover, it is apparent that some claims referring to specific claims may be combined with another claims referring to the other claims other than the specific claims to constitute the implementation or add new claims by means of amendment after the application is filed.

[345] The implementations of the present disclosure may be achieved by various means, for example, hardware, firmware, software, or a combination thereof. In a hardware configuration, the methods according to the implementations of the present disclosure may be achieved by one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, microcontrollers, microprocessors, etc.

[346] In a firmware or software configuration, the implementations of the present disclosure may be implemented in the form of a module, a procedure, a function, etc. Software code may be stored in the memory and executed by the processor. The memory may be located at the interior or exterior of the processor and may transmit data to and receive data from the processor via various known means.

[347] It will be apparent to those skilled in the art that various modifications and variations can be made in the present disclosure without departing from the spirit or scope of the disclosures. Thus, it is intended that the present disclosure covers the modifications and variations of this disclosure provided they come within the scope of the appended claims and their equivalents.

Industrial Applicability

[348] The scheme for transmitting and receiving channel state information in a wireless communication system of the present disclosure has been illustrated as being applied to a 3GPP LTE/LTE-A system and a 5G system (new RAT system), but may be applied to various other wireless communication systems.

Claims

[Claim 1] A method of performing channel state information (CSI) reporting by a terminal in a wireless communication system, the method comprising:
receiving downlink control information (DCI) that triggers the CSI reporting;
receiving a CSI-reference signal (CSI-RS) for the CSI reporting; and
transmitting, to a base station, CSI that is determined based on the CSI-RS that is received,
wherein a minimum required time for the CSI reporting is configured based on (i) a first minimum required time from a last timing of the CSI-RS to a transmission timing of the CSI reporting, and (ii) a second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS.

[Claim 2] The method of claim 1, wherein reporting information for the CSI reporting comprises any one of (i) a CSI-RS resource indicator (CRI) and a reference signal received power (RSRP), (ii) a synchronization signal block (SSB) identifier and the RSRP, or (iii) no report.

[Claim 3] The method of claim 2, wherein the minimum required time for the CSI reporting is configured as a sum of (i) the first minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI reporting, and (ii) the second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS.

[Claim 4] The method of claim 3, wherein information for the first minimum required time is reported, by the terminal, to the base station as UE capability information.

[Claim 5] The method of claim 3, wherein the CSI-RS is configured to be aperiodically transmitted, and
wherein the DCI that schedules the CSI-RS is triggering DCI for the CSI-RS.

[Claim 6] The method of claim 5, wherein information for the second minimum required time is reported, by the terminal, to the base station as user equipment (UE) capability information.

[Claim 7] The method of claim 2, wherein a number of processing units that are utilized by the terminal to perform the CSI reporting is equal to 1.

[Claim 8] A terminal configured to perform channel state information (CSI) reporting in a wireless communication system, the terminal comprising:
a radio frequency (RF) unit;

at least one processor; and

at least one computer memory operably connectable to the at least one processor and storing instructions that, when executed by the at least one processor, perform operations comprising:

receiving, through the RF unit, downlink control information (DCI) that triggers the CSI reporting;

receiving, through the RF unit, a CSI-reference signal (CSI-RS) for the CSI reporting; and

transmitting, to a base station through the RF unit, CSI that is determined based on the CSI-RS that is received,

wherein a minimum required time for the CSI reporting is configured based on (i) a first minimum required time from a last timing of the CSI-RS to a transmission timing of the CSI reporting, and (ii) a second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS.

[Claim 9] The terminal of claim 8, wherein reporting information for the CSI reporting comprises any one of (i) a CSI-RS resource indicator (CRI) and a reference signal received power (RSRP), (ii) a synchronization signal block (SSB) identifier and the RSRP, or (iii) no report.

[Claim 10] The terminal of claim 9, wherein the minimum required time for the CSI reporting is configured as a sum of (i) the first minimum required time from the last timing of the CSI-RS to the transmission timing of the CSI reporting, and (ii) the second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS.

[Claim 11] The terminal of claim 10, wherein information for the first minimum required time is reported, by the terminal, to the base station as UE capability information.

[Claim 12] The terminal of claim 10, wherein the CSI-RS is configured to be aperiodically transmitted, and

wherein the DCI that schedules the CSI-RS is triggering DCI for the CSI-RS.

