

METHODS AND APPARATUSES FOR CHANNEL MEASUREMENT RESOURCE CONFIGURATION

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to methods and apparatuses for channel measurement resource configuration for channel state information (CSI) reporting based on enhanced Type II codebook for predicted precoding matrix indicator (PMI).

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 indicating a set of CSI reference signal (CSI-RS) resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; receive CSI-RS based on the configuration information; and perform channel measurement based on the received CSI-RS.

[0005] In some implementations of the UE described herein, the configuration information indicates that the set of CSI-RS resources includes a first number of aperiodic CSI-RS resource subsets, and that each aperiodic CSI-RS resource subset includes a second number of aperiodic CSI-RS resources.

[0006] In some implementations of the UE described herein, for aperiodic CSI-RS resources with a same index in each aperiodic CSI-RS resource subset of the first number of aperiodic CSI-RS resource subsets, the configuration information indicates at least one of: a same number of CSI-RS ports; same CSI-RS port index(es); a same bandwidth (BW); same resource element (RE) location(s); or a same power control offset value.

[0007] In some implementations of the UE described herein, the configuration information further indicates a time spacing between any two consecutive aperiodic CSI-RS resource subsets in the first number of aperiodic CSI-RS resource subsets.

[0008] In some implementations of the UE described herein, the time spacing between any two consecutive aperiodic CSI-RS resource subsets is 0 slot or 1 slot.

[0009] In some implementations of the UE described herein, a time spacing between any two consecutive aperiodic CSI-RS resource subsets is predefined or specified to be 0 slot.

[0010] In some implementations of the UE described herein, each aperiodic CSI-RS resource subset occupies a third number of consecutive slots, and the third number is 1 or 2.

[0011] In some implementations of the UE described herein, the at least one processor is configured to cause the UE to: determine a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset based on an assumption that same orthogonal frequency division multiplexing (OFDM) symbols are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset in different slots or non-overlapping REs are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset in a same slot.

[0012] In some implementations of the UE described herein, the configuration information further indicates that a fourth number of CSI-RS resources in each aperiodic CSI-RS resource subset are included in a first slot of the third number of consecutive slots.

[0013] In some implementations of the UE described herein, the configuration information further indicates a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset.

[0014] In some implementations of the UE described herein, the third number is 1 in case of CSI reporting using 48 or 64 CSI-RS ports, or 2 in case of CSI reporting using 96 or 128 CSI-RS ports.

[0015] In some implementations of the UE described herein, the CSI reporting based on the enhanced Type II codebook for predicted PMI only uses no more than 64 CSI-RS ports, and a number of consecutive slots occupied by each aperiodic CSI-RS resource subset is predefined or specified to be 1 slot.

[0016] In some implementations of the UE described herein, the set of CSI-RS resources includes a plurality of aperiodic CSI-RS resources, a time spacing between any two consecutive aperiodic CSI-RS resources is 0 slot or 1 slot, and the at least one processor is configured to cause the UE to: determine a slot index for each aperiodic CSI-RS resource in the plurality of aperiodic CSI-RS resources based on an assumption that same OFDM symbols are configured for aperiodic CSI-RS resources in different slots.

[0017] In some implementations of the UE described herein, the set of CSI-RS resources includes a plurality of aperiodic CSI-RS resources, and the configuration information indicates a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in the plurality of aperiodic CSI-RS resources.

[0018] In some implementations of the UE described herein, the corresponding time spacing is 0 slot or 1 slot.

[0019] In some implementations of the UE described herein, the configuration information includes the first number, and the first number is selected from a predefined set of aperiodic CSI-RS resource subset numbers.

[0020] In some implementations of the UE described herein, the predefined set of aperiodic CSI-RS resource subset numbers includes 2, 4, 6 and 8.

[0021] In some implementations of the UE described herein, the at least one processor is configured to cause the UE to: transmit first capability information indicating an aperiodic CSI-RS resource subset number supported by the UE.

[0022] In some implementations of the UE described herein, the aperiodic CSI-RS resource subset number supported by the UE is irrelevant with a CSI-RS port number or based on an assumed CSI-RS port number.

[0023] In some implementations of the UE described herein, the configuration information indicates that the set of CSI-RS resources includes a fifth number of aperiodic CSI-RS resources, and the fifth number is selected from a predefined set of aperiodic CSI-RS resource numbers.

[0024] In some implementations of the UE described herein, the predefined set of aperiodic CSI-RS resource numbers includes 4, 8, 12, 16, and 24.

[0025] In some implementations of the UE described herein, the at least one processor is configured to cause the UE to: transmit second capability information indicating an aperiodic CSI-RS resource number supported by the UE.

[0026] In some implementations of the UE described herein, the set of CSI-RS resources includes a plurality of periodic or semi-persistent CSI-RS resources or a CSI-RS resource subset including a plurality of periodic or semi-persistent CSI-RS resources.

[0027] In some implementations of the UE described herein, the plurality of periodic or semi-persistent CSI-RS resources have a common periodicity, and a time offset value between any two periodic or semi-persistent CSI-RS resources in the plurality of periodic or semi-persistent CSI-RS resources are smaller than the common periodicity.

[0028] In some implementations of the UE described herein, the configuration information indicates same values of a set of parameters for each of a plurality of periodic or semi-persistent CSI-RS resources included in the set of CSI-RS resources, or for each of a plurality of periodic or semi-persistent CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, or for each of a plurality of aperiodic CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, and the set of parameters includes at least one of: a first parameter indicating a number of ports; a second parameter indicating a code-division multiplexing (CDM) type; a third parameter indicating a CSI-RS frequency density of each CSI-RS port per physical resource block (PRB); a fourth parameter indicating a frequency band for CSI-RS; a fifth parameter indicating an assumed ratio of physical downlink shared channel (PDSCH) energy per resource element (EPRE) to non-zero-power (NZP) CSI-RS EPRE; a sixth parameter indicating an assumed ratio of NZP CSI-RS EPRE to synchronization signal block (SSB) EPRE; a seventh parameter indicating a scrambling identity (ID) of CSI-RS; an eighth parameter containing a reference to a transmission configuration indicator (TCI) state indicating quasi co-located (QCL) source reference signal(s) and QCL type(s); or a ninth parameter indicating a frequency domain resource allocation.

[0029] In some implementations of the UE described herein, only one NZP CSI-RS resource or only one CSI interference measurement (CSI-IM) resource is configured for interference measurement, and the one NZP CSI-RS resource or the one CSI-IM resource is associated with the set of CSI-RS resources for channel measurement.

[0030] In some implementations of the UE described herein, the configuration information only indicates a set of periodic or semi-persistent CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

[0031] 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 indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; and transmit CSI-RS based on the configuration information.

[0032] In some implementations of the BS described herein, the configuration information indicates that the set of CSI-RS resources includes a first number of aperiodic CSI-RS resource subsets, and that each aperiodic CSI-RS resource subset includes a second number of aperiodic CSI-RS resources.

[0033] In some implementations of the BS described herein, for aperiodic CSI-RS resources with a same index in each aperiodic CSI-RS resource subset of the first number of aperiodic CSI-RS resource subsets, the configuration information indicates at least one of: a same number of CSI-RS ports; same CSI-RS port index(es); a same BW; same RE location(s); or a same power control offset value.

[0034] In some implementations of the BS described herein, the configuration information further indicates a time spacing between any two consecutive aperiodic CSI-RS resource subsets in the first number of aperiodic CSI-RS resource subsets.

[0035] In some implementations of the BS described herein, the time spacing between any two consecutive aperiodic CSI-RS resource subsets is 0 slot or 1 slot.

[0036] In some implementations of the BS described herein, a time spacing between any two consecutive aperiodic CSI-RS resource subsets is predefined or specified to be 0 slot.

[0037] In some implementations of the BS described herein, each aperiodic CSI-RS resource subset occupies a third number of consecutive slots, and the third number is 1 or 2.

[0038] In some implementations of the BS described herein, same OFDM symbols are configured for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in different slots or non-overlapping REs are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset in a same slot.

