METHODS AND APPARATUSES FOR CSI OMISSION

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to methods and apparatuses for channel state information (CSI) omission.

BACKGROUND

[0002] A wireless communications system may include one or multiple network communication devices, such as base stations (BSs), which may support wireless communications for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communications system may support wireless communications with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers, or the like). Additionally, the wireless communications system may support wireless communications across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

SUMMARY

[0003] An article "a" before an element is unrestricted and understood to refer to "at least one" of those elements or "one or more" of those elements. The terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. As used herein, including in the claims, "or" as used in a list of items (e.g., a list of items prefaced by a phrase such as "at least one of" or "one or more of" or "one or both of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as "based on condition A" may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be

construed in the same manner as the phrase "based at least in part on." Further, as used herein, including in the claims, a "set" may include one or more elements.

[0004] Some implementations of the methods and apparatuses described herein may include a UE for wireless communication. The UE may include: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the UE to: receive configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CSI reference signal (CSI-RS) resource indicator (CRI); and transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0005] In some implementations of the UE described herein, the CSI omission scheme is based on an order of priority levels associated with the plurality of information groups.

[0006] In some implementations of the UE described herein, each priority level is associated with N information groups of the plurality of information groups, wherein N is a positive integer.

[0007] In some implementations of the UE described herein, N is 1, 2, M/2, or M, and M is a number of the plurality of information groups.

[0008] In some implementations of the UE described herein, the priority levels associated with the plurality of information groups are decreased according to an increasing order of values of CRIs associated with the plurality of information groups, or determined based on an order of CSI-RS resources associated with the plurality of information groups in a CSI-RS resource set or an order of quality related metrics associated with the plurality of information groups.

[0009] In some implementations of the UE described herein, according to the CSI omission scheme, group 0 CSI for all of the plurality of information groups of the at least one CSI report and for CSI report(s) other than the at least one CSI report in the plurality of CSI reports has a higher priority reporting level than group 1 CSI and group 2 CSI for any of the plurality of information groups of the at least one CSI report and any CSI report other than the at least one CSI report in the plurality of CSI reports, or part 2 wideband CSI for all of the plurality of information groups of the at least one CSI report and CSI report(s) other than the at least one CSI report in the plurality of CSI reports has a higher priority reporting level than part 2 subband

CSI of even subbands and part 2 subband CSI of odd subbands for any of the plurality of information groups of the at least one CSI report and any CSI report other than the at least one CSI report in the plurality of CSI reports.

[0010] In some implementations of the UE described herein, a packing order of group 0 CSI or part 2 wideband CSI corresponding to the plurality of information groups for each of the at least one CSI report is based on the order of the priority levels associated with the plurality of information groups.

[0011] In some implementations of the UE described herein, according to the CSI omission scheme, in the case that group 1 CSI, group 2 CSI, part 2 subband CSI of even subbands, or part 2 subband CSI of odd subbands for an information group is omitted from a CSI report of the at least one CSI report, group 0 CSI or part 2 wideband CSI for the information group is omitted from all of the at least one CSI report.

[0012] In some implementations of the UE described herein, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports or part 2 subband CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to a decreasing order of the priority levels associated with the plurality of information groups, and thirdly according to an increasing order of CSI group indexes or an order of frequency domain types, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0013] In some implementations of the UE described herein, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports or part 2 subband CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to an increasing order of CSI group indexes or an order of frequency domain types, and thirdly according to a decreasing order of the priority levels associated with the plurality of information groups, wherein the order of frequency domain types indicates that part 2 subband

CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0014] In some implementations of the UE described herein, in the case that the plurality of CSI reports are a plurality of CSI sub-reports, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports are decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to a decreasing order of the priority levels associated with the plurality of information groups, and fourthly according to an increasing order of CSI group indexes or an order of frequency domain types, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0015] In some implementations of the UE described herein, in the case that the plurality of CSI reports are a plurality of CSI sub-reports, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports are decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to an increasing order of CSI group indexes or an order of frequency domain types, and fourthly according to a decreasing order of the priority levels associated with the plurality of information groups, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0016] In some implementations of the UE described herein, an order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the at least one CSI

report is determined based on report index(es) associated with the at least one CSI report and the priority levels associated with the plurality of information groups.

[0017] In some implementations of the UE described herein, for each of the at least one CSI report, the priority reporting levels for CSI parts corresponding to the plurality of information groups are decreased according to a decreasing order of the priority levels associated with the plurality of information groups.

[0018] In some implementations of the UE described herein, in the case that the at least CSI report is at least one CSI sub-report, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, an order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the at least one CSI sub-report is determined based on report index(es) associated with corresponding CSI report(s) of the at least one CSI sub-report, index(es) of corresponding CSI sub-configuration(s) associated with the at least one CSI sub-report, and the priority levels associated with the plurality of information groups.

[0019] In some implementations of the UE described herein, for each of the at least one CSI sub-report, the priority reporting levels for CSI parts corresponding to the plurality of information groups are decreased firstly according to an increasing order of index(es) of corresponding CSI sub-configuration(s) associated with the at least one CSI sub-report, and secondly according to a decreasing order of the priority levels associated with the plurality of information groups.

[0020] In some implementations of the UE described herein, the CSI omission scheme includes one or more information groups for CSI reporting selected by the UE from the plurality of information groups.

[0021] In some implementations of the UE described herein, the CSI omission scheme includes one or more information groups for CSI reporting selected by the UE from the plurality of information groups and based on the order of the priority levels associated with the plurality of information groups.

[0022] In some implementations of the UE described herein, the configuration information includes information for indicating or updating the order of the priority levels associated with the plurality of information groups.

[0023] In some implementations of the UE described herein, the configuration information indicates priority levels associated with a set of information groups for CSI reporting with more than 32 CSI-RS ports, wherein the set of information groups includes the plurality of information groups, and each information group in the set of information groups is associated with a corresponding CRI.

[0024] In some implementations of the UE described herein, the configuration information indicates a corresponding priority level for each information group in the set of information groups.

[0025] In some implementations of the UE described herein, the configuration information includes a bit map, and each bit in the bit map is associated with a corresponding information group in the set of information groups and indicates whether the corresponding information group has a high priority level or a low priority level.

[0026] In some implementations of the UE described herein, the configuration information is received via radio resource control (RRC) signaling or medium access control (MAC) control element (CE).

[0027] In some implementations of the UE described herein, the at least one processor is configured to cause the UE to select a number of the plurality of information groups.

[0028] In some implementations of the UE described herein, the number of the plurality of information groups is selected such that it is not needed to perform CSI omission for any of the plurality of information groups.

[0029] Some implementations of the methods and apparatuses described herein may include a processor for wireless communication. The processor may include: at least one controller coupled with at least one memory and configured to cause the processor to: receive configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of

information groups is associated with a CRI; and transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0030] Some implementations of the methods and apparatuses described herein may include a BS for wireless communication. The BS may include: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the BS to: transmit configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI; and receive one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0031] Some implementations of the methods and apparatuses described herein may include a method performed by a UE. The method may include: receiving configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI; and transmitting one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0032] Some implementations of the methods and apparatuses described herein may include a method performed by a BS. The method may include: transmitting configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI; and receiving one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] In order to describe the manner in which advantages and features of the application can be obtained, a description of the application is rendered by reference to specific embodiments thereof, which are illustrated in the appended drawings. These drawings depict

only example embodiments of the application and are not therefore to be considered limiting of its scope.

[0034] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0035] Figure 2 illustrates a flowchart of an exemplary method performed by a UE in accordance with aspects of the present disclosure.

[0036] Figure 3 illustrates a flowchart of an exemplary method performed by a BS in accordance with aspects of the present disclosure.

[0037] Figure 4 illustrates an example of a UE in accordance with aspects of the present disclosure.

[0038] Figure 5 illustrates an example of a processor in accordance with aspects of the present disclosure.

[0039] Figure 6 illustrates an example of a BS in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0040] The detailed description of the appended drawings is intended as a description of preferred embodiments of the present application and is not intended to represent the only form in which the present application may be practiced. It should be understood that the same or equivalent functions may be accomplished by different embodiments that are intended to be encompassed within the spirit and scope of the present application.

[0041] While operations are depicted in the drawings in a particular order, persons skilled in the art will readily recognize that such operations need not be performed in the particular order as shown or in a sequential order, or that all illustrated operations need be performed, to achieve desirable results; sometimes one or more operations can be skipped. Further, the drawings can schematically depict one or more example processes in the form of a flow diagram. However, other operations that are not depicted can be incorporated in the example processes that are schematically illustrated. For example, one or more additional operations can be

performed before, after, simultaneously, or between any of the illustrated operations. In certain circumstances, multitasking and parallel processing can be advantageous.

[0042] Reference will now be made in detail to some embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. To facilitate understanding, embodiments of the present disclosure are provided under specific network architectures and service scenarios, such as 3rd generation partnership project (3GPP) long-term evolution (LTE) and LTE advanced, 3GPP 5G new radio (NR), 5G-Advanced, 6G, and so on. It is contemplated that along with developments of network architectures and new service scenarios, all embodiments in the present disclosure are also applicable to similar technical problems; and moreover, the terminologies recited in the present disclosure may change, which should not affect the principle of the present disclosure.

[0043] Aspects of the present disclosure are described in the context of a wireless communications system.

[0044] Figure 1 illustrates an example of a wireless communications system 100 in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more network equipments (NEs) (e.g., BSs) 102, one or more UEs 104, and a core network (CN) 106. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be an NR network, such as a 5G network, a 5G-Advanced (5G-A) network, or a 5G ultrawideband (5G-UWB) network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G, for example, 6G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0045] The one or more NEs 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the NEs 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a network function, a network entity, a radio access network (RAN), a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. An NE 102 and a UE 104 may communicate via a communication link, which may be a wireless or wired connection. For example, an NE 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0046] An NE 102 may provide a geographic coverage area for which the NE 102 may support services for one or more UEs 104 within the geographic coverage area. For example, an NE 102 and a UE 104 may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, an NE 102 may be moveable, for example, a satellite associated with a non-terrestrial network (NTN). In some implementations, different geographic coverage areas associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with different NEs 102.