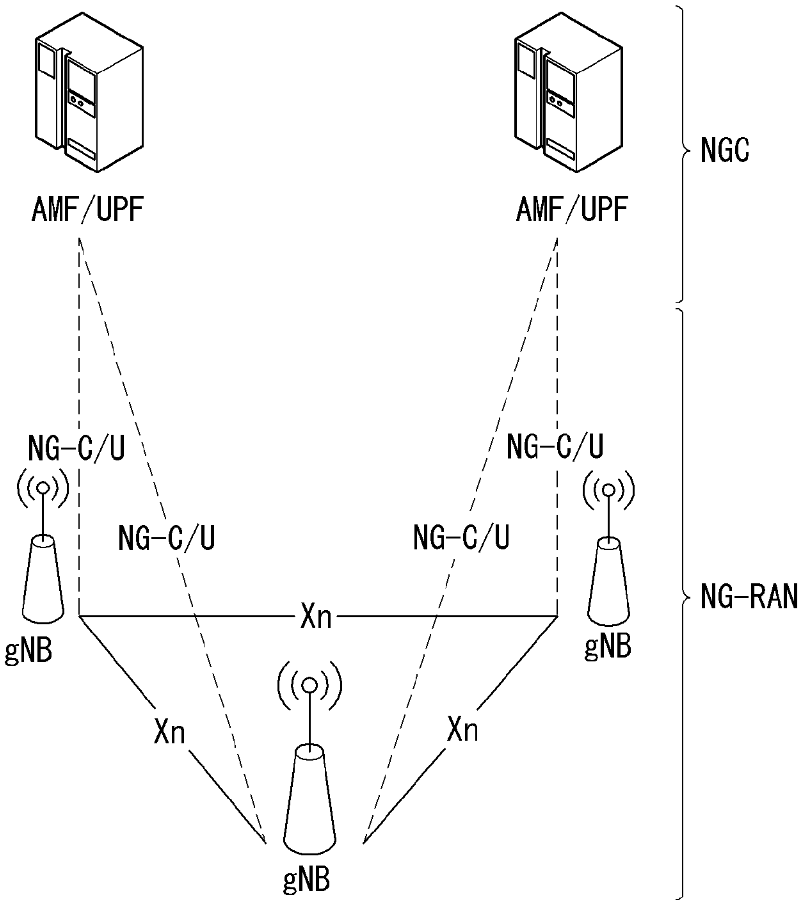
[Claim 13] The terminal of claim 12, wherein information for the second minimum required time is reported, by the terminal, to the base station as user equipment (UE) capability information.

[Claim 14] The terminal of claim 9, wherein a number of processing units that are utilized by the terminal to perform the CSI reporting is equal to 1.

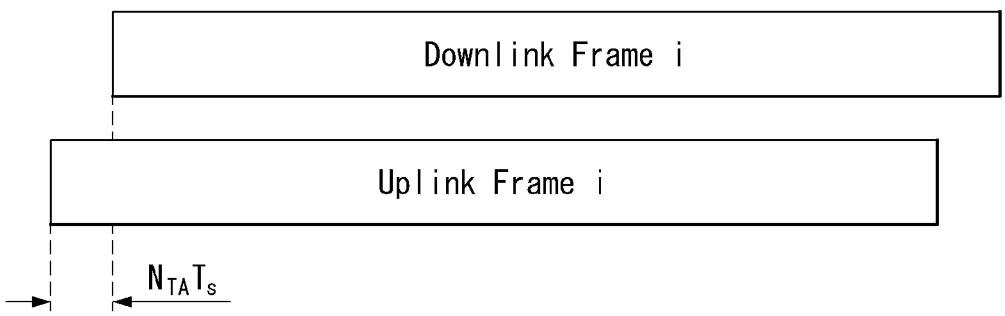
[Claim 15] A base station configured to receive channel state information (CSI) in a wireless communication system, the base station comprising:

a radio frequency (RF) unit;
at least one processor; and
at least one computer memory operably connectable to the at least one processor and storing instructions that, when executed by the at least one processor, perform operations comprising:
transmitting, through the RF unit, downlink control information (DCI) that triggers the CSI reporting;
transmitting, through the RF unit, a CSI-reference signal (CSI-RS) for the CSI reporting; and
receiving, from a terminal through the RF unit, CSI that is determined based on the CSI-RS that was transmitted,
wherein a minimum required time for the CSI reporting is configured based on (i) a first minimum required time from a last timing of the CSI-RS to a transmission timing of the CSI reporting by the terminal, and (ii) a second minimum required time between a DCI triggering the CSI-RS and a reception of the CSI-RS.