[0039] In some implementations of the BS described herein, the configuration information further indicates that a fourth number of CSI-RS resources in each aperiodic CSI-RS resource subset are included in a first slot of the third number of consecutive slots.

[0040] In some implementations of the BS described herein, the configuration information further indicates a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset.

[0041] In some implementations of the BS described herein, the third number is 1 in case of CSI reporting using 48 or 64 CSI-RS ports, or 2 in case of CSI reporting using 96 or 128 CSI-RS ports.

[0042] In some implementations of the BS described herein, the CSI reporting based on the enhanced Type II codebook for predicted PMI only uses no more than 64 CSI-RS ports, and a number of consecutive slots occupied by each aperiodic CSI-RS resource subset is predefined or specified to be 1 slot.

[0043] In some implementations of the BS described herein, the set of CSI-RS resources includes a plurality of aperiodic CSI-RS resources, same OFDM symbols are configured for aperiodic CSI-RS resources in different slots, and a time spacing between any two consecutive aperiodic CSI-RS resources is 0 slot or 1 slot.

[0044] In some implementations of the BS described herein, the set of CSI-RS resources includes a plurality of aperiodic CSI-RS resources, and the configuration information indicates a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in the plurality of aperiodic CSI-RS resources.

[0045] In some implementations of the BS described herein, the corresponding time spacing is 0 slot or 1 slot.

[0046] In some implementations of the BS described herein, the configuration information includes the first number, and the first number is selected from a predefined set of aperiodic CSI-RS resource subset numbers.

[0047] In some implementations of the BS described herein, the predefined set of aperiodic CSI-RS resource subset numbers includes 2, 4, 6 and 8.

[0048] In some implementations of the BS described herein, the at least one processor is configured to cause the BS to: receive first capability information indicating an aperiodic CSI-RS resource subset number supported by a UE.

[0049] In some implementations of the BS described herein, the aperiodic CSI-RS resource subset number supported by the UE is irrelevant with a CSI-RS port number or based on an assumed CSI-RS port number.

[0050] In some implementations of the BS described herein, the configuration information indicates that the set of CSI-RS resources includes a fifth number of aperiodic CSI-RS resources, and the fifth number is selected from a predefined set of aperiodic CSI-RS resource numbers.

[0051] In some implementations of the BS described herein, the predefined set of aperiodic CSI-RS resource numbers includes 4, 8, 12, 16, and 24.

[0052] In some implementations of the BS described herein, the at least one processor is configured to cause the BS to: receive second capability information indicating an aperiodic CSI-RS resource number supported by a UE.

[0053] In some implementations of the BS described herein, the set of CSI-RS resources includes a plurality of periodic or semi-persistent CSI-RS resources or a CSI-RS resource subset including a plurality of periodic or semi-persistent CSI-RS resources.

[0054] In some implementations of the BS described herein, the plurality of periodic or semi-persistent CSI-RS resources have a common periodicity, and a time offset value between any two periodic or semi-persistent CSI-RS resources in the plurality of periodic or semi-persistent CSI-RS resources are smaller than the common periodicity.

[0055] In some implementations of the BS described herein, the configuration information indicates same values of a set of parameters for each of a plurality of periodic or semi-persistent CSI-RS resources included in the set of CSI-RS resources, or for each of a plurality of periodic or semi-persistent CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, or for each of a plurality of aperiodic CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, and the set of parameters includes at least one of: a first parameter indicating a number of ports; a second parameter indicating a CDM type; a third

parameter indicating a CSI-RS frequency density of each CSI-RS port per PRB; a fourth parameter indicating a frequency band for CSI-RS; a fifth parameter indicating an assumed ratio of PDSCH EPRE to NZP CSI-RS EPRE; a sixth parameter indicating an assumed ratio of NZP CSI-RS EPRE to SSB EPRE; a seventh parameter indicating a scrambling ID of CSI-RS; or an eighth parameter containing a reference to a TCI state indicating QCL source reference signal(s) and QCL type(s); or a ninth parameter indicating a frequency domain resource allocation.

[0056] In some implementations of the BS described herein, only one NZP CSI-RS resource or only one CSI-IM resource is configured for interference measurement, and the one NZP CSI-RS resource or the one CSI-IM resource is associated with the set of CSI-RS resources for channel measurement.

[0057] In some implementations of the BS described herein, the configuration information only indicates a set of periodic or semi-persistent CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

[0058] 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 indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; receive CSI-RS based on the configuration information; and perform channel measurement based on the received CSI-RS.

[0059] Some implementations of the methods and apparatuses described herein may include a method performed by a UE. The method may include: receiving configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; receiving CSI-RS based on the configuration information; and performing channel measurement based on the received CSI-RS.

[0060] Some implementations of the methods and apparatuses described herein may include a method performed by a BS. The method may include: transmitting configuration information

indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; and transmitting CSI-RS based on the configuration information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0061] 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.

[0062] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0063] Figure 2 illustrates exemplary aperiodic CSI-RS resource sets for channel measurement in accordance with aspects of the present disclosure.

[0064] Figure 3 illustrates a flowchart of an exemplary method performed by a UE in accordance with aspects of the present disclosure.

[0065] Figure 4 illustrates a flowchart of an exemplary method performed by a BS in accordance with aspects of the present disclosure.

[0066] Figure 5 illustrates an example of a UE in accordance with aspects of the present disclosure.

[0067] Figure 6 illustrates an example of a processor in accordance with aspects of the present disclosure.

[0068] Figure 7 illustrates an example of a BS in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0069] 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.

[0070] 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.

[0071] 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 are provided under specific network architecture and new 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.

[0072] Aspects of the present disclosure are described in the context of a wireless communications system.

[0073] 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.

[0074] 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.

[0075] 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.

[0076] 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.

[0077] 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.

[0078] 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).

[0079] 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.

[0080] 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).

[0081] 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.

[0082] 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., $\mu=0$) 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., $\mu=0$) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., $\mu=1$) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., $\mu=2$) 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., $\mu=3$) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., $\mu=4$) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0083] 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.

[0084] 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., $\mu=0$, $\mu=1$, $\mu=2$, $\mu=3$, $\mu=4$) 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., 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., $\mu=0$) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0085] 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.

[0086] 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., $\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu=2$), 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., $\mu=2$), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., $\mu=3$), which includes 120 kHz subcarrier spacing.

[0087] With the development of communication technology, enhancements on downlink multiple input multiple output (MIMO) that facilitate the use of large antenna array, for both FR1 and FR2, are proposed to fulfil the demand for evolution of NR deployments, especially for 7GHz frequency band(s). 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, especially for the case that the CSI-RS ports are implemented with full digital ports. Herein, the terms "port," "CSI-RS port," "antenna port" and "CSI-RS antenna port" may be used interchangeably.

[0088] An enhanced Type II codebook for predicted PMI (also referred to as eType2-Doppler codebook) may be used for scenarios where UEs move with medium or high velocities to provide more accurate CSI. An enhanced Type II codebook for predicted PMI can be denoted by PMI values and may include codewords (i.e., precoding matrices) corresponding to the PMI values.

[0089] In the existing 5G system, an enhanced Type II codebook for predicted PMI may be designed based on CSI-RS with 8, 12, 16, 24, or 32 ports. For a UE which is configured with a

higher layer parameter *CSI-ReportConfig* which contains *CodebookConfig* containing configuration parameters for enhanced Type II codebook for predicted PMI and *reportQuantity* set to 'cri-RI-PMI-CQI', a UE is expected to be configured with K ($K \in \{4, 8, 12\}$) aperiodic CSI-RS resources or with a single periodic or semi-persistent CSI-RS resource in a resource set for channel measurement. In other words, the channel measurement resource (CMR) configuration for CSI reporting based on an enhanced Type II codebook for predicted PMI using no more than 32 CSI-RS ports may include K ($K \in \{4, 8, 12\}$) aperiodic CSI-RS resources or include a single periodic or semi-persistent CSI-RS resource.

[0090] For a large antenna array with more than 32 ports, multiple legacy CSI-RS resources may be used jointly for generating a CSI-RS resource with more than 32 ports. In such cases, the total number of CSI-RS resources for channel measurement may be increased. Then, how to configure channel measurement resources for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports needs to be solved.