[0047] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a remote unit, a mobile device, a wireless device, a remote device, a subscriber device, a transmitter device, a receiver device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples.

[0048] A UE 104 may be able to support wireless communication directly with other UEs 104 over a communication link. For example, a UE 104 may support wireless communication directly with another UE 104 over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link may be referred to as a

sidelink. For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0049] An NE 102 may support communications with the CN 106, or with another NE 102, or both. For example, an NE 102 may interface with other NE 102 or the CN 106 through one or more backhaul links (e.g., S1, N2, N2, or network interface). In some implementations, the NEs 102 may communicate with each other directly. In some other implementations, the NEs 102 may communicate with each other indirectly (e.g., via the CN 106). In some implementations, one or more NEs 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as radio heads, smart radio heads, or transmission-reception points (TRPs).

[0050] The CN 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The CN 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management function (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more NEs 102 associated with the CN 106.

[0051] The CN 106 may communicate with a packet data network over one or more backhaul links (e.g., via an S1, N2, N2, or another network interface). The packet data network may include an application server. In some implementations, one or more UEs 104 may communicate with the application server. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the CN 106 via an NE 102. The CN 106 may route traffic (e.g., control information, data, and the like) between the UE 104 and the application server using the established session (e.g., the established PDU session). The PDU session may

be an example of a logical connection between the UE 104 and the CN 106 (e.g., one or more network functions of the CN 106).

[0052] In the wireless communications system 100, the NEs 102 and the UEs 104 may use resources of the wireless communications system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communications). In some implementations, the NEs 102 and the UEs 104 may support different resource structures. For example, the NEs 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the NEs 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the NEs 102 and the UEs 104 may support various frame structures (e.g., multiple frame structures). The NEs 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0053] One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., μ=0) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., μ=0) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., μ=1) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., μ=2) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., μ=3) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., μ=4) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0054] A time interval of a resource (e.g., a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (ms) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1 ms duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a frame may have the same duration.

[0055] Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For instance, the first, second, third, fourth, and fifth numerologies (e.g., μ=0, μ=1, μ=2, μ=3, μ=4) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., orthogonal frequency division multiplexing (OFDM) symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., μ=0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0056] In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the NEs 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the NEs 102 and the UEs 104, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the NEs 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0057] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., μ=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., μ=1), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., μ=3), which includes 120 kHz subcarrier spacing.

[0058] To improve a cell coverage and achieve a higher downlink spectrum efficiency, larger antenna arrays for single transmission point transmissions with an increased number of antennas have an increased interest in the industry, partly due to new available frequency bands (e.g., 7GHz frequency band(s)). In such cases, enhancements to existing specifications that support both hybrid beamforming (e.g., with one beam for each downlink (DL) transmission) and fully digital beamforming are needed to maintain the cost-effectiveness and performance tradeoff in implementation.

[0059] In current specifications, the support for such large antenna arrays with a large number of CSI-RS ports for CSI measurement and reporting is limited. Therefore, it is needed to increase the number of CSI-RS ports for CSI reporting (up to 128 CSI-RS ports) and enhance hybrid beamforming to multi-beam reporting (e.g., with CSI per beam), so as to extend hybrid beamforming to larger antenna arrays and increase multiple input multiple output (MIMO) scheduling opportunities.

[0060] In the existing 5G system, the CSI-RS port is designed based on a maximum port number of 32. However, for the large antenna array, a larger number of CSI-RS ports (e.g., more than 32 ports) may be used to further increase beamforming gain, thereby improving the cell coverage and cell average/edge throughput. Herein, the terms "port," "CSI-RS port," "antenna port" and "CSI-RS antenna port" may be used interchangeably.

[0061] For a large antenna array with more than 32 CSI-RS ports (e.g., up to 128 CSI-RS ports), multiple legacy CSI-RS resources may be used jointly for generating a CSI-RS resource with more than 32 CSI-RS ports. For example, a UE may be configured with K_S CSI-RS

resources with an equal number of CSI-RS ports per CSI-RS resource for generating a CSI-RS resource with more than 32 CSI-RS ports. The number of CSI-RS ports per CSI-RS resource may be less than or equal to 32. As an example, exemplary supported combinations of K_S values and corresponding maximum numbers of CSI-RS ports per CSI-RS resource are shown in the following Table 1.

Table 1

K_S	Maximum number of CSI-RS ports per CSI-RS resource
2, 3, 4	32
5, 6, 7, 8	16

[0062] The UE may perform measurement on each CSI-RS resource of the K_S CSI-RS resources and obtain a corresponding information group for each CSI-RS resource. An information group may be associated with a CRI of a corresponding CSI-RS resource. As an example, an information group may at least include a CRI, a rank indicator (RI), a precoding matrix indicator (PMI), and a channel quality indicator (CQI). An information group consisting of CRI, RI, PMI, and CQI may be referred to as a quadruplet.

[0063] The UE may include M ($M \leq K_S$) information groups in a CSI report and transmit the CSI report to a BS. The value of M may be configured by the BS via RRC signaling or may be selected by the UE.

[0064] A CSI report may include one part or two parts. For a CSI report with two parts (i.e., part 1 and part 2), part 1 of the CSI report (also referred to as part 1 CSI herein) may have a fixed payload size and is used to identify the number of information bits in part 2 of the CSI report (also referred to as part 2 CSI herein), and part 2 of the CSI report may include CSI (e.g., at least one of CQI, PMI, or RI). In some cases, the uplink channel quality may be not good enough to carry all the bits of CSI reports to be transmitted, the UE may omit some of the CSI reports or some information from the CSI reports. In 3GPP release 15 (Rel.15), release 16 (Rel.16), and release 17 (Rel.17), the CSI omission may be performed based on priority reporting levels associated with the CSI reports to be transmitted or associated with information in each CSI report.

[0065] As an example, for CSI reports with two parts transmitted on physical uplink control channel (PUCCH) or on physical uplink shared channel (PUSCH), the UE may omit a portion of the part 2 CSI according to the priority reporting levels defined in the following Table 2, which is the same as Table 5.2.3-1 as specified in 3GPP specification TS 38.214.

Table 2

Priority 0: For CSI reports 1 to N_{Rep}, Group 0 CSI for CSI reports configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 wideband CSI for CSI reports configured otherwise
Priority 1: Group 1 CSI for CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for CSI report 1, if configured otherwise
Priority 2: Group 2 CSI for CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for CSI report 1, if configured otherwise
Priority 3: Group 1 CSI for CSI report 2, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for CSI report 2, if configured otherwise
Priority 4: Group 2 CSI for CSI report 2, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for CSI report 2, if configured otherwise

⋮
Priority $2N_{Rep}-1$: Group 1 CSI for CSI report N_{Rep}, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for CSI report N_{Rep}, if configured otherwise
Priority $2N_{Rep}$: Group 2 CSI for CSI report N_{Rep}, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for CSI report N_{Rep}, if configured otherwise

[0066] Definitions for group 0 CSI (i.e., CSI group index is 0), group 1 CSI (i.e., CSI group index is 1), group 2 CSI (i.e., CSI group index is 2), part 2 wideband CSI and part 2 subband CSI can be found in TS 38.214 and are omitted here for simplicity.

[0067] In Table 2, N_{Rep} is the number of CSI reports configured to be carried on PUSCH or PUCCH. Priority 0 is the highest priority reporting level and priority $2N_{Rep}$ is the lowest priority reporting level. CSI report n (also referred to as CSI report with report index of n) in Table 2 corresponds to a CSI report with the nth smallest $\mathrm{Pri}_{iCSI}(y,k,c,s)$ value among the N_{Rep} CSI reports, where $\mathrm{Pri}_{iCSI}(y,k,c,s)$ may be defined by the following formula (1) as specified in TS 38.214:

$$\mathrm{Pri}_{iCSI}(y,k,c,s) = 2 \cdot N_{cells} \cdot M_s \cdot y + N_{cells} \cdot M_s \cdot k + M_s \cdot c + s \qquad (1).$$

[0068] Definitions for the parameters in formula (1) can be found in TS 38.214 and are omitted here for simplicity.

[0069] Based on formula (1), a first CSI report is said to have a higher priority over a second CSI report if $\mathrm{Pri}_{iCSI}(y,k,c,s)$ value of the first CSI report is lower than that of the second CSI report.

[0070] In general, an order of the priority reporting levels from high to low as shown in Table 2 may be described as follows: group 0 CSI or part 2 wideband CSI for all CSI reports,

followed by group 1 CSI or part 2 subband CSI of even subbands for CSI report 1, group 2 CSI or part 2 subband CSI of odd subbands for CSI report 1, …, until group 2 CSI or part 2 subband CSI of odd subbands for CSI report N_{Rep}.

[0071] The UE may omit CSI level by level according to an order of the priority reporting levels shown in Table 2, beginning from the lowest priority reporting level until the remaining CSI meets uplink channel quality requirements (e.g., meet a target data rate requirement). When omitting CSI for a particular priority reporting level, the UE may omit all of the CSI at that priority reporting level.

[0072] As another example, for CSI reports with one part transmitted on PUCCH, the UE may omit some of the CSI reports. For example, for N_{Rep} CSI reports to be reported, priority reporting levels of the N_{Rep} CSI reports may be decreased according to an increasing order of report indexes of the N_{Rep} CSI reports. The report indexes of the N_{Rep} CSI reports may be determined based on the aforementioned $\mathrm{Pri}_{iCSI}(y,k,c,s)$ values defined by formula (1), wherein a CSI report with index n (i.e., CSI report n) corresponds to a CSI report with the nth smallest $\mathrm{Pri}_{iCSI}(y,k,c,s)$ value among the N_{Rep} CSI reports.

[0073] In such example, The UE may omit CSI reports according to an order of the priority reporting levels, beginning from the lowest priority reporting level until the remaining CSI reports meets uplink channel quality requirements (e.g., a code rate of the remaining CSI reports is less than or equal to a maximum code rate or a CSI overhead of the remaining CSI reports is no larger than a maximum number of bits carried by PUSCH or PUCCH corresponding to the maximum code rate).