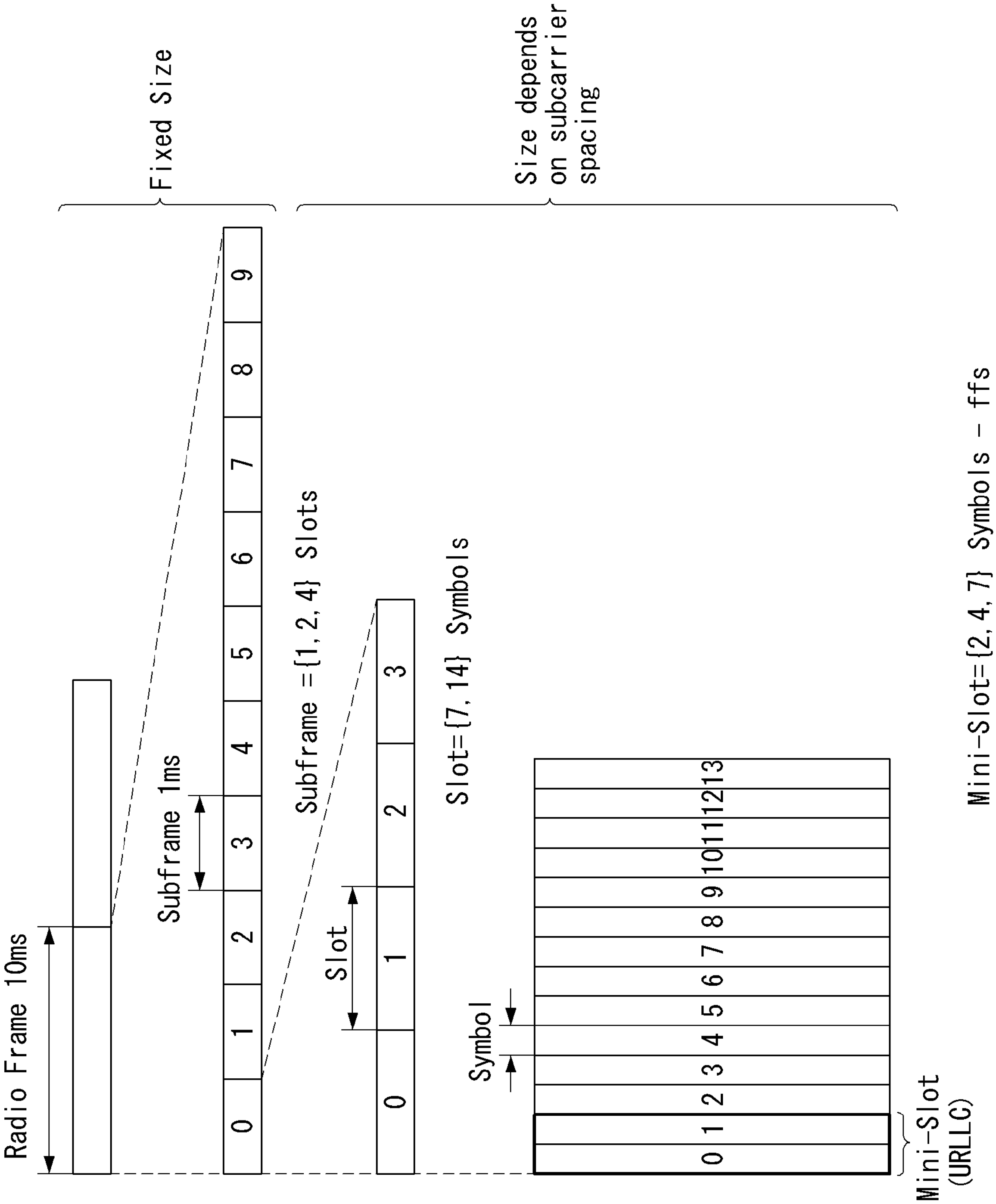
[Fig. 1]


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

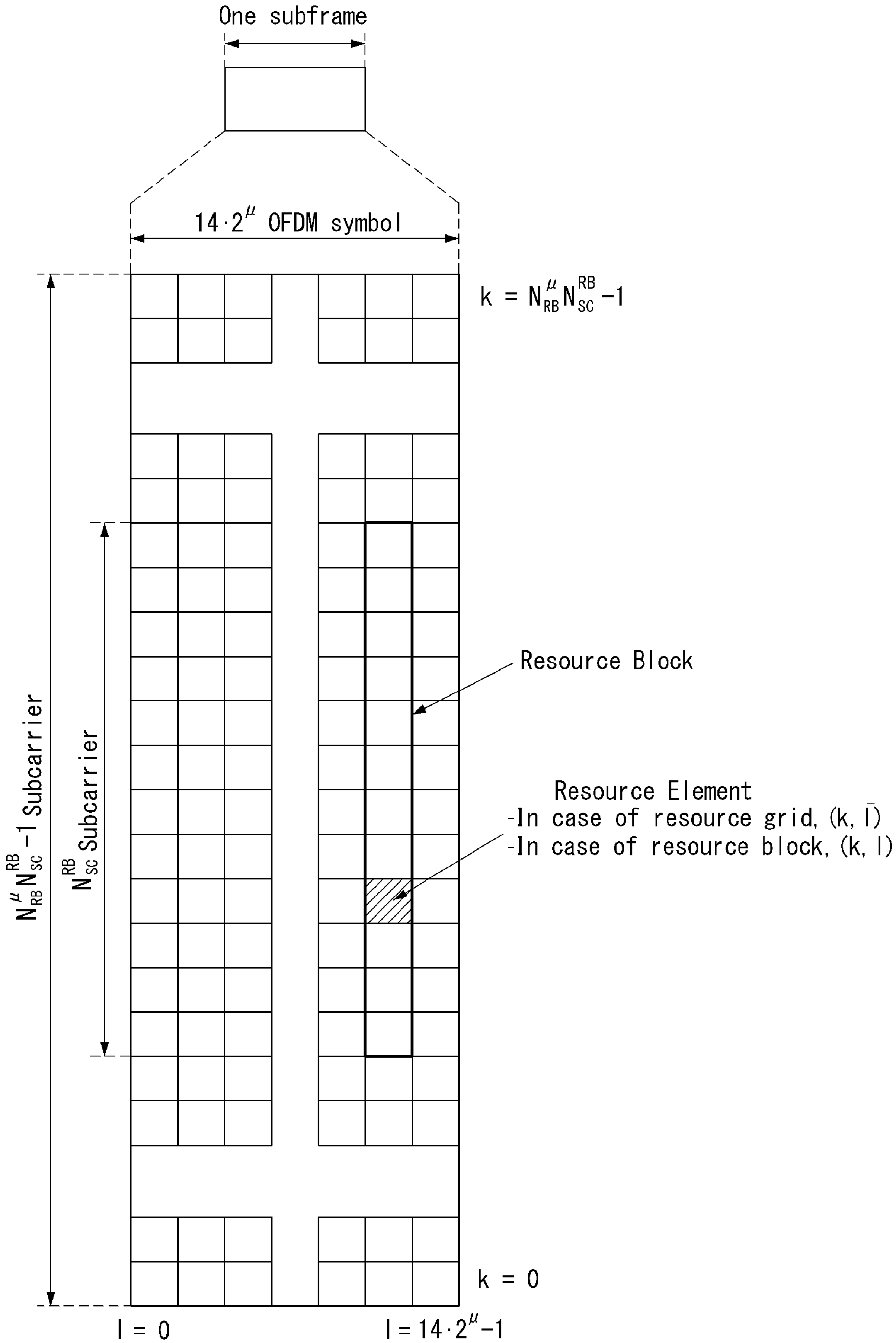
[Fig. 2]