[0091] Embodiments of the present disclosure provide solutions for channel measurement resource configuration for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports, which may include solutions for aperiodic CSI-RS resource set configuration and solutions for periodic or semi-persistent CSI-RS resource set configuration. More details will be described in the following text in combination with the appended drawings.

[0092] According to some embodiments of the present application, for a first CSI-RS resource with more than 32 CSI-RS ports (e.g., up to 128 CSI-RS ports), a first number (e.g., denoted as K_1) of second CSI-RS resources may be configured for a UE to be aggregated to generate the first CSI-RS resource with more than 32 CSI-RS ports. Accordingly, the first CSI-RS resource may be referred to as an aggregated CSI-RS resource. Each of the K_1 second CSI-RS resources may be referred to as a component CSI-RS resource.

[0093] In some examples, each component CSI-RS resource may have no more than 32 CSI-RS ports. In some other examples, at least one of the K_1 component CSI-RS resources may have more than 32 CSI-RS ports. In some examples, the K_1 component CSI-RS resources may have different numbers of CSI-RS ports.

[0094] The channel measurement resource for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may be based on the K_1 component CSI-RS resources.

[0095] According to some embodiments of the present application, a UE may receive, from a BS, configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports. For example, the configuration information may be transmitted by the BS via a radio resource control (RRC) signaling. The set of CSI-RS resources may be an aperiodic CSI-RS resource set including a plurality of aperiodic CSI-RS resources or may be a periodic or semi-persistent CSI-RS resource set including a plurality of periodic or semi-persistent CSI-RS resources. The following Embodiment I provides solutions for configuring an aperiodic CSI-RS resource set and the following Embodiment II provides solutions for configuring a periodic or semi-persistent CSI-RS resource set.

[0096] **Embodiment I**

[0097] In Embodiment I, a UE may receive, from a BS, configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

[0098] In some examples of Embodiment I, the aperiodic CSI-RS resource set may include a second number (e.g., denoted as K_2) of aperiodic CSI-RS resource subsets, and each aperiodic CSI-RS resource subset corresponds to an aggregated CSI-RS resource with more than 32 CSI-RS ports. The aggregated CSI-RS resource may include K_1 component CSI-RS resources, and each component CSI-RS resource may be referred to as an aperiodic CSI-RS resource. Accordingly, there are $K_1 K_2$ aperiodic CSI-RS resources for channel measurement. All of the $K_1 K_2$ aperiodic CSI-RS resources are triggered by a same triggering instance.

[0099] For legacy CMR configuration for CSI reporting based on an enhanced Type II codebook for predicted PMI using no more than 32 CSI-RS ports, a UE may be configured with K ($K \in \{4, 8, 12\}$) aperiodic CSI-RS resources. A value of a time spacing m (in units of slots) between any two consecutive CSI-RS resources may be configured by a higher layer parameter in *NZP-CSI-RS-ResourceSet* as specified in 3GPP standard documents, and the value of m is

restricted as $m \in \{1,2\}$. Accordingly, the number of slots occupied by K CSI-RS resources may be in a range of 4-23 slots. Herein, "two consecutive CSI-RS resources" refer to two CSI-RS resources with consecutive indexes or two adjacent CSI-RS resources in time domain.

[0100] For CMR configuration for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 ports, the number of slots occupied by an aperiodic CSI-RS resource set may be determined based on a third number (e.g., denoted as M_3) of consecutive slots occupied by each aperiodic CSI-RS resource subset, a time spacing (e.g., denoted as M_2) (in units of slots) between any two consecutive aperiodic CSI-RS resource subsets, and the number (e.g., K_2) of aperiodic CSI-RS resource subsets included in the aperiodic CSI-RS resource set. M_3 may depend on the number (e.g., K_1) of aperiodic CSI-RS resources included in an aperiodic CSI-RS resource subset and a corresponding time spacing (e.g., denoted as M_1) (in units of slots) for each two consecutive aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset. Herein, "two consecutive aperiodic CSI-RS resource subsets" refer to two aperiodic CSI-RS resource subsets with consecutive subset indexes or two adjacent aperiodic CSI-RS resource subsets in time domain. Similarly, "two consecutive aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset" refer to two aperiodic CSI-RS resources with consecutive indexes in an aperiodic CSI-RS resource subset or two adjacent aperiodic CSI-RS resources in time domain in an aperiodic CSI-RS resource subset.

[0101] Figure 2 illustrates exemplary aperiodic CSI-RS resource sets for channel measurement in accordance with aspects of the present disclosure. The examples illustrated in Figure 2 include two cases.

[0102] For case 1, $K_1 = 2$ and $K_2 = 4$. That is, the aperiodic CSI-RS resource set for channel measurement includes 4 aperiodic CSI-RS resource subsets, and each aperiodic CSI-RS resource subset includes 2 aperiodic CSI-RS resources (which are denoted as CSI-RS resource 1 and CSI-RS resource 2). A time spacing (in units of slots) between CSI-RS resource 1 and CSI-RS resource 2 in a same aperiodic CSI-RS resource subset is M_1 slots. $M_1 = 0$ means that CSI-RS resource 1 and CSI-RS resource 2 in a same aperiodic CSI-RS resource subset is in a same slot, $M_1 = 1$ means that CSI-RS resource 1 and CSI-RS resource 2 in a same aperiodic CSI-RS resource subset is in two consecutive slots, and so on. Each aperiodic CSI-RS resource subset may occupy M_3 consecutive slots. For example, for an aperiodic CSI-RS resource subset,

in the case that both CSI-RS resource 1 and CSI-RS resource 2 are in slot #1, $M_3 = 1$; in the case that CSI-RS resource 1 is in slot #1 and CSI-RS resource 2 is in slot #2, $M_3 = 2$; in the case that CSI-RS resource 1 is in slot #1 and CSI-RS resource 2 is in slot #3, $M_3 = 3$. The time spacing (in units of slots) between any two consecutive aperiodic CSI-RS resource subsets is M_2 , which is calculated from an end of a slot that an aperiodic CSI-RS resource subset occupies to a start of a slot that a next aperiodic CSI-RS resource subset occupies. The total number of slots occupied by the aperiodic CSI-RS resource set is shown as M_{total1} in Figure 2.

[0103] For case 2, $K_1 = 4$ and $K_2 = 4$. That is, the aperiodic CSI-RS resource set for channel measurement includes 4 aperiodic CSI-RS resource subsets, and each aperiodic CSI-RS resource subset includes 4 aperiodic CSI-RS resources (which are denoted as CSI-RS resources 1-4, respectively). A time spacing (in units of slots) between CSI-RS resource 1 and CSI-RS resource 2 in a same aperiodic CSI-RS resource subset is 0 slot. A time spacing (in units of slots) between CSI-RS resource 2 and CSI-RS resource 3 in a same aperiodic CSI-RS resource subset is M_1 slots. A time spacing (in units of slots) between CSI-RS resource 3 and CSI-RS resource 4 in a same aperiodic CSI-RS resource subset is 0 slot. Each aperiodic CSI-RS resource subset may occupy M_3 consecutive slots. M_1 and M_3 may be calculated in the same manner as described above. The time spacing (in units of slots) between any two consecutive aperiodic CSI-RS resource subsets is M_2 , which is calculated from an end of a slot that an aperiodic CSI-RS resource subset occupies to a start of a slot that a next aperiodic CSI-RS resource subset occupies. The total number of slots occupied by the aperiodic CSI-RS resource set is shown as M_{total2} in Figure 2.

[0104] In some embodiments of the present application, a time spacing between two consecutive CSI-RS resources being 0 slot (i.e., the two consecutive CSI-RS resources in a same slot) may be realized by configuring the two consecutive CSI-RS resources with different symbols in the slot. Such scheme may be referred to as a time-division multiplexing (TDM) scheme. Alternatively or additionally, a time spacing between two consecutive CSI-RS resources being 0 slot may be realized by configuring the two consecutive CSI-RS resources with different physical resource blocks (PRBs) when a CSI-RS frequency density (e.g., denoted as ρ , which may be configured by a higher layer parameter, e.g., *density* as specified in 3GPP standard documents) is configured as 0.5. For example, one of the two consecutive CSI-RS

resources may be configured with PRBs with even indexes and the other may be configured with PRBs with odd indexes. Such scheme may be referred to as a PRB-level frequency-division multiplexing (FDM) scheme. Alternatively or additionally, a time spacing between two consecutive CSI-RS resources being 0 slot may be realized by configuring the two consecutive CSI-RS resources with different REs. Such scheme may be referred to as an RE-level FDM scheme.