[0074] For CSI reporting with more than 32 CSI-RS ports, multiple information groups may be included in a CSI report with each information group associated with a CRI, and thus the CSI reporting payload may be increased. When the uplink channel quality is not good enough to carry CSI bits for all the CSI reports, how to perform CSI omission needs to be further studied.

[0075] Embodiments of the present disclosure provide solutions for CSI omission for multi-CRI based CSI reporting with more than 32 CSI-RS ports. For example, some embodiments of the present disclosure provide solutions regarding enhanced priority reporting levels with refiner omission granularity, the order of enhanced priority reporting levels, and packing schemes for

CSI parts. Some embodiments of the present disclosure provide solutions regarding UE's behaviors for CSI omission when a number of information groups for CSI reporting is selected by a UE. More details will be described in the following text in combination with the appended drawings.

[0076] For a large antenna array with more than 32 CSI-RS ports (e.g., up to 128 CSI-RS ports), a UE may be configured with K_S CSI-RS resources with an equal number of CSI-RS ports per CSI-RS resource for generating a CSI-RS resource with more than 32 CSI-RS ports. Exemplary supported combinations of K_S values and corresponding maximum numbers of CSI-RS ports per CSI-RS resource are shown in the aforementioned Table 1.

[0077] The UE may perform measurement on each CSI-RS resource of the K_S CSI-RS resources and obtain a corresponding information group for each CSI-RS resource. Consequently, the UE may obtain K_S information groups for the K_S CSI-RS resources. An information group may be associated with a CRI of a corresponding CSI-RS resource. As an example, an information group may at least include a CRI, an RI, a PMI, and a CQI. An information group consisting of CRI, RI, PMI, and CQI may be referred to as a quadruplet.

[0078] According to some embodiments of the present application, a UE may receive, from a BS, configuration information for a plurality of CSI reports. As an example, the configuration information may indicate a number (e.g., denoted as N_{rep}) of the plurality of CSI reports and a K_S value as described above. In some examples, the configuration information may be transmitted via RRC signaling.

[0079] In the plurality of CSI reports, at least one CSI report (e.g., L CSI report(s), $L \geqslant 1$) may include a plurality of information groups (e.g., M information groups, $M \leq K_S$), wherein each information group is associated with a CRI. The value of M may be configured by the BS via RRC signaling or may be selected by the UE. Different CSI reports may include different number of information groups.

[0080] In some cases, the uplink channel quality may be not good enough to carry all of the plurality of CSI reports. Then, the UE may transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme. The CSI omission scheme may be associated

with the plurality of information groups. The following embodiments provide several CSI omission schemes.

[0081] **Embodiment 1**

[0082] In Embodiment 1, the CSI omission scheme may be based on an order of priority levels associated with the plurality of information groups.

[0083] In some embodiments, each priority level may be associated with N information groups of the plurality of information groups, wherein N is a positive integer. For example, N may be 1, 2, M/2, or M, wherein M is a number of the plurality of information groups.

[0084] In some embodiments, the priority levels associated with the plurality of information groups may be decreased according to an increasing order of indexes associated with the plurality of information groups.

[0085] As stated above, each information group is associated with a CRI. An information group with a higher index may be associated with a CRI with a higher value. In such embodiments, the priority levels associated with the plurality of information groups may be decreased according to an increasing order of values of CRIs associated with the plurality of information groups.

[0086] In some embodiments, the priority levels associated with the plurality of information groups may be determined based on an order of CSI-RS resources associated with the plurality of information groups in a CSI-RS resource set (e.g., a CSI-RS resource set consisting of the configured K_S CSI-RS resources). For example, an information group associated with a CSI-RS resource which has a smaller index in the CSI-RS resource set has a higher priority level. In an embodiment, the order of CSI-RS resources may be configured by RRC signaling.

[0087] In some embodiments, the priority levels associated with the plurality of information groups may be determined based on an order of quality related metrics associated with the plurality of information groups. For example, the priority levels associated with the plurality of information groups may be decreased according to an increasing order of reference signal receiving power (RSRP) values associated with the plurality of information groups.

[0088] Based on whether each CSI report includes two parts or one part, Embodiment 1 may include Embodiment 1-1 and Embodiment 1-2.

[0089] **Embodiment 1-1**

[0090] In Embodiment 1-1, each CSI report of the plurality of CSI reports may include two parts (i.e., part 1 and part 2) transmitted on PUCCH or on PUSCH. In such embodiment, the UE may omit a portion of the part 2 CSI.

[0091] In Embodiment 1-1, the priority reporting levels as shown in Table 2 may be enhanced for finer granularity based on an order of priority levels associated with the plurality of information groups.

[0092] Embodiment 1-1 may further include Scheme 1 and Scheme 2.

[0093] **Scheme 1**

[0094] In Scheme 1, the enhanced priority reporting levels for CSI may be determined based on at least one of the following principles:

- group 0 CSI (including those for all information groups) for the plurality of CSI reports has a higher priority reporting level than group 1 CSI and group 2 CSI for the plurality of CSI reports - in other words, group 0 CSI for all of the plurality of information groups of the L CSI report(s) and for CSI report(s) other than the L CSI report(s) in the plurality of CSI reports has a higher priority reporting level than group 1 CSI and group 2 CSI for any of the plurality of information groups of the L CSI report(s) and for any CSI report other than the L CSI report(s) in the plurality of CSI reports;
- part 2 wideband CSI (including those for all information groups) for the plurality of CSI reports has a higher priority reporting level than part 2 subband CSI of even subbands and part 2 subband CSI of odd subbands for the plurality of CSI reports - in other words, part 2 wideband CSI for all of the plurality of information groups of the L report(s) and for CSI report(s) other than the L CSI report(s) in the plurality of CSI reports has a higher priority reporting level than part 2 subband CSI of even subbands and part 2 subband CSI of odd subbands for any of the plurality of information groups of the L CSI report(s) and for any CSI report other than the L CSI report(s) in the plurality of CSI reports;

- priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to a decreasing order of the priority levels associated with the plurality of information groups, and thirdly according to an increasing order of CSI group indexes (referring to group 1 CSI has a higher priority reporting level than group 2 CSI); or
- priority reporting levels for part 2 subband CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to a decreasing order of the priority levels associated with the plurality of information groups, and thirdly according to an order of frequency domain types, e.g., the order of frequency domain types may indicate that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0095] As aforementioned, the report indexes associated with the plurality of CSI reports may be determined based on their $\mathrm{Pri}_{iCSI}(y,k,c,s)$ values defined by the aforementioned formula (1). A CSI report with index n may correspond to a CSI report with the nth smallest $\mathrm{Pri}_{iCSI}(y,k,c,s)$ value among the plurality of CSI reports.

[0096] In Scheme 1, a packing order for the plurality of CSI reports may be based on (e.g., the same as) the aforementioned order of the enhanced priority reporting levels.

[0097] In some cases, group 0 CSI or part 2 wideband CSI for all of the plurality of CSI reports may have the same priority reporting level, i.e., the highest priority reporting level.

[0098] In such cases, a packing order of group 0 CSI or part 2 wideband CSI for the plurality of CSI reports may be firstly based on an increasing order of report indexes associated with the plurality of CSI reports. For each CSI report including the plurality of information groups, a packing order of group 0 CSI or part 2 wideband CSI corresponding to the plurality of information groups may be based on (e.g., the same as) the priority levels associated with the plurality of information groups. For example, group 0 CSI or part 2 wideband CSI corresponding to an information group with a higher priority level is placed in front of that corresponding to an information group with a lower priority level in the packing order.

[0099]

[0100] As an example of Scheme 1, for a CSI report including M information groups (e.g., denoted as information group 0 to information group M-1) where the priority levels associated with the M information groups are decreased based on an increasing order of the indexes of the M information groups, an order of priority reporting levels and a packing order for CSI may be as follows, wherein CSI in front has a higher priority reporting level:

- group 0 CSI or part 2 wideband CSI for all of the M information groups, group 1 CSI or part 2 subband CSI of even subbands for information group 0, group 2 CSI or part 2 subband CSI of odd subbands for information group 0, group 1 CSI or part 2 subband CSI of even subbands for information group 1, group 2 CSI or part 2 subband CSI of odd subbands for information group 1, ..., group 1 CSI or part 2 subband CSI of even subbands for information group M-1, and group 2 CSI or part 2 subband CSI of odd subbands for information group M-1.

[0101] In some other cases, group 0 CSI or part 2 wideband CSI for the plurality of CSI reports may have different priority reporting levels which are based on the priority levels associated with the M information groups. For example, an order of the priority reporting levels and a packing order for group 0 CSI or part 2 wideband CSI for the plurality of CSI reports may be as follows, wherein CSI in front has a higher priority reporting level:

- group 0 CSI or part 2 wideband CSI for information group 0 of the L CSI report(s) and for CSI report(s) other than the L CSI report(s) in the plurality of CSI reports, group 0 CSI or part 2 wideband CSI for information group 1 of the L CSI report(s), group 0 CSI or part 2 wideband CSI for information group 2 of the L CSI report(s), ..., group 0 CSI or part 2 wideband CSI for information group M-1 of the L CSI report(s).

[0102] As an example of Scheme 1, the following Table 3 illustrates exemplary enhanced priority reporting levels for part 2 CSI. Table 3 is generated based on Table 2.

Table 3

Priority 0: For CSI reports 1 to N_{Rep}, Group 0 CSI for M information groups for CSI reports configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 wideband CSI for M information groups for CSI reports configured otherwise
Priority 1: Group 1 CSI for information group 0 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for information group 0 of CSI report 1, if configured otherwise
Priority 2: Group 2 CSI for information group 0 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for information group 0 of CSI report 1, if configured otherwise
....
Priority 2M-1: Group 1 CSI for information group M-1 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for information group M-1 of CSI report 1, if configured otherwise
Priority 2M: Group 2 CSI for information group M-1 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for information group M-1 of CSI report 1, if configured otherwise
....

Priority $2MN_{Rep}$:
Group 2 CSI for information group M-1 of CSI report N_{Rep}, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for information group M-1 of CSI report N_{Rep}, if configured otherwise

[0103] In this example, it is assumed that each of the N_{Rep} CSI reports includes M information groups. Referring to Table 3, the priority reporting levels are decreased with the increasing priority values. That is, priority 0 indicates the highest priority reporting level, and priority $2MN_{Rep}$ indicates the lowest priority reporting level.