Downlink Frame i
Uplink Frame i
$N_{TA}T_s$

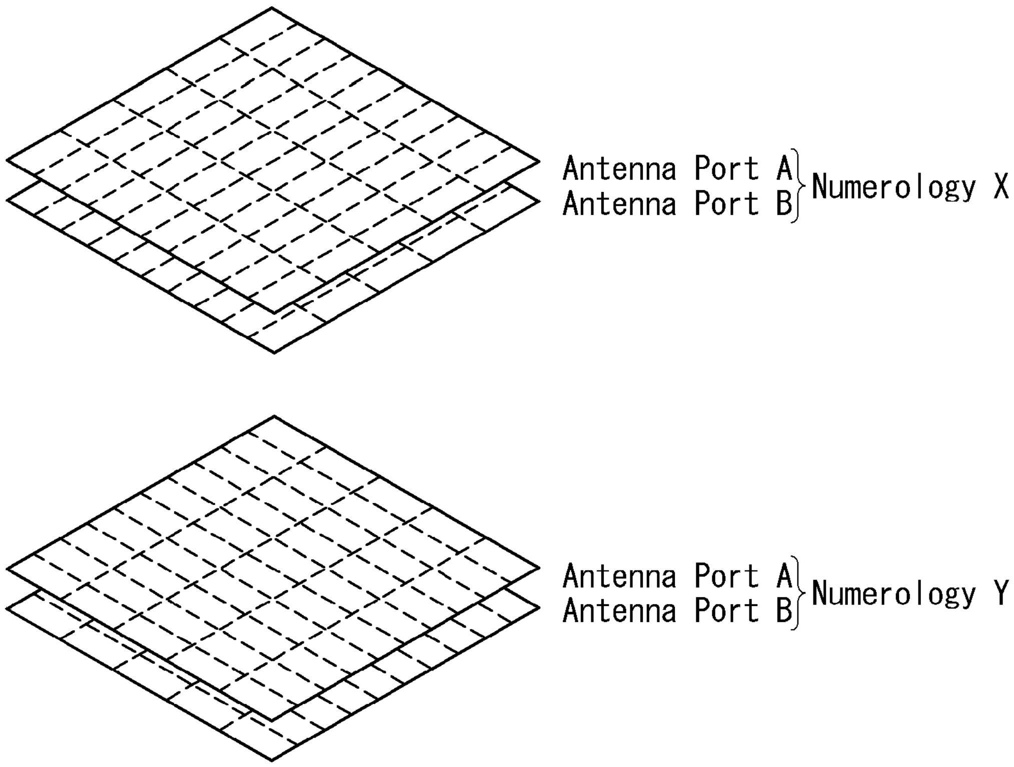
[Fig. 3]


Fixed Size
Size depends on subcarrier spacing
Radio Frame 10ms
Subframe 1ms
Subframe ={1, 2, 4} Slots
Slot
Slot={7, 14} Symbols
Symbol
Mini-Slot={2, 4, 7} Symbols - ffs
Mini-Slot (URLLC)
0 1 2 3 4 5 6 7 8 9
0 1 2 3
0 1 2 3 4 5 6 7 8 9 10 11 12 13