[0105] It is assumed that a legacy value of K (i.e., the number of aperiodic CSI-RS resources configured for CSI reporting based on an enhanced Type II codebook for predicted PMI using no more than 32 CSI-RS ports, which is selected from $\{4,8,12\}$) is reused for K_2 , a legacy value of m (i.e., the time spacing between any two consecutive CSI-RS resources configured for CSI reporting based on an enhanced Type II codebook for predicted PMI using no more than 32 CSI-RS ports, which is selected from $\{1,2\}$) is reused for M_1 and M_2 . For CSI reporting with 64 ports, 2 legacy CSI-RS resources with 32 ports may be aggregated to generate a CSI-RS resource with 64 ports, i.e., $K_1 = 2$. Then, the maximum number of slots occupied by an aperiodic CSI-RS resource set for channel measurement may be 47 slots. For CSI reporting with 128 ports, 4 legacy CSI resources with 32 ports may be aggregated to generate a CSI-RS resource with 128 ports, i.e., $K_1 = 4$. Then, the maximum number of slots occupied by an aperiodic CSI-RS resource set for channel measurement may be 95 slots. It is not desirable to take so many slots for CSI-RS transmission because (1) the required time for obtaining reported CSI is too long, which is not beneficial for aperiodic reporting for a high-speed UE with fast channel change, and (2) it may have impact on other signals or channels from a multiplexing perspective.

[0106] In some other examples of Embodiment I, the aperiodic CSI-RS resource set may include K_2 aggregated CSI-RS resources with more than 32 CSI-RS ports, wherein each aggregated CSI-RS resource may include K_1 component CSI-RS resources, and each component CSI-RS resource may be referred to as an aperiodic CSI-RS resource. Accordingly, the aperiodic CSI-RS resource set includes $K_1 K_2$ aperiodic CSI-RS resources for channel measurement, which are triggered by a same triggering instance. The $K_1 K_2$ aperiodic CSI-RS resources may be indexed within the whole aperiodic CSI-RS resource set. That is, they may not be explicitly organized into aperiodic CSI-RS resource subsets. The K_2 aggregated CSI-RS resources may be implicitly derived based on indexes of the $K_1 K_2$ aperiodic CSI-RS resources.

For example, a first aggregated CSI-RS resource may include aperiodic CSI-RS resources with indexes of 0 to $K_1 - 1$, a second aggregated CSI-RS resource may include aperiodic CSI-RS resources with indexes of K_1 to $2K_1 - 1$, and so on. The issue mentioned in the above paragraph is also involved in such examples.

[0107] Given this, the following Schemes 1 and 2 provide solutions for configuring an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports, which may reduce the total number of slots occupied by an aperiodic CSI-RS resource set. For example, Scheme 1 may provide solutions for restricting a time spacing between aperiodic CSI-RS resource subsets and/or a time spacing between aperiodic CSI-RS resources, and Scheme 2 may provide solutions for restricting the number of aperiodic CSI-RS resource subsets and/or the number of aperiodic CSI-RS resources.

[0108] **Scheme 1**

[0109] Scheme 1 may include Scheme 1-1 and Scheme 1-2. Scheme 1-1 provides solutions based on aperiodic CSI-RS resource subsets, whereas Scheme 1-2 provides solutions not based on aperiodic CSI-RS resource subsets but based on aperiodic CSI-RS resources.

[0110] **Scheme 1-1**

[0111] In Scheme 1-1, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may indicate that: the aperiodic CSI-RS resource set includes K_2 aperiodic CSI-RS resource subsets, and each aperiodic CSI-RS resource subset includes K_1 aperiodic CSI-RS resources. In some embodiments, a legacy value of K (i.e., the number of aperiodic CSI-RS resources configured for CSI reporting based on an enhanced Type II codebook for predicted PMI using no more than 32 CSI-RS ports) may be reused for K_2 , i.e., $K_2 \in \{4, 8, 12\}$, which is used to guarantee a similar prediction performance as a legacy system.

[0112] According to some embodiments of Scheme 1-1, for aperiodic CSI-RS resources with a same index in each aperiodic CSI-RS resource subset of the K_2 aperiodic CSI-RS resource subsets, the configuration information may further indicate at least one of: a same

number of CSI-RS ports; same CSI-RS port index(es); a same BW; same RE location(s); or a same power control offset value.

[0113] According to some embodiments of Scheme 1-1, the configuration information may further indicate a time spacing M_2 (in units of slots) between any two consecutive aperiodic CSI-RS resource subsets in the K_2 aperiodic CSI-RS resource subsets. In some embodiments, M_2 may be 0 slot or 1 slot.

[0114] According to some embodiments of Scheme 1-1, an aggregated CSI-RS resource with 48, 64, 96, or 128 CSI-RS ports may take 48, 64, 96, or 128 REs, respectively. Thus, an aggregated CSI-RS resource with 48 or 64 CSI-RS ports (i.e., an aperiodic CSI-RS resource subset for 48 or 64 CSI-RS ports) may take 1 slot or 2 slots, and an aggregated CSI-RS resource with 96 or 128 CSI-RS ports (i.e., an aperiodic CSI-RS resource subset for 96 or 128 CSI-RS ports) may take at least 2 slots.

[0115] To determine a time spacing between consecutive aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset or a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset, it may be restricted that each aperiodic CSI-RS resource subset occupies 1 or 2 consecutive slots (i.e., $M_3 = 1 \text{ or } 2$), which is used to guarantee the time coherence for up to 128 CSI-RS ports. Based on this restriction, various solutions may be used for determining a time spacing between consecutive aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset or a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset.

[0116] In some embodiments, the UE may assume that same OFDM symbols are configured for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in different slots or non-overlapping REs are configured for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in a same slot (i.e., aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in a same slot are not configured with overlapping REs). In such embodiments, the BS should configure same OFDM symbols for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in different slots or configure non-overlapping REs for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in a same slot.

[0117] Based on the above assumption, the UE may determine a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset.

[0118] Taking a first aperiodic CSI-RS resource subset in the aperiodic CSI-RS resource set as an example, based on a higher layer parameter, e.g., *aperiodicTriggeringOffset* as specified in 3GPP standard documents, the UE may determine a starting slot index of the aperiodic CSI-RS resource set, which is also the slot index of a first aperiodic CSI-RS resource in the first aperiodic CSI-RS resource subset. The exact OFDM symbol index(es) for the first aperiodic CSI-RS resource may be determined based on higher layer parameter(s), e.g., at least one of *firstOFDMSymbolInTimeDomain* or *firstOFDMSymbolInTimeDomain2* as specified in 3GPP standard documents. Then, based on the assumption that same OFDM symbols are configured for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in different slots or non-overlapping REs are configured for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in a same slot, the UE may determine slot indexes for all the other aperiodic CSI-RS resources in the first aperiodic CSI-RS resource subset, which may be the same as the slot index of the first aperiodic CSI-RS resource or may be the slot index of the first aperiodic CSI-RS resource plus 1. In such embodiments, M_3 (i.e., the number of consecutive slots occupied by an aperiodic CSI-RS resource subset) can be implicitly determined. For example, if all the CSI-RS transmission associated with the first aperiodic CSI-RS resource subset are detected in one slot, then $M_3 = 1$; if all the CSI-RS transmission associated with the first aperiodic CSI-RS resource subset are detected in two slots, then $M_3 = 2$.

[0119] A slot index for each aperiodic CSI-RS resource in any other aperiodic CSI-RS resource subset in the aperiodic CSI-RS resource set may be determined in a similar manner. The difference is that the starting slot index of any other aperiodic CSI-RS resource subset may be determined further based on M_2 , i.e., the time spacing between any two consecutive aperiodic CSI-RS resource subsets.