[0104] The difference between Table 3 and Table 2 is that: in Table 3, each of the N_{Rep} CSI reports includes M information groups, wherein the priority levels associated with the M information groups are decreased based on an increasing order of the indexes of the M information groups. Then, the reporting priority level for each CSI report illustrated in Table 2 may be refined based on Scheme 1, and thus $2N_{Rep}$ reporting priority levels in Table 2 may be refined to $2MN_{Rep}$ reporting priority levels.

[0105] The enhanced priority reporting levels illustrated in Table 3 are only for illustrative purpose. In some other examples, not all of the N_{Rep} CSI reports include more than one information group. In such examples, the priority reporting level for any CSI report which includes only one information group may refer back to Table 2 or skip priority reporting level(s) associated with information group(s) that the CSI report does not have. In some embodiments, the enhanced priority reporting levels may be not reflected in the form of a table, but indicated in 3GPP standard document in the form of text.

[0106] In Scheme 1, the UE may omit CSI level by level according to an order of the priority reporting levels, beginning from the lowest priority reporting level until the remaining CSI meets uplink channel quality requirements (e.g., meet a target data rate requirement). When omitting CSI for a particular priority reporting level, the UE may omit all of the CSI at that priority reporting level.

[0107] According to some embodiments, in the case that group 1 CSI, group 2 CSI, part 2 subband CSI of even subbands, or part 2 subband CSI of odd subbands for an information group is omitted from a CSI report, group 0 CSI or part 2 wideband CSI for the information group may be omitted from all the CSI report.

[0108] As aforementioned, each priority level may be associated with N information groups of the M information groups in a CSI report. In the case that N is larger than 1 (for example, N may be 2, M/2, or M), when CSI in a priority reporting level is omitted, all of the N information groups associated with the same priority level may be omitted simultaneously.

[0109] The order for the enhanced priority reporting levels in Scheme 1 may be used to protect CSI part corresponding to an information group. In this way, Scheme 1 may provide much CSI for an information group, including group 1 CSI and group 2 CSI, or part 2 subband CSI of even subbands and part 2 subband CSI of odd subbands. Scheme 1 is compatible with the existing CSI omission scheme, which can be deemed as the case that all the CSI reports include M information groups where M=1.

[0110] **Scheme 2**

[0111] In Scheme 2, the enhanced priority reporting levels for CSI may be determined based on at least one of the following principles:

- group 0 CSI (including those for all information groups) for the plurality of CSI reports has a higher priority reporting level than group 1 CSI and group 2 CSI for the plurality of CSI reports - in other words, group 0 CSI for all of the plurality of information groups of the L CSI report(s) and for CSI report(s) other than the L CSI report(s) in the plurality of CSI reports has a higher priority reporting level than group 1 CSI and group 2 CSI for any of the plurality of information groups of the L CSI report(s) and for any CSI report other than the L CSI report(s) in the plurality of CSI reports;
- part 2 wideband CSI (including those for all information groups) for the plurality of CSI reports has a higher priority reporting level than part 2 subband CSI of even subbands and part 2 subband CSI of odd subbands for the plurality of CSI reports - in other words, part 2 wideband CSI for all of the plurality of information groups of the L CSI report(s) and CSI report(s) other than the L CSI report(s) in the plurality of CSI reports has a higher priority

reporting level than part 2 subband CSI of even subbands and part 2 subband CSI of odd subbands for any of the plurality of information groups of the L CSI report(s) and for any CSI report other than the L CSI report(s) in the plurality of CSI reports;

- priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to an increasing order of CSI group indexes (referring to group 1 CSI has a higher priority reporting level than group 2 CSI), and thirdly according to a decreasing order of the priority levels associated with the plurality of information groups; or
- priority reporting levels for part 2 subband CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to an order of frequency domain types (e.g., the order of frequency domain types may indicate that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands), and thirdly according to a decreasing order of the priority levels associated with the plurality of information groups.

[0112] As aforementioned, the report indexes associated with the plurality of CSI reports may be determined based on their $\mathrm{Pri}_{iCSI}(y,k,c,s)$ values defined by the aforementioned formula (1). A CSI report with index n may correspond to a CSI report with the nth smallest $\mathrm{Pri}_{iCSI}(y,k,c,s)$ value among the plurality of CSI reports.

[0113] In scheme 2, a packing order for the plurality of CSI reports may be based on (e.g., the same as) the aforementioned order of the enhanced priority reporting levels.

[0114] In some cases, group 0 CSI or part 2 wideband CSI for all of the plurality of CSI reports may have the same priority reporting level, i.e., the highest priority reporting level.

[0115] In such cases, a packing order of group 0 CSI or part 2 wideband CSI for the plurality of CSI reports may be firstly based on an increasing order of report indexes associated with the plurality of CSI reports. For each CSI report including the plurality of information groups, a packing order of group 0 CSI or part 2 wideband CSI corresponding to the plurality of information groups may be based on (e.g., the same as) the priority levels associated with the plurality of information groups. For example, group 0 CSI or part 2 wideband CSI

corresponding to an information group with a higher priority level is placed in front of that corresponding to an information group with a lower priority level in the packing order.

[0116] As an example of Scheme 2, for a CSI report including M information groups (e.g., denoted as information group 0 to information group M-1) where the priority levels associated with the M information groups are decreased based on an increasing order of the indexes of the M information groups, an order of priority reporting levels and a packing order for CSI may be as follows, wherein CSI in front has a higher priority reporting level:

- group 0 CSI or part 2 wideband CSI for all of the M information groups, group 1 CSI or part 2 subband CSI of even subbands for information group 0, group 1 CSI or part 2 subband CSI of even subbands for information group 1, ..., group 1 CSI or part 2 subband CSI of even subbands for information group M-1, group 2 CSI or part 2 subband CSI of odd subbands for information group 0, group 2 CSI or part 2 subband CSI of odd subbands for information group 1, ..., and group 2 CSI or part 2 subband CSI of odd subbands for information group M-1.

[0117] In some other cases, group 0 CSI or part 2 wideband CSI for the plurality of CSI reports may have different priority reporting levels which are based on the priority levels associated with the M information groups. For example, an order of the priority reporting levels and a packing order for group 0 CSI or part 2 wideband CSI for the plurality of CSI reports may be as follows, wherein CSI in front has a higher priority reporting level:

- group 0 CSI or part 2 wideband CSI for information group 0 of the L CSI report(s) and for CSI report(s) other than the L CSI report(s) in the plurality of CSI reports, group 0 CSI or part 2 wideband CSI for information group 1 of the L CSI report(s), group 0 CSI or part 2 wideband CSI for information group 2 of the L CSI report(s), ..., group 0 CSI or part 2 wideband CSI for information group M-1 of the L CSI report(s).

[0118] As an example of Scheme 2, the following Table 4 illustrates exemplary enhanced priority reporting levels for part 2 CSI. Table 4 is generated based on Table 2.

Table 4

Priority 0: For CSI reports 1 to N_{Rep}, Group 0 CSI for M information groups for CSI reports configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 wideband CSI for M information groups for CSI reports configured otherwise
Priority 1: Group 1 CSI for information group 0 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for information group 0 of CSI report 1, if configured otherwise
Priority 2: ….
Priority M: Group 1 CSI for information group M-1 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of even subbands for information group M-1 of CSI report 1, if configured otherwise
Priority M+1: Group 2 CSI for information group 0 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for information group 0 of CSI report 1, if configured otherwise
….
Priority 2M: Group 2 CSI for information group M-1 of CSI report 1, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for information group M-1 of CSI report 1, if configured otherwise
….

Priority $2MN_{Rep}$:
Group 2 CSI for information group M-1 of CSI report N_{Rep}, if configured as 'typeII-r16', 'typeII-PortSelection-r16', 'typeII-PortSelection-r17', 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18'; Part 2 subband CSI of odd subbands for information group M-1 of CSI report N_{Rep}, if configured otherwise

[0119] In this example, it is assumed that each of the N_{Rep} CSI reports includes M information groups. Referring to Table 4, the priority reporting levels are decreased with the increasing priority values. That is, priority 0 indicates the highest priority reporting level, and priority $2MN_{Rep}$ indicates the lowest priority reporting level.

[0120] The difference between Table 4 and Table 2 is that: in Table 4, each of the N_{Rep} CSI reports includes M information groups, wherein the priority levels associated with the M information groups are decreased based on an increasing order of the indexes of the M information groups. Then, the reporting priority level for each CSI report illustrated in Table 2 may be refined based on Scheme 2, and thus $2N_{Rep}$ reporting priority levels in Table 2 may be refined to $2MN_{Rep}$ reporting priority levels.

[0121] The enhanced priority reporting levels illustrated in Table 4 are only for illustrative purpose. In some other examples, not all of the N_{Rep} CSI reports include more than one information groups. In such examples, the priority reporting level for any CSI report which includes only one information group may refer back to Table 2 or skip priority reporting level(s) associated with information group(s) that the CSI report does not have. In some embodiments, the enhanced priority reporting levels may be not reflected in the form of a table, but indicated in 3GPP standard document in the form of text.

[0122] In Scheme 2, the UE may omit CSI level by level according to an order of the priority reporting levels, beginning from the lowest priority reporting level until the remaining CSI meets uplink channel quality requirements (e.g., meet a target data rate requirement). When omitting CSI for a particular priority reporting level, the UE may omit all of the CSI at that priority reporting level.

[0123] According to some embodiments, in the case that group 1 CSI, group 2 CSI, part 2 subband CSI of even subbands, or part 2 subband CSI of odd subbands for an information group

is omitted from a CSI report, group 0 CSI or part 2 wideband CSI for the information group may be omitted from all the CSI report.

[0124] As aforementioned, each priority level may be associated with N information groups of the M information groups in a CSI report. In the case that N is larger than 1 (for example, N may be 2, M/2, or M), when CSI in a priority reporting level is omitted, all of the N information groups associated with the same priority level may be omitted simultaneously.