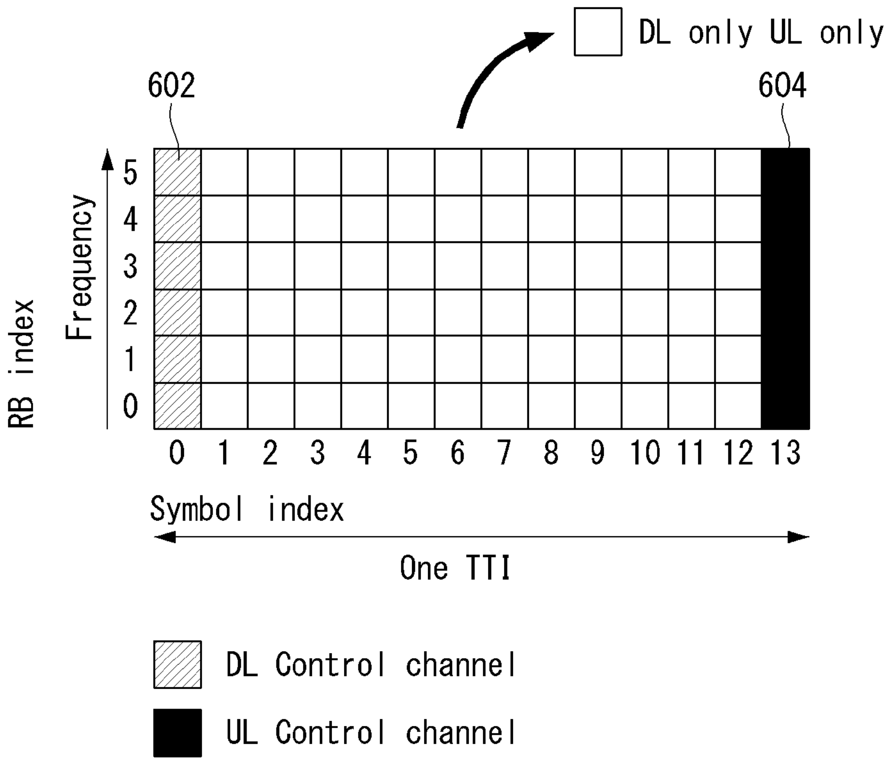
[Fig. 4]


One subframe
14·2^μ OFDM symbol
k = N^μ_RB N^RB_SC −1
Resource Block
Resource Element
-In case of resource grid, (k, l̄)
-In case of resource block, (k, l)
N^μ_RB N^RB_SC −1 Subcarrier
N^RB_SC Subcarrier
k = 0
l = 0
l = 14·2^μ−1

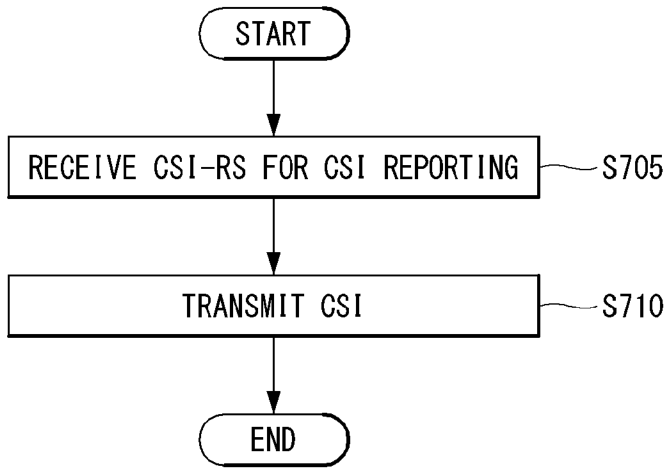
[Fig. 5]


Antenna Port A
Antenna Port B
Numerology X
Antenna Port A
Antenna Port B
Numerology Y

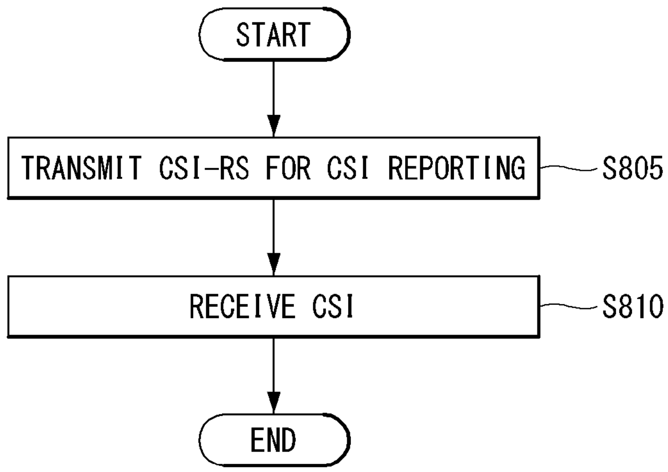
[Fig. 6]