[0120] In some embodiments, flexible OFDM symbols may be configured for aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset in different slots. In such embodiments, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may further indicate that a fourth number (e.g., denoted

as K_3) of CSI-RS resources in each aperiodic CSI-RS resource subset are included in a first slot of M_3 consecutive slots occupied by the aperiodic CSI-RS resource subset. Then, a number of CSI-RS resources included in a second slot of the M_3 consecutive slots may be determined as $K_1 - K_3$. In such embodiments, M_3 can be implicitly determined. For example, if $K_1 = K_3$, then $M_3 = 1$; if $K_1 \neq K_3$ then $M_3 = 2$.

[0121] In such embodiments, the UE may determine a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset based on K_3 . Still taking the first aperiodic CSI-RS resource subset in the aperiodic CSI-RS resource set as an example, the UE may determine a slot index of a first aperiodic CSI-RS resource in the first aperiodic CSI-RS resource subset based on a higher layer parameter, e.g., *aperiodicTriggeringOffset* as specified in 3GPP standard documents. If $K_1 = K_3$, the slot indexes of all the other aperiodic CSI-RS resources in the first aperiodic CSI-RS resource subset are the same as that of the first aperiodic CSI-RS resource. If $K_1 \neq K_3$, the slot indexes of second to K_3 -th aperiodic CSI-RS resources in the first aperiodic CSI-RS resource subset are the same as that of the first aperiodic CSI-RS resource, and the slot indexes of $(K_3 + 1)$ -th to K_1 -th aperiodic CSI-RS resources in the first aperiodic CSI-RS resource subset are the slot index of the first aperiodic CSI-RS resource plus 1.

[0122] A slot index for each aperiodic CSI-RS resource in any other aperiodic CSI-RS resource subset in the aperiodic CSI-RS resource set may be determined in a similar manner. The difference is that the starting slot index of any other aperiodic CSI-RS resource subset may be determined further based on M_2 , i.e., the time spacing between any two consecutive aperiodic CSI-RS resource subsets.

[0123] In some embodiments, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may further indicate a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset. In some examples, the corresponding time spacing may be 0 slot or 1 slot. The corresponding time spacing between the i -th aperiodic CSI-RS resource and the $(i-1)$ -th aperiodic CSI-RS resource may be denoted as $M_{1,i}$, wherein $2 \leq i \leq K_1$. Then, each aperiodic CSI-RS resource subset may occupy $M_3 = 1 + \sum_{i=2}^{K_1} M_{1,i}$ consecutive slots.

[0124] In such embodiments, the UE may determine a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset based on the corresponding time spacing. Still taking the first aperiodic CSI-RS resource subset in the aperiodic CSI-RS resource set as an example, the UE may determine a slot index of a first aperiodic CSI-RS resource in the first aperiodic CSI-RS resource subset based on a higher layer parameter, e.g., *aperiodicTriggeringOffset* as specified in 3GPP standard documents. Then, the UE may determine slot indexes of all the other aperiodic CSI-RS resources in the first aperiodic CSI-RS resource subset based on the corresponding time spacing.

[0125] A slot index for each aperiodic CSI-RS resource in any other aperiodic CSI-RS resource subset in the aperiodic CSI-RS resource set may be determined in a similar manner. The difference is that the starting slot index of any other aperiodic CSI-RS resource subset may be determined further based on M_2 , i.e., the time spacing between any two consecutive aperiodic CSI-RS resource subsets.

[0126] According to some embodiments of Scheme 1-1, to reduce aperiodic CSI-RS transmission time, M_3 (i.e., the number of consecutive slots occupied by an aperiodic CSI-RS resource subset) may be further restricted as a value related with CSI-RS port number. For example, M_3 may be 1 in case of CSI reporting using 48 or 64 CSI-RS ports, or may be 2 in case of CSI reporting using 96 or 128 CSI-RS ports.

[0127] According to some embodiments of Scheme 1-1, to reduce aperiodic CSI-RS transmission time, it may be restricted that the CSI reporting based on the enhanced Type II codebook for predicted PMI only uses no more than 64 CSI-RS ports, and a number of consecutive slots (e.g., M_3) occupied by each aperiodic CSI-RS resource subset is predefined or specified to be 1 slot.

[0128] According to some embodiments of Scheme 1-1, to reduce aperiodic CSI-RS transmission time, the time spacing (e.g., M_2) between any two consecutive aperiodic CSI-RS resource subsets may be predefined or specified to be 0 slot.

[0129] According to some embodiments of Scheme 1-1, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may

further indicate same values of a set of parameters for each of the aperiodic CSI-RS resources included in a aperiodic CSI-RS resource subset, and the set of parameters may include at least one of:

- a first parameter (e.g., *nrofPorts* as specified in 3GPP standard documents) indicating a number of ports;
- a second parameter (e.g., *cdm-Type* as specified in 3GPP standard documents) indicating a CDM type;
- a third parameter (e.g., *density* as specified in 3GPP standard documents) indicating a CSI-RS frequency density of each CSI-RS port per PRB;
- a fourth parameter (e.g., *freqBand* as specified in 3GPP standard documents) indicating a frequency band for CSI-RS;
- a fifth parameter (e.g., *powerControlOffset* as specified in 3GPP standard documents) indicating an assumed ratio of PDSCH EPRE to NZP CSI-RS EPRE;
- a sixth parameter (e.g., *powerControlOffsetSS* as specified in 3GPP standard documents) indicating an assumed ratio of NZP CSI-RS EPRE to SSB EPRE;
- a seventh parameter (e.g., *scramblingID* as specified in 3GPP standard documents) indicating a scrambling ID of CSI-RS;
- an eighth parameter (e.g., *qcl-InfoPeriodicCSI-RS* as specified in 3GPP standard documents) containing a reference to a TCI state indicating QCL source reference signal(s) and QCL type(s); or
- a ninth parameter (e.g., *frequencyDomainAllocation* as specified in 3GPP standard documents) indicating a frequency domain resource allocation.

[0130] In some examples, if the third parameter is configured as 1, a TDM scheme may be used for the aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset. If the third parameter is configured as 0.5, a PRB-level FDM scheme may be used for the aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset. In some examples, if a TDM scheme is used for the aperiodic CSI-RS resources included in the aperiodic CSI-RS resource subset, the

configuration information may indicate a same value of the ninth parameter for of the TDMed aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset. However, if a FDM scheme is used for the aperiodic CSI-RS resources included in the aperiodic CSI-RS resource subset, the configuration information may indicate different values of the ninth parameter for the FDMed aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset.

[0131] Scheme 1-2

[0132] In Scheme 1-2, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may indicate that the aperiodic CSI-RS resource set includes a plurality of aperiodic CSI-RS resources. The plurality of aperiodic CSI-RS resources may be indexed within the whole aperiodic CSI-RS resource set. As described above, although not explicitly organized into aperiodic CSI-RS resource subsets, the plurality of aperiodic CSI-RS resources may correspond to K_2 aggregated CSI-RS resources with more than 32 CSI-RS ports, wherein each aggregated CSI-RS resource may include K_1 components CSI-RS resources.

[0133] For illustrative purpose only, the K_1 component CSI-RS resources of an aggregated CSI-RS resources with more than 32 CSI-RS ports may also be referred to an aperiodic CSI-RS resource subset although not explicitly organized into an aperiodic CSI-RS resource subset, and thus the plurality of aperiodic CSI-RS resources include K_2 aperiodic CSI-RS resource subsets. Then, the plurality of aperiodic CSI-RS resources may be ordered as {CSI-RS resource 1 from aperiodic CSI-RS resource subset 1, CSI-RS resource 2 from aperiodic CSI-RS resource subset 1, ..., CSI-RS resource K_1 from aperiodic CSI-RS resource subset 1, CSI-RS resource 1 from aperiodic CSI-RS resource subset 2, ..., CSI-RS resource K_1 from aperiodic CSI-RS resource subset 2, ..., CSI-RS resource 1 from aperiodic CSI-RS resource subset K_2 , ..., CSI-RS resource K_1 from aperiodic CSI-RS resource subset K_2 }.