[0125] The order for the enhanced priority reporting levels in Scheme 2 may be used to protect group 1 CSI or part 2 subband CSI of even subbands with a higher priority reporting level. In this way, Scheme 2 may provide CSI for multiple information groups although it may only include group 1 CSI or part 2 subband CSI of even subbands. Scheme 2 provides more scheduling flexibility for a BS among multiple hybrid beams corresponding multiple information groups.

[0126] According to some embodiments of the present application, based on different scheduling requirements, the BS may configure Scheme 1 or Scheme 2 to the UE for CSI omission.

[0127] According to some embodiments of the present application, a packing order for a CSI part corresponding to an information group in a CSI report may be the same as that in an existing system. For example, for part 2 wideband CSI, the packing order may be {wideband CQI for the second TB, layer indicator, PMI wideband information X1, PMI wideband information X2}. As another example, for part 2 subband CSI of even subbands, the packing order may be {subband differential CQI for the second TB of all even subbands, PMI subband information X2 of even subband with increasing order of subband index}. As another example, for part 2 subband CSI of odd subbands, the packing order may be {subband different CQI for second TB of all odd subbands, PMI subband information X2 of even subband with increasing order of subband index}.

[0128] According to some embodiments of the present application, Embodiment 1-1 may also be used together with CSI omission schemes for network energy saving (NES), where a plurality of sub-configurations are introduced for a CSI report. In such case, a CSI report in Scheme 1 and Scheme 2 may be changed to a CSI sub-report corresponding to a CSI sub-

configuration if existing. In addition, an order of the priority reporting levels for the plurality of CSI reports in Scheme 1 and Scheme 2 may be further enhanced.

[0129] For example, for Scheme 1, in the case that the plurality of CSI reports are a plurality of CSI sub-reports, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports are decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to a decreasing order of the priority levels associated with the plurality of information groups, and fourthly according to an increasing order of CSI group indexes or an order of frequency domain types, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0130] As another example, for Scheme 2, in the case that the plurality of CSI reports are a plurality of CSI sub-reports, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports are decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to an increasing order of CSI group indexes or an order of frequency domain types, and fourthly according to a decreasing order of the priority levels associated with the plurality of information groups, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0131] If the plurality of CSI reports include both CSI report(s) and CSI sub-report(s), the aforementioned methods for determining priority reporting levels for CSI report(s) and those for CSI sub-report(s) may be applied respectively to the CSI report(s) and CSI sub-report(s).

[0132] The indexes of CSI sub-configurations may be provided by a parameter *csi-ReportSubConfigID* as specified in 3GPP standard documents.

[0133] Embodiment 1-1 provides solutions for CSI omission for part 2 CSI. In some cases, the channel quality may be worse, and thus it cannot carry all the part 1 CSI from all the CSI reports. In such cases, when CSI omission happens for multiple CSI reports including at least one CSI report with multiple information groups, as an example, the omission level may be defined based on report index(es) (which is determined based on $\mathrm{Pri}_{iCSI}(y,k,c,s)$ defined by formula (1)) associated with the multiple CSI reports and priority levels associated with the multiple information groups; as another example, the omission level may be defined based on the CSI omission scheme in the following Embodiment 1-2.

[0134] **Embodiment 1-2**

[0135] In Embodiment 1-2, each CSI report of the plurality of CSI reports may include only one part transmitted on PUCCH. For example, for the configurations with *pmi-FormatIndicator=widebandPMI* and *cqi-FormatIndicator=widebandCQI*, or the configurations with *reportQuantity* set to '*cri-RI-CQI*' and *cqi-FormatIndicator=widebandCQI*, a CSI report may include only one part.

[0136] In such embodiment, for CSI reports in the plurality of CSI reports which include only one information group, a portion of the CSI reports may be omitted based on priority reporting levels for the CSI reports. The priority reporting levels for the CSI reports may be decreased based on an increasing order of report index(es) (determined based on $\mathrm{Pri}_{iCSI}(y,k,c,s)$ defined by formula (1)) associated with the CSI reports.

[0137] For at least one CSI report in the plurality of CSI reports which includes the plurality of information groups, each CSI report may include a plurality of CSI parts, wherein each part may correspond to an information group of the plurality of information groups. Then, for the at least one CSI report, a portion of the CSI parts may be omitted based on an order of priority reporting levels for CSI parts of the at least one CSI report. For example, the order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the at least one CSI report may be determined based on report index(es) (determined based on

$\mathrm{Pri}_{iCSI}(y,k,c,s)$ defined by formula (1)) associated with the at least one CSI report and the priority levels associated with the plurality of information groups.

[0138] In other words, in Embodiment 1-2, the priority reporting levels for the plurality of CSI reports may be decreased firstly based on the an increasing order of report indexes (determined based on $\mathrm{Pri}_{iCSI}(y,k,c,s)$ defined by formula (1)) associated with the plurality of CSI reports. Then, for each of the at least one CSI report which includes the plurality of information groups, it may include priority reporting levels for CSI parts. The priority reporting levels for CSI parts corresponding to the plurality of information groups may be decreased according to a decreasing order of the priority levels associated with the plurality of information groups.

[0139] As an example, for a CSI report including M CSI parts corresponding to M information groups (e.g., denoted as information group 0 to information group M-1) where the priority levels associated with the M information groups are decreased based on an increasing order of the indexes of the M information groups, an order of priority reporting levels and a packing order for CSI may be as follows, wherein a CSI part in front has a higher priority reporting level:

- CSI part corresponding to information group 0, CSI part corresponding to information group 1, …, CSI part corresponding to information group M-1.

[0140] As an example, for a CSI report, a priority reporting level for a CSI part corresponding to an information group may be determined based on the following formula (2):

$$\mathrm{Pri}_{iCSI}(y,k,c,s) = 2 \cdot N_{cells} \cdot M_s \cdot M \cdot y + N_{cells} \cdot M_s \cdot M \cdot k + M_s \cdot M \cdot c + M \cdot s + n \quad (2).$$

[0141] Compared with formula (1), n in formula (2) is a newly introduced index, which may be an index of the information group.

[0142] According to some embodiments of the present disclosure, if a joint indication is used for indicating an information group (e.g., CRI, RI, PMI, and CQI), then a priority level for the information group may be higher when a value of the joint indication is smaller.

[0143] According to some embodiments of the present application, a packing order for a CSI part corresponding to an information group in a CSI report may be the same as that in an

existing system. For example, a packing order for a CSI part may be {CRI, RI, LI, Zero padding if existed, PMI wideband information X1, PMI wideband information X2, wideband CQI for the first TB, wideband CQI for the second TB}.

[0144] In Embodiment 1-2, the UE may omit a CSI report or a CSI part of a CSI report, beginning from the lowest priority reporting level until the remaining CSI report(s) and/or CSI part(s) meets uplink channel quality requirements (e.g., less than or equal to a maximum code rate).

[0145] As aforementioned, each priority level may be associated with N information groups of the M information groups in a CSI report. In the case that N is larger than 1 (for example, N may be 2, M/2, or M), when CSI in a priority reporting level is omitted, all of the N information groups associated with the same priority level may be omitted simultaneously.

[0146] According to some embodiments of the present application, Embodiment 1-2 may also be used together with CSI omission schemes for NES, where a plurality of sub-configurations are introduced for a CSI report. In such case, a CSI report in Embodiment 1-2 may be changed to a CSI sub-report corresponding to a CSI sub-configuration if existing. In addition, an order of the priority reporting levels for the plurality of CSI reports in Embodiment 1-2 may be further enhanced.

[0147] As an example, in the case that the L CSI report(s) is L CSI sub-report(s), and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, an order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the L CSI sub-report is determined based on report index(es) associated with corresponding CSI report(s) of the L CSI sub-report(s), index(es) of corresponding CSI sub-configuration(s) associated with the L CSI sub-report(s), and the priority levels associated with the plurality of information groups.

[0148] For each of the L CSI sub-report(s), the priority reporting levels for CSI parts corresponding to the plurality of information groups are decreased firstly according to an increasing order of index(es) of corresponding CSI sub-configuration(s) associated with the L CSI sub-report(s), and secondly according to a decreasing order of the priority levels associated with the plurality of information groups.

[0149] If the plurality of CSI reports include both CSI report(s) and CSI sub-report(s), the aforementioned methods for determining priority reporting levels for CSI report(s) and those for CSI sub-report(s) may be applied respectively to the CSI report(s) and CSI sub-report(s).

[0150] **Embodiment 2**

[0151] In Embodiment 2, for each CSI report including a plurality of information groups, the UE may select one or more information groups (e.g., M1 information groups) from the plurality of information groups (e.g., M information groups) for CSI reporting. In other words, the unselected M-M1 information groups are omitted. Embodiment 2 may include Embodiment 2-1 and Embodiment 2-2.

[0152] **Embodiment 2-1**

[0153] In Embodiment 2-1, the UE may select (e.g., freely or randomly selecting) M1 information groups from M information groups for CSI reporting so as to meet uplink channel quality requirements.

[0154] In some cases of Embodiment 2-1, each CSI report may include two parts (i.e., part 1 and part 2). In such embodiments, the CSI omission scheme may include selecting, by the UE, M1 information groups from the M information groups for CSI reporting such that an overload of the one or more CSI reports to be reported is no more than a maximum overload supported by PUSCH for uplink control information (UCI) transmission.

[0155] In some examples, the selecting may be based on the enhanced priority reporting levels as defined in Embodiment 1-1 (e.g., based on an order of priority levels or indexes associated with the information groups). In some other examples, the selecting may not be based on the order of priority levels or indexes associated with the information groups, which means that the UE may not select information groups with the M1 highest priority levels or lowest indexes.

[0156] In some examples, a packing order for CSI for the M1 information groups in a CSI report may be based on an order of priority levels or indexes associated with the M1 information groups.

[0157] For example, referring to Table 3, for CSI report $N_{Rep}-1$, the UE may select information group M-1, and thus CSI in priority reporting level $2N_{Rep}-5+2M$ and priority reporting level $2N_{Rep}-4+2M$ are selected for CSI reporting, and CSI in priority reporting level $2N_{Rep}-3$ to priority reporting level $2N_{Rep}-6+2M$ are omitted.