DL only UL only
602
604
RB index
Frequency
5
4
3
2
1
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13
Symbol index
One TTI
DL Control channel
UL Control channel

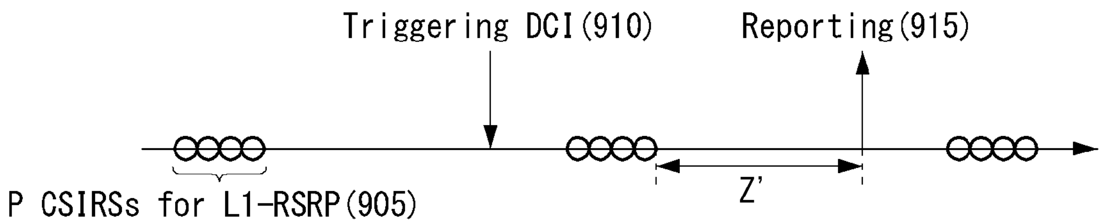
[Fig. 7]



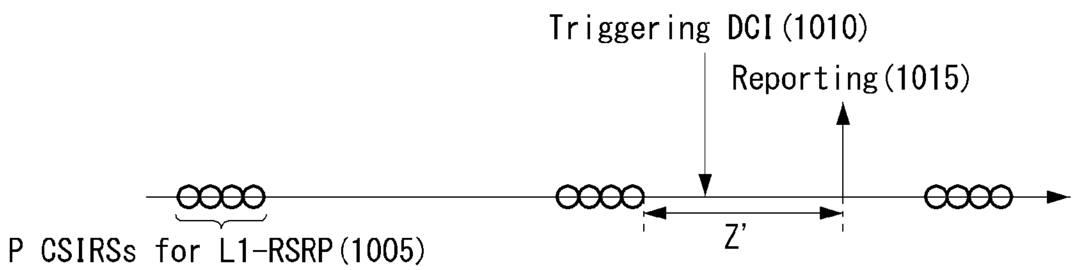
[Fig. 8]



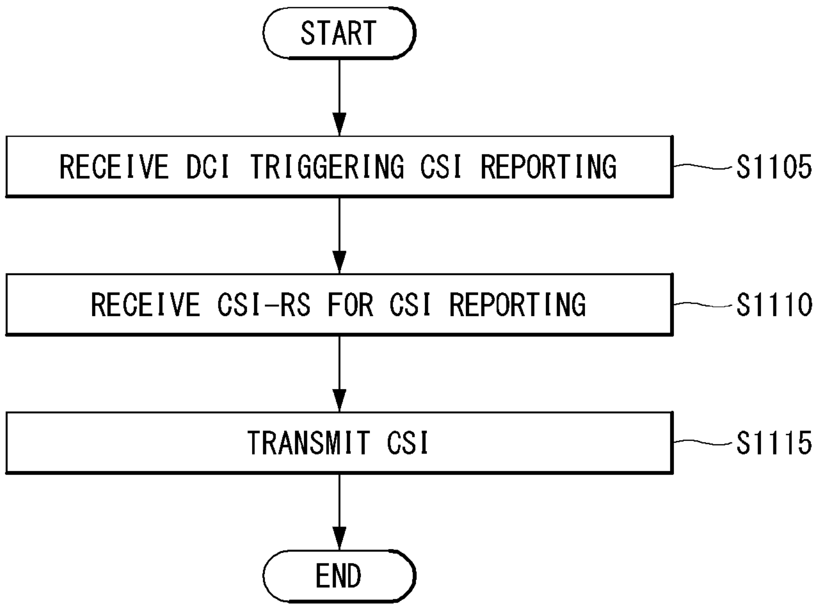
[Fig. 9]



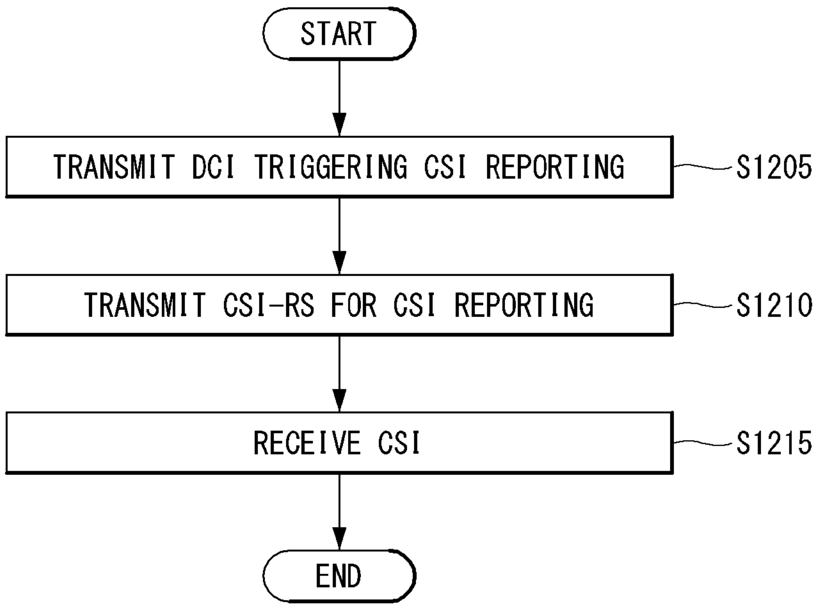
[Fig. 10]