[0134] The following embodiments provide solutions for determining a time spacing between consecutive aperiodic CSI-RS resources in the aperiodic CSI-RS resource set or a slot index for each aperiodic CSI-RS resource in the aperiodic CSI-RS resource set. Herein, "consecutive aperiodic CSI-RS resources in the aperiodic CSI-RS resource set" refer to

aperiodic CSI-RS resources with consecutive indexes in the aperiodic CSI-RS resource set or adjacent aperiodic CSI-RS resources in time domain in the aperiodic CSI-RS resource set.

[0135] According to some embodiments of Scheme 1-2, it is restricted that a time spacing between any two consecutive aperiodic CSI-RS resources is 0 slot or 1 slot. A UE may assume that same OFDM symbols are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource set in different slots. In such embodiments, the BS should configure same OFDM symbols for aperiodic CSI-RS resources in the aperiodic CSI-RS resource set in different slots. Based on the above assumption, the UE may determine a slot index for each aperiodic CSI-RS resource in the aperiodic CSI-RS resource set.

[0136] For example, the UE may determine a slot index of a first aperiodic CSI-RS resource in the aperiodic CSI-RS resource set based on a higher layer parameter, e.g., *aperiodicTriggeringOffset* as specified in 3GPP standard documents. The exact OFDM symbol index(es) for the first aperiodic CSI-RS resource may be determined based on higher layer parameter(s), e.g., at least one of *firstOFDMSymbolInTimeDomain* or *firstOFDMSymbolInTimeDomain2* as specified in 3GPP standard documents. Then, based on the assumption that same OFDM symbols are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource set in different slots, the UE may determine a slot index for a second aperiodic CSI-RS resource in the aperiodic CSI-RS resource set, which may be the same as the slot index of the first aperiodic CSI-RS resource or may be the slot index of the first aperiodic CSI-RS resource plus 1. The UE may determine slot index(es) for the remaining aperiodic CSI-RS resource(s) in the aperiodic CSI-RS resource set similarly. The UE may determine slot indexes of the aperiodic CSI-RS resources according to an increasing order of indexes of aperiodic CSI-RS resources. That is, a slot index of an aperiodic CSI-RS resource may be determined based on a slot index of a previous aperiodic CSI-RS resource.

[0137] According to some embodiments of Scheme 1-2, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may further indicate a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in the plurality of aperiodic CSI-RS resources included in the aperiodic CSI-RS resource set. In some examples, the corresponding time spacing may be 0 slot or 1 slot.

[0138] In such embodiments, the UE may determine a slot index for each aperiodic CSI-RS resource in the aperiodic CSI-RS resource set based on the corresponding time spacing

[0139] For example, the UE may determine a slot index of a first aperiodic CSI-RS resource in the aperiodic CSI-RS resource set based on a higher layer parameter, e.g., *aperiodicTriggeringOffset* as specified in 3GPP standard documents. The exact OFDM symbol index(es) for the first aperiodic CSI-RS resource may be determined based on higher layer parameter(s), e.g., at least one of *firstOFDMSymbolInTimeDomain* or *firstOFDMSymbolInTimeDomain2* as specified in 3GPP standard documents. Then, the UE may determine a slot index of each of the other aperiodic CSI-RS resources in the aperiodic CSI-RS resource set based on the corresponding time spacing between the aperiodic CSI-RS resource and a previous aperiodic CSI-RS resource.

[0140] For example, the corresponding time spacing between the i -th aperiodic CSI-RS resource and $(i-1)$ -th aperiodic CSI-RS resource in the aperiodic CSI-RS resource set may be denoted as $M_{1,i}$, wherein $2 \leq i \leq K_{total}$, K_{total} is a total number of aperiodic CSI-RS resources included in the aperiodic CSI-RS resource set. Then, the aperiodic CSI-RS resource set may occupy $1 + \sum_{i=2}^{K_{total}} M_{1,i}$ consecutive slots.

[0141] In some cases, the total CSI-RS transmission time is linear with the number of aperiodic CSI-RS resource subsets included in the set of aperiodic CSI-RS resources. Given this, it is beneficial to limit the number of aperiodic CSI-RS resource subsets. In addition, the required CSI processing unit (CPU) number may increase as the total number of aperiodic CSI-RS resources increases. It is also beneficial to limit the number of aperiodic CSI-RS resource subsets, so as to decrease the total number of aperiodic CSI-RS resources, thereby reducing the required CPU number. The following Scheme 2 provides solutions related to the number of aperiodic CSI-RS resource subsets in an aperiodic CSI-RS resource set or the number of aperiodic CSI-RS resources in an aperiodic CSI-RS resource set.

[0142] **Scheme 2**

[0143] Scheme 2 may include Scheme 2-1 and Scheme 2-2.

[0144] **Scheme 2-1**

[0145] Scheme 2-1 may provide solutions for limiting the number of aperiodic CSI-RS resource subsets in an aperiodic CSI-RS resource set.

[0146] According to some embodiments of Scheme 2-1, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may indicate that: the aperiodic CSI-RS resource set includes K_2 aperiodic CSI-RS resource subsets, and each aperiodic CSI-RS resource subset includes K_1 aperiodic CSI-RS resources.

[0147] In some embodiments, the configuration information may include K_2 , wherein K_2 may be selected from a predefined set of aperiodic CSI-RS resource subset numbers. In some examples, the predefined set of aperiodic CSI-RS resource subset numbers includes 2, 4, 6 and 8.

[0148] In some embodiments, the UE may transmit, to the BS, capability information indicating an aperiodic CSI-RS resource subset number supported by the UE. Based on the capability information, the BS may configure a suitable value of K_2 to the UE without exceeding the capability supported by the UE.

[0149] In an embodiment, the aperiodic CSI-RS resource subset number indicated in the capability information may be irrelevant with a CSI-RS port number.

[0150] In another embodiment, the aperiodic CSI-RS resource subset number indicated in the capability information may be based on an assumed or predefined CSI-RS port number. For example, the assumed or predefined CSI-RS port number may be 32, 64, or 128. In some embodiments, K_2 configured by the BS may be a scaled value of the aperiodic CSI-RS resource subset number indicated in the capability information reported by the UE when the configured CSI-RS port number is not the same as the assumed or predefined CSI-RS port number. For example, it is assumed that the assumed or predefined CSI-RS port number is 32, and the aperiodic CSI-RS resource subset number indicated in the capability information reported by the UE is 8. In the case that the configured CSI-RS port number is 64, i.e., each aperiodic CSI-RS resource subset includes 2 aperiodic CSI-RS resource, the BS may configure K_2 as 4.

[0151] Scheme 2-1 may be combined with Scheme 1-1 in configuring an aperiodic CSI-RS resource set.

[0152] Scheme 2-2

[0153] Scheme 2-2 may provide solutions for limiting the number of aperiodic CSI-RS resources in an aperiodic CSI-RS resource set.

[0154] According to some embodiments of Scheme 2-2, the configuration information indicating an aperiodic CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may indicate that the aperiodic CSI-RS resource set includes a fifth number (e.g., denoted as K_4) of aperiodic CSI-RS resources. For example, the configuration information may include K_4 . K_4 may be selected from a predefined set of aperiodic CSI-RS resource numbers. For example, the predefined set of aperiodic CSI-RS resource numbers includes 4, 8, 12, 16, and 24.

[0155] In some embodiments, based on K_1 (i.e., the number of component CSI-RS resources included in an aggregated CSI-RS resources with more than 32 CSI-RS ports or the number of aperiodic CSI-RS resources included in an aperiodic CSI-RS resource subset) configured by the BS, the UE may further determine the number of aggregated CSI-RS resources or the number of aperiodic CSI-RS resource subsets included in the aperiodic CSI-RS resource set as $K_2 = K_4/K_1$.

[0156] In some embodiments, the UE may transmit, to the BS, capability information indicating an aperiodic CSI-RS resource number supported by the UE. Based on the capability information, the BS can configure a suitable value of K_4 to the UE without exceeding the UE's capability.