[0158] In an embodiment, in the case that group 1 CSI, group 2 CSI, part 2 subband CSI of even subbands, or part 2 subband CSI of odd subbands for an information group is omitted from a CSI report, group 0 CSI or part 2 wideband CSI for the information group may be omitted from all the CSI reports.

[0159] As an example, when the UE is scheduled to transmit a transport block on PUSCH not using repetition type B multiplexed with a CSI report(s), part 2 CSI is omitted only when $\left\lceil \left(O_{\text{CSI-2}}+L_{\text{CSI-2}}\right)\cdot\beta_{\text{offset}}^{\text{PUSCH}}\cdot\sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1}M_{\text{sc}}^{\text{UCI}}(l)\Big/\sum_{r=0}^{C_{\text{UL-SCH}}-1}K_r\right\rceil$ is larger than $\left\lceil\alpha\cdot\sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1}M_{\text{sc}}^{\text{UCI}}(l)\right\rceil-Q'_{ACK/CG-UCI}-Q'_{\text{CSI-1}}$, where parameters $O_{\text{CSI-2}}$, $L_{\text{CSI-2}}$, $\beta_{\text{offset}}^{\text{PUSCH}}$, $N_{\text{symb,all}}^{\text{PUSCH}}$, $M_{\text{sc}}^{\text{UCI}}(l)$, $C_{\text{UL-SCH}}$, K_r, $Q'_{\text{CSI-1}}$, $Q'_{ACK/CG-UCI}$ and α are defined in TS 38.212. Part 2 CSI is omitted based on enhanced priority reporting levels as described in Embodiment 1-1 but with the selected $M1$ information groups until the selected priority reporting levels causes $\left\lceil \left(O_{\text{CSI-2}}+L_{\text{CSI-2}}\right)\cdot\beta_{\text{offset}}^{\text{PUSCH}}\cdot\sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1}M_{\text{sc}}^{\text{UCI}}(l)\Big/\sum_{r=0}^{C_{\text{UL-SCH}}-1}K_r\right\rceil$ to be less than or equal to $\left\lceil\alpha\cdot\sum_{l=0}^{N_{\text{symb,all}}^{\text{PUSCH}}-1}M_{\text{sc}}^{\text{UCI}}(l)\right\rceil-Q'_{ACK/CG-UCI}-Q'_{\text{CSI-1}}$.

[0160] In some other cases of Embodiment 2-1, each CSI report may include only one part. In such cases, the CSI omission scheme may include selecting, by the UE, M1 information groups from the M information groups for CSI reporting such that a code rate of the one or more CSI reports to the reported is no larger than a maximum code rate.

[0161] That is, for a CSI report including M information groups, CSI parts corresponding to M1 information groups are retained for CSI reporting, and CSI parts corresponding to information groups other than the M1 information groups are omitted from the CSI report.

[0162] In such examples, a packing order for the M1 CSI parts corresponding to the M1 information groups in the CSI report may be based on (e.g., the same as) an order of priority levels or index associated with the M1 information groups.

[0163] As an example, the value of $N_{\text{CSI}}^{\text{reported}}$ including the selected $M1$ information groups satisfies $\left(O_{\text{ACK}} + O_{\text{SR}} + \sum_{n=1}^{N_{\text{CSI}}^{\text{reported}}} O_{\text{CSI-part1},n} + O_{\text{CRC,CSI-part1},N}\right) \leq M_{\text{RB}}^{\text{PUCCH}} \cdot N_{\text{sc,ctrl}}^{\text{RB}} \cdot N_{\text{symb-UCI}}^{\text{PUCCH}} \cdot Q_m \cdot r$ and $\left(O_{\text{ACK}} + O_{\text{SR}} + \sum_{n=1}^{N_{\text{CSI}}^{\text{reported}}+1} O_{\text{CSI-part1},n} + O_{\text{CRC,CSI-part1},N+1}\right) > M_{\text{RB}}^{\text{PUCCH}} \cdot N_{\text{sc,ctrl}}^{\text{RB}} \cdot N_{\text{symb-UCI}}^{\text{PUCCH}} \cdot Q_m \cdot r$, wherein parameters in the above formula are defined in TS 38.212.

[0164] In Embodiment 2-1, regarding the actually reported information groups, there is no ambiguity understandings for the UE and the BS because each reported information group includes a CRI associated with the information group.

[0165] **Embodiment 2-2**

[0166] In Embodiment 2-2, the UE may also select M1 information groups from the M information groups, and the difference between Embodiment 2-2 and Embodiment 2-1 is that in Embodiment 2-2, the UE may select M1 information groups from the M information groups based on an order of priority levels associated with the M information groups, so as to meet uplink channel quality requirements, and the priority levels associated with the M information groups may be predefined or configured by a BS. For example, the UE may select M1 information groups with higher priority levels in the M information groups for CSI reporting. Other definitions and operations in Embodiment 2-1 may also apply herein, and thus are omitted for simplicity.

[0167] In some cases of Embodiment 2-2, each CSI report may include two parts (i.e., part 1 and part 2). In such cases, the CSI omission scheme may include selecting, by the UE and based on an order of priority levels associated with M information groups, M1 information groups from the M information groups for CSI reporting such that an overload of the one or more CSI reports to be reported is no more than a maximum overload supported by PUSCH for UCI. In such cases, a packing order for CSI for the M1 information groups in a CSI report may be based on an order of priority levels associated with the M1 information groups.

[0168] In an embodiment, in the case that group 1 CSI, group 2 CSI, part 2 subband CSI of even subbands, or part 2 subband CSI of odd subbands for an information group is omitted from a CSI report, group 0 CSI or part 2 wideband CSI for the information group may be omitted from all the CSI reports.

[0169] In some other cases of Embodiment 2-2, each CSI report may include only one part. In such cases, the CSI omission scheme may include selecting, by the UE and based on an order of priority levels associated with M information groups, M1 information groups from the M information groups for CSI reporting such that a code rate of the one or more CSI reports to the reported is no larger than a maximum code rate. In such cases, a packing order for CSI parts corresponding to the M1 informaiton groups in a CSI report may be based on (e.g., the same as) an order of priority levels associated with the M1 information groups.

[0170] In some embodiments, the priority levels associated with the M information groups may be decreased according to an increasing order of indexes associated with the M information groups.

[0171] As stated above, each information group is associated with a CRI. An information group with a higher index may be associated with a CRI with a higher value. In such embodiments, the priority levels associated with the M information groups may be decreased according to an increasing order of values of CRIs associated with the M information groups.

[0172] In some embodiments, the priority levels associated with the plurality of information groups may be determined based on an order of CSI-RS resources associated with the M information groups in a CSI-RS resource set (e.g., a CSI-RS resource set consisting of configured K_S CSI-RS resources). For example, an information group associated with a CSI-RS resource which has a smaller index in the CSI-RS resource set has a higher priority level.

[0173] In an embodiment, the UE may receive, from the BS, configuration information for updating the order of the priority levels associated with the M information groups. For example, If the BS wants to update the order of CSI omission, it can update the order of the M information groups or the order of associated CSI-RS resources in the CSI-RS resource set by RRC signaling or MAC CE.

[0174] In some embodiments, the priority levels associated with the plurality of information groups may be determined based on an order of quality related metrics associated with the plurality of information groups. For example, the priority levels associated with the plurality of information groups may be decreased according to an increasing order of RSRP values associated with the plurality of information groups.

[0175] In some other cases of Embodiment 2-2, the UE may receive, from the BS, configuration information for indicating priority levels associated with a set of information groups (e.g., consisting of Ks information groups) for CSI reporting with more than 32 CSI-RS ports. Since the M information groups are part of all of the Ks information groups, based on the configuration information, the priority levels associated with the M information groups can also be determined. The configuration information may be received via RRC signaling or MAC CE.

[0176] As an example, the configuration information may indicate a corresponding priority level for each information group in the set of information groups. For example, when Ks = 8, a 3-bit indication may be used for indicating a priority level for each information group. In such example, a smaller value of a 3-bit indication may indicate a higher priority level. That is, a value of a 3-bit indication being "000" may indicate a highest priority level, and a value of a 3-bit indication being "111" may indicate a lowest priority level. For another example, when Ks = 8, 16 bits are used for jointly indicating all the possible combinations of priority levels associated with the Ks information groups.

[0177] As another example, the configuration information may include a bit map, and each bit in the bit map may be associated with a corresponding information group in the set of information groups and indicates whether the corresponding information group has a high priority level or a low priority level. For example, a bit value being "0" may indicate a high priority level, and a bit value being "1" may indicate a low priority level.

[0178] In some cases, the M information groups may include two or more information groups with the same priority level. In such cases, as an example, the UE may freely select information group(s) from the two or more information groups for CSI reporting. As another example, the UE may select information group(s) from the two or more information groups for CSI reporting based on indexes of the two or more information groups or values of CRIs

associated with the two or more information groups. For example, the UE may select information group(s) with smaller indexes or smaller values of CRIs.

[0179] According to some embodiments of the present application, Embodiment 2 may also be used together with CSI omission schemes for NES, where a plurality of sub-configurations are introduced for a CSI report. In such case, a CSI report in Embodiment 2 may be changed to a CSI sub-report corresponding a CSI sub-configuration if existing.

[0180] According to some embodiments of the present disclosure, the UE may select the number of information groups for CSI reporting. That is, the UE may select the value of M. The UE may indicate the selected value of M in a CSI report and transmit the CSI report to the BS. Depending on whether CSI omission is considered together with the selection of the value of M by the UE, the UE may have the following behaviours.

[0181] As an example, CSI omission can happen in the case of the UE selecting the value of M, which means that it is independent for CSI omission and the UE selecting the value of M. In such example, when CSI omission happens, the UE may use the solutions and schemes provided in Embodiment 1 or Embodiment 2 for CSI reporting.

[0182] As another example, CSI omission for M information groups is guaranteed not to happen in the case of the UE selecting the value of M. In such example, M is selected such that it is not needed to perform CSI omission for any of the M information groups. That is, the UE is not expected to make CSI omission for M information groups when the value of M is selected by the UE. With this restriction, the realizations at the UE and the BS can be simplified on account of not performing partial CSI omission operation for the M information groups in a CSI report.