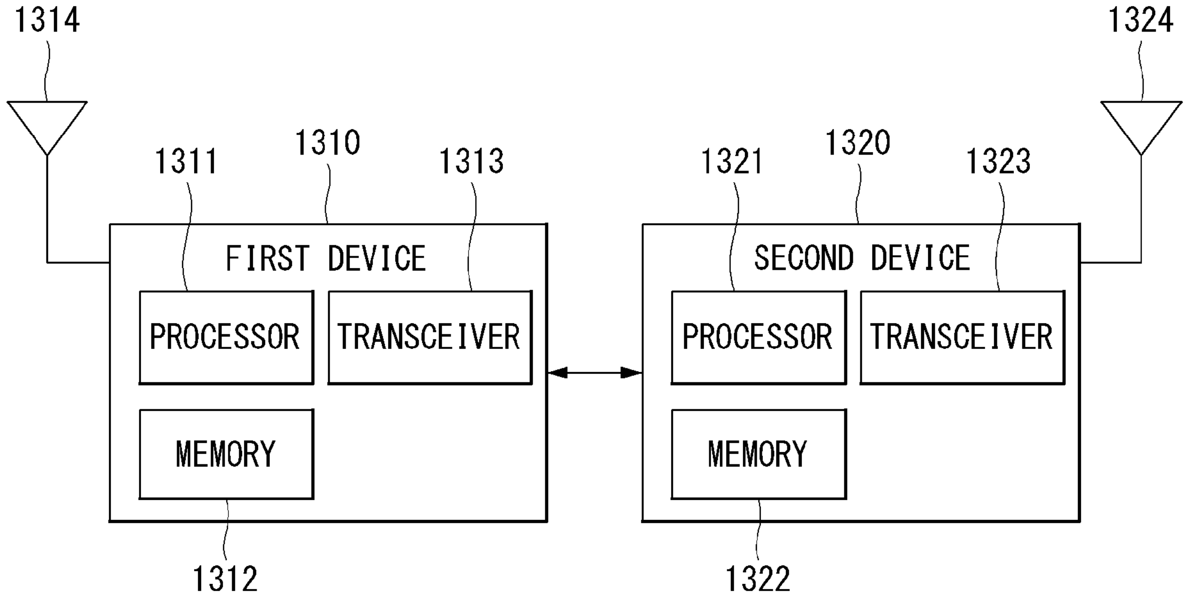
[Fig. 11]