[0157] Scheme 2-2 may be combined with Scheme 1-1 or Scheme 1-2 in configuring an aperiodic CSI-RS resource set.

[0158] Although in Embodiment I, the aperiodic CSI-RS resources corresponding to an aggregated CSI-RS resource with more than 32 ports is referred to as an aperiodic CSI-RS resource subset, they may also be referred to as a set of aperiodic CSI-RS resources, a group of aperiodic CSI-RS resources, etc., without departing from the spirit and scope of the disclosure.

[0159] Embodiment II

[0160] In Embodiment II, a UE may receive, from a BS, configuration information indicating a periodic or semi-persistent CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports. The periodic or semi-persistent CSI-RS resource set may include a plurality of periodic or semi-persistent CSI-RS resources or include a CSI-RS resource subset (e.g., only one CSI-RS resource subset) including a plurality of periodic or semi-persistent CSI-RS resources.

[0161] For example, the plurality of periodic or semi-persistent CSI-RS resources may correspond to an aggregated CSI-RS resource with more than 32 ports which includes K_1 component CSI-RS resources. In some examples, a value of K_1 may be selected from {2, 3, 4, 8}. Each of the K_1 component CSI-RS resources may be referred to as a periodic or semi-persistent CSI-RS resource.

[0162] In some embodiments, for the plurality of periodic or semi-persistent CSI-RS resources, one or multiple transmission occasions no later than a CSI reference resource can be used for determining CSI with UE prediction.

[0163] In some embodiments, the plurality of periodic or semi-persistent CSI-RS resources may have a common periodicity. A time offset value between any two periodic or semi-persistent CSI-RS resources in the plurality of periodic or semi-persistent CSI-RS resources are smaller than the common periodicity, thereby avoiding the resource collision between the transmissions of the plurality of periodic or semi-persistent CSI-RS resources.

[0164] In some embodiments, the configuration information indicating a periodic or semi-persistent CSI-RS resource set for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports may further indicate same values of a set of parameters for each of the plurality of periodic or semi-persistent CSI-RS resources, and the set of parameters may include at least one of:

- a first parameter (e.g., *nrofPorts* as specified in 3GPP standard documents) indicating a number of ports;
- a second parameter (e.g., *cdm-Type* as specified in 3GPP standard documents) indicating a CDM type;

- a third parameter (e.g., *density* as specified in 3GPP standard documents) indicating a CSI-RS frequency density of each CSI-RS port per PRB;
- a fourth parameter (e.g., *freqBand* as specified in 3GPP standard documents) indicating a frequency band for CSI-RS;
- a fifth parameter (e.g., *powerControlOffset* as specified in 3GPP standard documents) indicating an assumed ratio of PDSCH EPRE to NZP CSI-RS EPRE;
- a sixth parameter (e.g., *powerControlOffsetSS* as specified in 3GPP standard documents) indicating an assumed ratio of NZP CSI-RS EPRE to SSB EPRE;
- a seventh parameter (e.g., *scramblingID* as specified in 3GPP standard documents) indicating a scrambling ID of CSI-RS;
- an eighth parameter (e.g., *qcl-InfoPeriodicCSI-RS* as specified in 3GPP standard documents) containing a reference to a transmission TCI state indicating QCL source reference signal(s) and QCL type(s); or
- a ninth parameter (e.g., *frequencyDomainAllocation* as specified in 3GPP standard documents) indicating a frequency domain resource allocation

[0165] In some examples, if the third parameter is configured as 1, a TDM scheme may be used for the plurality of periodic or semi-persistent CSI-RS resources. If the third parameter is configured as 0.5, a PRB-level FDM scheme may be used for the plurality of periodic or semi-persistent CSI-RS resources. In some examples, if a TDM scheme is used for the plurality of periodic or semi-persistent CSI-RS resources, the configuration information may indicate a same value of the ninth parameter for of the TDMed periodic or semi-persistent CSI-RS resources. However, if a FDM scheme is used for the plurality of periodic or semi-persistent CSI-RS resources, the configuration information may indicate different values of the ninth parameter for the FDMed periodic or semi-persistent CSI-RS resources.

[0166] According to some embodiments of the present application, the BS may configure only one NZP CSI-RS resource or only one CSI-IM resource for the UE to perform interference measurement, and the one NZP CSI-RS resource or the one CSI-IM resource is associated with

the set of CSI-RS resources for channel measurement (i.e., the aforementioned aperiodic CSI-RS resource set or periodic or semi-persistent CSI-RS resource set) configured by the BS.

[0167] According to some embodiments of the present application, the UE is not expected to receive a set of aperiodic CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports. That is, the configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports is not expected to indicate a set of aperiodic CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for PMI using more than 32 CSI-RS ports. In other words, the configuration information only indicates a set of periodic or semi-persistent CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

[0168] According to some embodiments of the present application, the BS may transmit CSI-RS based on the configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports. Correspondingly, the UE may receive the CSI-RS based on the configuration information. Then, the UE may perform channel measurement based on the received CSI-RS, so as to determine PMI associated with the enhanced Type II codebook for predicted PMI. Then, the UE may transmit a CSI report to the BS, and the CSI report may include the determined PMI. Consequently, the BS may receive the CSI report.

[0169] 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 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.

[0170] As shown in Figure 3, in step 302, the UE may receive, from a BS (e.g., NE 102 in Figure 1), configuration information (e.g., via RRC signaling) indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

[0171] According to some embodiments of the present disclosure, the configuration information may indicate that the set of CSI-RS resources includes a first number of aperiodic CSI-RS resource subsets, and that each aperiodic CSI-RS resource subset includes a second number of aperiodic CSI-RS resources.

[0172] In some embodiments, for aperiodic CSI-RS resources with a same index in each aperiodic CSI-RS resource subset of the first number of aperiodic CSI-RS resource subsets, the configuration information may indicate at least one of: a same number of CSI-RS ports; same CSI-RS port index(es); a same BW; same RE location(s); or a same power control offset value.

[0173] In some embodiments, the configuration information may further indicate a time spacing between any two consecutive aperiodic CSI-RS resource subsets in the first number of aperiodic CSI-RS resource subsets. For example, the time spacing between any two consecutive aperiodic CSI-RS resource subsets is 0 slot or 1 slot.

[0174] In some embodiments, a time spacing between any two consecutive aperiodic CSI-RS resource subsets may be predefined or specified to be 0 slot.

[0175] In some embodiments, each aperiodic CSI-RS resource subset may occupy a third number of consecutive slots, and the third number is 1 or 2.

[0176] In an embodiment, the UE may determine a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset based on an assumption that same OFDM symbols are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset in different slots or non-overlapping REs are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset in a same slot.

[0177] In another embodiment, the configuration information may further indicate that a fourth number of CSI-RS resources in each aperiodic CSI-RS resource subset are included in a first slot of the third number of consecutive slots.

[0178] In some embodiments, the configuration information may further indicate a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset. For example, the corresponding time spacing is 0 slot or 1 slot.

[0179] In some embodiments, the third number may be 1 in case of CSI reporting using 48 or 64 CSI-RS ports, or 2 in case of CSI reporting using 96 or 128 CSI-RS ports.

[0180] In some embodiments, the CSI reporting based on the enhanced Type II codebook for predicted PMI may only use no more than 64 CSI-RS ports, and a number of consecutive slots occupied by each aperiodic CSI-RS resource subset is predefined or specified to be 1 slot.

[0181] According to some embodiments of the present disclosure, the set of CSI-RS resources may include a plurality of aperiodic CSI-RS resources, a time spacing between any two consecutive aperiodic CSI-RS resources is 0 slot or 1 slot, and the UE may determine a slot index for each aperiodic CSI-RS resource in the plurality of aperiodic CSI-RS resources based on an assumption that same OFDM symbols are configured for aperiodic CSI-RS resources in different slots.

[0182] According to some embodiments of the present disclosure, the set of CSI-RS resources may include a plurality of aperiodic CSI-RS resources, and the configuration information indicates a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in the plurality of aperiodic CSI-RS resources. For example, the corresponding time spacing is 0 slot or 1 slot.