[0183] Figure 2 illustrates a flowchart of an exemplary method in accordance with aspects of the present disclosure. The operations of the method illustrated in Figure 2 may be performed by a UE (e.g., UE 104 in Figure 1) as described herein or other apparatus with the like functions. In some implementations, the UE may execute a set of instructions to control functional elements of the UE to perform the described operations or functions.

[0184] As shown in Figure 2, in step 202, the UE may receive, from a BS (e.g., NE 102 in Figure 1), configuration information for a plurality of CSI reports, wherein at least one CSI

report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI.

[0185] In step 204, the UE may transmit, to the BS, one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0186] According to some embodiments of the present disclosure, the CSI omission scheme may be based on an order of priority levels associated with the plurality of information groups.

[0187] In some embodiments, each priority level may be associated with N information groups of the plurality of information groups, wherein N is a positive integer. For example, N may be 1, 2, M/2, or M, and M is a number of the plurality of information groups.

[0188] In some embodiments, the priority levels associated with the plurality of information groups may be decreased according to an increasing order of values of CRIs associated with the plurality of information groups, or determined based on an order of CSI-RS resources associated with the plurality of information groups in a CSI-RS resource set or an order of quality related metrics associated with the plurality of information groups.

[0189] In some embodiments, according to the CSI omission scheme, group 0 CSI for all of the plurality of information groups may have a higher priority reporting level than group 1 CSI and group 2 CSI for any of the plurality of information groups, or part 2 wideband CSI for all of the plurality of information groups has a higher priority reporting level than part 2 subband CSI of even subbands and part 2 subband CSI of odd subbands for any of the plurality of information groups.

[0190] In an embodiment, a packing order of group 0 CSI or part 2 wideband CSI corresponding to the plurality of information groups for each of the at least one CSI report may be based on the order of the priority levels associated with the plurality of information groups.

[0191] In another embodiment, according to the CSI omission scheme, in the case that group 1 CSI, group 2 CSI, part 2 subband CSI of even subbands, or part 2 subband CSI of odd subbands for an information group is omitted from a CSI report of the at least one CSI report, group 0 CSI

or part 2 wideband CSI for the information group is omitted from all of the at least one CSI report.

[0192] In yet another embodiment, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports or part 2 subband CSI for the plurality of CSI reports may be decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to a decreasing order of the priority levels associated with the plurality of information groups, and thirdly according to an increasing order of CSI group indexes or an order of frequency domain types, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0193] In yet another embodiment, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports or part 2 subband CSI for the plurality of CSI reports may be decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to an increasing order of CSI group indexes or an order of frequency domain types, and thirdly according to a decreasing order of the priority levels associated with the plurality of information groups, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0194] In yet another embodiment, in the case that the plurality of CSI reports are a plurality of CSI sub-reports, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports may be decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to a decreasing order of the priority levels associated with the plurality of information groups, and fourthly according to an increasing order of CSI group indexes or an order of frequency domain types, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0195] In yet another embodiment, in the case that the plurality of CSI reports are a plurality of CSI sub-reports, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, according to the CSI omission scheme, priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports may be decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to an increasing order of CSI group indexes or an order of frequency domain types, and fourthly according to a decreasing order of the priority levels associated with the plurality of information groups, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

[0196] In some embodiments, an order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the at least one CSI report may be determined based on report index(es) associated with the at least one CSI report and the priority levels associated with the plurality of information groups.

[0197] In an embodiment, for each of the at least one CSI report, the priority reporting levels for CSI parts corresponding to the plurality of information groups may be decreased according to a decreasing order of the priority levels associated with the plurality of information groups.

[0198] In some embodiments, in the case that the at least CSI report is at least one CSI sub-report, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, an order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the at least one CSI sub-report may be determined based on report index(es) associated with corresponding CSI report(s) of the at least one CSI sub-report, index(es) of corresponding CSI sub-configuration(s) associated with the at least one CSI sub-report, and the priority levels associated with the plurality of information groups.

[0199] In an embodiment, for each of the at least one CSI sub-report, the priority reporting levels for CSI parts corresponding to the plurality of information groups may be decreased firstly according to an increasing order of index(es) of corresponding CSI sub-configuration(s)

associated with the at least one CSI sub-report, and secondly according to a decreasing order of the priority levels associated with the plurality of information groups.

[0200] According to some embodiments of the present disclosure, the CSI omission scheme may include selecting, by the UE, one or more information groups from the plurality of information groups for CSI reporting such that a code rate of the one or more CSI reports is no larger than a maximum code rate or an overload of the one or more CSI reports is no more than a maximum overload supported by PUSCH for UCI transmission.

[0201] According to some embodiments of the present disclosure, the CSI omission scheme may include selecting, by the UE and based on the order of the priority levels associated with plurality of information groups, one or more information groups from the plurality of information groups for CSI reporting such that a code rate of the one or more CSI reports is no larger than a maximum code rate or an overload of the one or more CSI reports is no more than a maximum overload supported by PUSCH for UCI transmission.

[0202] In some embodiments, the configuration information may include information for indicating or updating the order of the priority levels associated with the plurality of information groups.

[0203] In some embodiments, the configuration information may indicate priority levels associated with a set of information groups for CSI reporting with more than 32 CSI-RS ports, wherein the set of information groups includes the plurality of information groups, and each information group in the set of information groups is associated with a corresponding CRI.

[0204] In an embodiment, the configuration information may indicate a corresponding priority level for each information group in the set of information groups.

[0205] In another embodiment, the configuration information may include a bit map, and each bit in the bit map is associated with a corresponding information group in the set of information groups and indicates whether the corresponding information group has a high priority level or a low priority level.

[0206] In some embodiments, the configuration information may be received via RRC signaling or MAC CE.

[0207] According to some embodiments of the present disclosure, the UE may select a number of the plurality of information groups.

[0208] In some embodiments, the number of the plurality of information groups is selected such that it is not needed to perform CSI omission for any of the plurality of information groups.

[0209] It should be noted that the method described herein describes a possible implementation, and that the operations and the steps may be arranged or otherwise modified and that other implementations are possible.

[0210] Figure 3 illustrates a flowchart of an exemplary method in accordance with aspects of the present disclosure. The operations of the method illustrated in Figure 3 may be performed by a BS (e.g., NE 102 in Figure 1) as described herein or other apparatus with the like functions. In some implementations, the BS may execute a set of instructions to control functional elements of the BS to perform the described operations or functions.

[0211] As shown in Figure 3, in step 302, the BS may transmit, to a UE (e.g., UE 104 in Figure 1), configuration information (e.g., via RRC signaling) for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI.

[0212] In step 304, the BS may receive, from the UE, one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0213] All the definitions and operations related to the configuration information, the plurality of CSI reports, the plurality of information groups, and the CSI omission scheme as described in the aforementioned embodiments (e.g., with respect to Figure 2) may also apply here. Thus, details are omitted for simplicity.

[0214] It should be noted that the method described herein describes a possible implementation, and that the operations and the steps may be arranged or otherwise modified and that other implementations are possible.

[0215] Figure 4 illustrates an example of a UE 400 in accordance with aspects of the present disclosure. The UE 400 may include at least one processor 402 and at least one memory 404.

Additionally, the UE 400 may also include one or more of at least one controller 406 or at least one transceiver 408. The processor 402, the memory 404, the controller 406, or the transceiver 408, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0216] The processor 402, the memory 404, the controller 406, or the transceiver 408, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0217] The processor 402 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 402 may be configured to operate the memory 404. In some other implementations, the memory 404 may be integrated into the processor 402. The processor 402 may be configured to execute computer-readable instructions stored in the memory 404 to cause the UE 400 to perform various functions of the present disclosure.

[0218] The memory 404 may include volatile or non-volatile memory. The memory 404 may store computer-readable, computer-executable code including instructions when executed by the processor 402 cause the UE 400 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 404 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0219] In some implementations, the processor 402 and the memory 404 coupled with the processor 402 may be configured to cause the UE 400 to perform one or more of the functions described herein (e.g., executing, by the processor 402, instructions stored in the memory 404).

For example, the processor 402 may support wireless communication at the UE 400 in accordance with examples as disclosed herein. The UE 400 may be configured to support a means for performing the operations of the methods described in the embodiments of the present disclosure. In an embodiment, the processor 402 may be configured to cause the UE 400 to: receive configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI; and transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0220] The controller 406 may manage input and output signals for the UE 400. The controller 406 may also manage peripherals not integrated into the UE 400. In some implementations, the controller 406 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 406 may be implemented as part of the processor 402.

[0221] In some implementations, the UE 400 may include at least one transceiver 408. In some other implementations, the UE 400 may have more than one transceiver 408. The transceiver 408 may represent a wireless transceiver. The transceiver 408 may include one or more receiver chains 410, one or more transmitter chains 412, or a combination thereof.

[0222] A receiver chain 410 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 410 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 410 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 410 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 410 may include at least one decoder for decoding the demodulated signal to receive the transmitted data.

[0223] A transmitter chain 412 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 412 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over

a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 412 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 412 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0224] Figure 5 illustrates an example of a processor 500 in accordance with aspects of the present disclosure. The processor 500 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 500 may include at least one controller 502 configured to perform various operations in accordance with examples as described herein. The processor 500 may optionally include at least one memory 504, which may be, for example, a layer 1 (L1), layer 2 (L2), or layer 3 (L3) cache. Additionally, or alternatively, the processor 500 may optionally include one or more arithmetic-logic units (ALUs) 506. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0225] The processor 500 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 500) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[0226] The controller 502 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 500 to cause the processor 500 to support various operations in accordance with examples as described herein. For

example, the controller 502 may operate as a control unit of the processor 500, generating control signals that manage the operation of various components of the processor 500. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0227] The controller 502 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 504 and determine subsequent instruction(s) to be executed to cause the processor 500 to support various operations in accordance with examples as described herein. The controller 502 may be configured to track memory address of instructions associated with the memory 504. The controller 502 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 502 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 500 to cause the processor 500 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 502 may be configured to manage flow of data within the processor 500. The controller 502 may be configured to control transfer of data between registers, ALUs, and other functional units of the processor 500.