START
RECEIVE DCI TRIGGERING CSI REPORTING
S1105
RECEIVE CSI-RS FOR CSI REPORTING
S1110
TRANSMIT CSI
S1115
END

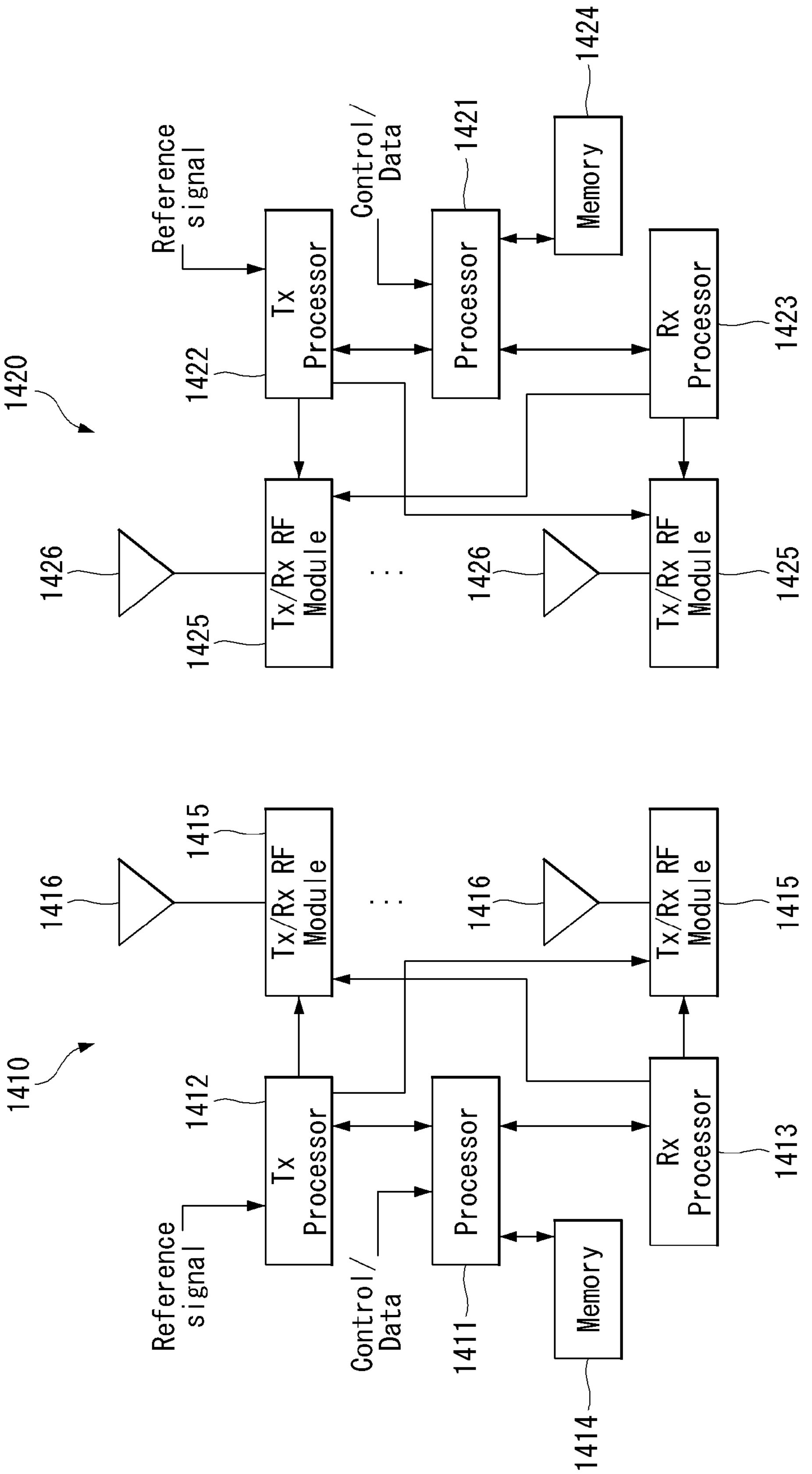
[Fig. 12]


START
TRANSMIT DCI TRIGGERING CSI REPORTING
S1205
TRANSMIT CSI-RS FOR CSI REPORTING
S1210
RECEIVE CSI
S1215
END

[Fig. 13]


1314
1324
1311
1310
1313
1321
1320
1323
FIRST DEVICE
SECOND DEVICE
PROCESSOR
TRANSCEIVER
PROCESSOR
TRANSCEIVER
MEMORY
MEMORY
1312
1322

[Fig. 14]


1420
Reference signal
Control/ Data
1424
1421
Memory
Tx Processor
Processor
Rx Processor
1422
1423
Tx/Rx RF Module
Tx/Rx RF Module
1426
1425
1410
1416
1415
1412
1411
1413
1414

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/009127

A. CLASSIFICATION OF SUBJECT MATTER

H04B 7/06(2006.01)i, H04B 7/0417(2017.01)i, H04W 24/10(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)
H04B 7/06; H04L 1/00; H04L 25/02; H04B 7/0417; H04W 24/10

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
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: channel state information (CSI), report, downlink control information (DCI), CSI-reference signal (CSI-RS), minimum required time

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	LG ELECTRONICS, 'Discussion on aperiodic CSI report timing and relaxation', R1-1802192, 3GPP TSG RAN WG1 Meeting #92, Athens, Greece, 16 February 2018 See pages 4-5; table 1; figure 3 of page 4.	1,8,15 2-7,9-14
Y	LG ELECTRONICS, 'Remaining issues on CSI reporting', R1-1806609, 3GPP TSG RAN WG1 Meeting #93, Busan, Korea, 12 May 2018 See pages 1-2.	2-7,9-14
X	INTERDIGITAL, INC., 'Remaining issues on CSI reporting', R1-1802618, 3GPP TSG RAN WG1 Meeting #92, Athens, Greece, 17 February 2018 See page 3; and figure 1.	1,8,15
X	INTERDIGITAL, INC., `Remaining issues on CSI reporting`, R1-1718481, 3GPP TSG RAN WG1 #90bis, Prague, Czech Republic, 03 October 2017 See pages 1-4 and figure 5.	1,8,15
X	NTT DOCOMO, `Remaining issues on CSI reporting`, R1-1802470, 3GPP TSG RAN WG1 Meeting #92, Athens, Greece, 17 February 2018 See section 6, proposal 9 and Figure 3.	1,8,15

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"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
05 December 2019 (05.12.2019)	**06 December 2019 (06.12.2019)**

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/009127

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ERICSSON, `Summary of views on CSI reporting v8`, R1-1805692, 3GPP TSG RAN WG1 #92bis, Sanya, China, 24 April 2018 See pages 4-7 and Table 2.	1-15
A	CN 107294643 A (ZTE CORPORATION) 24 October 2017 See the whole document.	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2019/009127

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 107294643 A	24/10/2017	US 2019-0132099 A1	02/05/2019
		WO 2017-167160 A1	05/10/2017