[0228] The memory 504 may include one or more caches (e.g., memory local to or included in the processor 500 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc.). In some implementations, the memory 504 may reside within or on a processor chipset (e.g., local to the processor 500). In some other implementations, the memory 504 may reside external to the processor chipset (e.g., remote to the processor 500).

[0229] The memory 504 may store computer-readable, computer-executable code including instructions that, when executed by the processor 500, cause the processor 500 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 502 and/or the processor 500 may be configured to execute computer-readable instructions stored in the memory 504 to cause the processor 500 to perform various functions. For example, the processor 500 and/or the controller 502 may be coupled with or to the memory 504, the processor 500, the controller 502, and the memory 504 may be configured to perform various functions described herein. In some examples, the processor 500 may include multiple

processors and the memory 504 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0230] The one or more ALUs 506 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 506 may reside within or on a processor chipset (e.g., the processor 500). In some other implementations, the one or more ALUs 506 may reside external to the processor chipset (e.g., the processor 500). One or more ALUs 506 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 506 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 506 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 506 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 506 to handle conditional operations, comparisons, and bitwise operations.

[0231] The processor 500 may support wireless communication in accordance with examples as disclosed herein. The processor 500 may be configured to or operable to support a means for performing the operations of the methods described in the embodiments of the present disclosure. In an embodiment, the controller 502 may cause the processor 500 to: receive configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI; and transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0232] Figure 6 illustrates an example of a BS 600 in accordance with aspects of the present disclosure. The BS 600 may include at least one processor 602 and at least one memory 604. Additionally, the BS 600 may also include one or more of at least one controller 606 or at least one transceiver 608. The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations thereof or various components thereof may be examples of means

for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0233] The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0234] The processor 602 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 602 may be configured to operate the memory 604. In some other implementations, the memory 604 may be integrated into the processor 602. The processor 602 may be configured to execute computer-readable instructions stored in the memory 604 to cause the BS 600 to perform various functions of the present disclosure.

[0235] The memory 604 may include volatile or non-volatile memory. The memory 604 may store computer-readable, computer-executable code including instructions when executed by the processor 602 cause the BS 600 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 604 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0236] In some implementations, the processor 602 and the memory 604 coupled with the processor 602 may be configured to cause the BS 600 to perform one or more of the functions described herein (e.g., executing, by the processor 602, instructions stored in the memory 604). For example, the processor 602 may support wireless communication at the BS 600 in accordance with examples as disclosed herein. The BS 600 may be configured to support a means for performing the operations of the methods described in the embodiments of the present

disclosure. In an embodiment, the processor 602 may be configured to cause the BS 600 to: receive configuration information for a plurality of CSI reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CRI; and transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

[0237] The controller 606 may manage input and output signals for the BS 600. The controller 606 may also manage peripherals not integrated into the BS 600. In some implementations, the controller 606 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 606 may be implemented as part of the processor 602.

[0238] In some implementations, the BS 600 may include at least one transceiver 608. In some other implementations, the BS 600 may have more than one transceiver 608. The transceiver 608 may represent a wireless transceiver. The transceiver 608 may include one or more receiver chains 610, one or more transmitter chains 612, or a combination thereof.

[0239] A receiver chain 610 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 610 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 610 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 610 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 610 may include at least one decoder for decoding the demodulated signal to receive the transmitted data.

[0240] A transmitter chain 612 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 612 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM).

The transmitter chain 612 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 612 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0241] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

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

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the UE to:

receive configuration information for a plurality of channel state information (CSI) reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CSI reference signal (CSI-RS) resource indicator (CRI); and

transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

2. The UE of Claim 1, wherein the CSI omission scheme is based on an order of priority levels associated with the plurality of information groups.

3. The UE of Claim 2, wherein each priority level is associated with N information groups of the plurality of information groups, wherein N is a positive integer, and wherein N is 1, 2, M/2, or M, and M is a number of the plurality of information groups.

4. The UE of Claim 2, wherein the priority levels associated with the plurality of information groups are decreased according to an increasing order of values of CRIs associated with the plurality of information groups, or determined based on an order of CSI-RS resources associated with the plurality of information groups in a CSI-RS resource set or an order of quality related metrics associated with the plurality of information groups.

5. The UE of Claim 2, wherein according to the CSI omission scheme, group 0 CSI for all of the plurality of information groups of the at least one CSI report and

for CSI report(s) other than the at least one CSI report in the plurality of CSI reports has a higher priority reporting level than group 1 CSI and group 2 CSI for any of the plurality of information groups of the at least one CSI report and for any CSI report other than the at least one CSI report in the plurality of CSI reports, or part 2 wideband CSI for all of the plurality of information groups of the at least one CSI report and for CSI report(s) other than the at least one CSI report in the plurality of CSI reports has a higher priority reporting level than part 2 subband CSI of even subbands and part 2 subband CSI of odd subbands for any of the plurality of information groups of the at least one CSI report and for any CSI report other than the at least one CSI report in the plurality of CSI reports.

6. The UE of Claim 5, wherein a packing order of group 0 CSI or part 2 wideband CSI corresponding to the plurality of information groups for each of the at least one CSI report is based on the order of the priority levels associated with the plurality of information groups.

7. The UE of Claim 5, wherein according to the CSI omission scheme, in the case that group 1 CSI, group 2 CSI, part 2 subband CSI of even subbands, or part 2 subband CSI of odd subbands for an information group is omitted from a CSI report of the at least one CSI report, group 0 CSI or part 2 wideband CSI for the information group is omitted from all of the at least one CSI report.

8. The UE of Claim 5, wherein according to the CSI omission scheme:

priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports or part 2 subband CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to a decreasing order of the priority levels associated with the plurality of information groups, and thirdly according to an increasing order of CSI group indexes or an order of frequency domain types, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands; or

priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI reports or part 2 subband CSI for the plurality of CSI reports are decreased firstly according to an increasing order of report indexes associated with the plurality of CSI reports, secondly according to an increasing order of CSI group indexes or an order of frequency domain types, and thirdly according to a decreasing order of the priority levels associated with the plurality of information groups, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

9. The UE of Claim 5, wherein in the case that the plurality of CSI reports are a plurality of CSI sub-reports, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, according to the CSI omission scheme,

priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports are decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to a decreasing order of the priority levels associated with the plurality of information groups, and fourthly according to an increasing order of CSI group indexes or an order of frequency domain types, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands; or

priority reporting levels for group 1 CSI and group 2 CSI for the plurality of CSI sub-reports or part 2 subband CSI for the plurality of CSI sub-reports are decreased firstly according to an increasing order of report index(es) associated with corresponding CSI report(s) of the plurality of CSI

sub-reports, secondly according to an increasing order of indexes of corresponding CSI sub-configurations associated with the plurality of CSI sub-reports, thirdly according to an increasing order of CSI group indexes or an order of frequency domain types, and fourthly according to a decreasing order of the priority levels associated with the plurality of information groups, wherein the order of frequency domain types indicates that part 2 subband CSI of even subbands has a higher priority reporting level than part 2 subband CSI of odd subbands.

10. The UE of Claim 2, wherein an order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the at least one CSI report is determined based on report index(es) associated with the at least one CSI report, and the priority levels associated with the plurality of information groups.

11. The UE of Claim 10, wherein for each of the at least one CSI report, the priority reporting levels for CSI parts corresponding to the plurality of information groups are decreased according to a decreasing order of the priority levels associated with the plurality of information groups.

12. The UE of Claim 2, wherein in the case that the at least CSI report is at least one CSI sub-report, and each CSI sub-report is associated with a corresponding CSI sub-configuration of a corresponding CSI report, an order of priority reporting levels for CSI parts corresponding to the plurality of information groups of the at least one CSI sub-report is determined based on report index(es) associated with corresponding CSI report(s) of the at least one CSI sub-report, index(es) of corresponding CSI sub-configuration(s) associated with the at least one CSI sub-report, and the priority levels associated with the plurality of information groups.

13. The UE of Claim 12, wherein for each of the at least one CSI sub-report, the priority reporting levels for CSI parts corresponding to the plurality of information groups are decreased firstly according to an increasing order of index(es) of corresponding CSI sub-configuration(s) associated with the at least one CSI sub-report, and

secondly according to a decreasing order of the priority levels associated with the plurality of information groups.

14. The UE of Claim 1, wherein the CSI omission scheme includes one or more information groups for CSI reporting selected by the UE from the plurality of information groups.

15. The UE of Claim 2, wherein the CSI omission scheme includes one or more information groups for CSI reporting selected by the UE from the plurality of information groups and based on the order of the priority levels associated with the plurality of information groups.

16. The UE of Claim 15, wherein:

the configuration information includes information for indicating or updating the order of the priority levels associated with the plurality of information groups; or

the configuration information indicates priority levels associated with a set of information groups for CSI reporting with more than 32 CSI-RS ports, wherein the set of information groups includes the plurality of information groups, and each information group in the set of information groups is associated with a corresponding CRI.

17. The UE of Claim 1, wherein the at least one processor is configured to cause the UE to select a number of the plurality of information groups, and wherein the number of the plurality of information groups is selected such that it is not needed to perform CSI omission for any of the plurality of information groups.

18. A processor for wireless communication, comprising:

at least one controller coupled with at least one memory and configured to cause the processor to:

receive configuration information for a plurality of channel state information (CSI) reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each

of the plurality of information groups is associated with a CSI reference signal (CSI-RS) resource indicator (CRI); and

transmit one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

19. A base station (BS) for wireless communication, comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the BS to:

transmit configuration information for a plurality of channel state information (CSI) reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CSI reference signal (CSI-RS) resource indicator (CRI); and

receive one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.

20. A method performed by a user equipment (UE), the method comprising:

receiving configuration information for a plurality of channel state information (CSI) reports, wherein at least one CSI report of the plurality of CSI reports includes a plurality of information groups, and each of the plurality of information groups is associated with a CSI reference signal (CSI-RS) resource indicator (CRI); and

transmitting one or more CSI reports of the plurality of CSI reports based on a CSI omission scheme, wherein the CSI omission scheme is associated with the plurality of information groups.