[0183] According to some embodiments of the present disclosure, the configuration information may include the first number, and the first number is selected from a predefined set of aperiodic CSI-RS resource subset numbers.

[0184] In some embodiments, the predefined set of aperiodic CSI-RS resource subset numbers may include 2, 4, 6 and 8.

[0185] According to some embodiments of the present disclosure, the UE may transmit first capability information indicating an aperiodic CSI-RS resource subset number supported by the UE.

[0186] In some embodiments, the aperiodic CSI-RS resource subset number supported by the UE is irrelevant with a CSI-RS port number or based on an assumed CSI-RS port number.

[0187] According to some embodiments of the present disclosure, the configuration information may indicate that the set of CSI-RS resources includes a fifth number of aperiodic

CSI-RS resources, and the fifth number is selected from a predefined set of aperiodic CSI-RS resource numbers.

[0188] In some embodiments, the predefined set of aperiodic CSI-RS resource numbers may include 4, 8, 12, 16, and 24.

[0189] According to some embodiments of the present disclosure, the UE may transmit second capability information indicating an aperiodic CSI-RS resource number supported by the UE.

[0190] According to some embodiments of the present disclosure, the set of CSI-RS resources may include a plurality of periodic or semi-persistent CSI-RS resources or a CSI-RS resource subset including a plurality of periodic or semi-persistent CSI-RS resources.

[0191] In some embodiments, the plurality of periodic or semi-persistent CSI-RS resources may have a common periodicity, and a time offset value between any two periodic or semi-persistent CSI-RS resources in the plurality of periodic or semi-persistent CSI-RS resources are smaller than the common periodicity.

[0192] According to some embodiments of the present disclosure, the configuration information may indicate same values of a set of parameters for each of a plurality of periodic or semi-persistent CSI-RS resources included in the set of CSI-RS resources, or for each of a plurality of periodic or semi-persistent CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, or for each of a plurality of aperiodic CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, and the set of parameters may include at least one of: a first parameter indicating a number of ports; a second parameter indicating a CDM type; a third parameter indicating a CSI-RS frequency density of each CSI-RS port per PRB; a fourth parameter indicating a frequency band for CSI-RS; a fifth parameter indicating an assumed ratio of PDSCH EPRE to NZP CSI-RS EPRE; a sixth parameter indicating an assumed ratio of NZP CSI-RS EPRE to SSB EPRE; a seventh parameter indicating a scrambling ID of CSI-RS; an eighth parameter containing a reference to a TCI state indicating QCL source reference signal(s) and QCL type(s); or a ninth parameter indicating a frequency domain resource allocation.

[0193] According to some embodiments of the present disclosure, only one NZP CSI-RS resource or only one CSI-IM resource is configured for interference measurement, and the one NZP CSI-RS resource or the one CSI-IM resource is associated with the set of CSI-RS resources for channel measurement.

[0194] According to some embodiments of the present disclosure, the configuration information only indicates a set of periodic or semi-persistent CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

[0195] In step 304, the UE may receive CSI-RS based on the configuration information received in step 302.

[0196] In step 306, the UE may perform channel measurement based on the received CSI-RS.

[0197] Figure 4 illustrates a flowchart of an exemplary method in accordance with aspects of the present disclosure. The operations of the method illustrated in Figure 4 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.

[0198] As shown in Figure 4, in step 402, the BS may transmit, to a UE (e.g., UE 104 in Figure 1), configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

[0199] In step 404, the BS may transmit, to the UE, CSI-RS based on the configuration information.

[0200] All the definitions and operations related to the configuration information and the set of CSI-RS resources described in the aforementioned embodiments and with respect to Figure 3 may also apply here. Thus, details are omitted for simplicity.

[0201] Figure 5 illustrates an example of a UE 500 in accordance with aspects of the present disclosure. The UE 500 may include at least one processor 502 and at least one memory 504.

Additionally, the UE 500 may also include one or more of at least one controller 506 or at least one transceiver 508. The processor 502, the memory 504, the controller 506, or the transceiver 508, 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.

[0202] The processor 502, the memory 504, the controller 506, or the transceiver 508, 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.

[0203] The processor 502 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 502 may be configured to operate the memory 504. In some other implementations, the memory 504 may be integrated into the processor 502. The processor 502 may be configured to execute computer-readable instructions stored in the memory 504 to cause the UE 500 to perform various functions of the present disclosure.

[0204] The memory 504 may include volatile or non-volatile memory. The memory 504 may store computer-readable, computer-executable code including instructions when executed by the processor 502 cause the UE 500 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 504 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.

[0205] In some implementations, the processor 502 and the memory 504 coupled with the processor 502 may be configured to cause the UE 500 to perform one or more of the functions described herein (e.g., executing, by the processor 502, instructions stored in the memory 504).

For example, the processor 502 may support wireless communication at the UE 500 in accordance with examples as disclosed herein. The UE 500 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 502 may be configured to cause the UE 500 to: receive configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; receive CSI-RS based on the configuration information; and perform channel measurement based on the received CSI-RS.

[0206] The controller 506 may manage input and output signals for the UE 500. The controller 506 may also manage peripherals not integrated into the UE 500. In some implementations, the controller 506 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 506 may be implemented as part of the processor 502.

[0207] In some implementations, the UE 500 may include at least one transceiver 508. In some other implementations, the UE 500 may have more than one transceiver 508. The transceiver 508 may represent a wireless transceiver. The transceiver 508 may include one or more receiver chains 510, one or more transmitter chains 512, or a combination thereof.

[0208] A receiver chain 510 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 510 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 510 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 510 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 510 may include at least one decoder for decoding the demodulated signal to receive the transmitted data.

[0209] A transmitter chain 512 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 512 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 512 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 512 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0210] Figure 6 illustrates an example of a processor 600 in accordance with aspects of the present disclosure. The processor 600 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 600 may include at least one controller 602 configured to perform various operations in accordance with examples as described herein. The processor 600 may optionally include at least one memory 604, which may be, for example, a layer 1 (L1), layer 2 (L2), or layer 3 (L3) cache. Additionally, or alternatively, the processor 600 may optionally include one or more arithmetic-logic units (ALUs) 606. 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).

[0211] The processor 600 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 600) 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).

[0212] The controller 602 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 600 to cause the processor 600 to support various operations in accordance with examples as described herein. For example, the controller 602 may operate as a control unit of the processor 600, generating

control signals that manage the operation of various components of the processor 600. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0213] The controller 602 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 604 and determine subsequent instruction(s) to be executed to cause the processor 600 to support various operations in accordance with examples as described herein. The controller 602 may be configured to track memory address of instructions associated with the memory 604. The controller 602 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 602 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 602 may be configured to manage flow of data within the processor 600. The controller 602 may be configured to control transfer of data between registers, ALUs, and other functional units of the processor 600.

[0214] The memory 604 may include one or more caches (e.g., memory local to or included in the processor 600 or other memory, such as RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc.). In some implementations, the memory 604 may reside within or on a processor chipset (e.g., local to the processor 600). In some other implementations, the memory 604 may reside external to the processor chipset (e.g., remote to the processor 600).

[0215] The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 600, cause the processor 600 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 602 and/or the processor 600 may be configured to execute computer-readable instructions stored in the memory 604 to cause the processor 600 to perform various functions. For example, the processor 600 and/or the controller 602 may be coupled with or to the memory 604, the processor 600, the controller 602, and the memory 604 may be configured to perform various functions described herein. In some examples, the processor 600 may include multiple processors and the memory 604 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.

[0216] The one or more ALUs 606 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 606 may reside within or on a processor chipset (e.g., the processor 600). In some other implementations, the one or more ALUs 606 may reside external to the processor chipset (e.g., the processor 600). One or more ALUs 606 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 606 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 606 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 606 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 606 to handle conditional operations, comparisons, and bitwise operations.

[0217] The processor 600 may support wireless communication in accordance with examples as disclosed herein. The processor 600 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 602 may cause the processor 600 to: receive configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; receive CSI-RS based on the configuration information; and perform channel measurement based on the received CSI-RS.

[0218] Figure 7 illustrates an example of a BS 700 in accordance with aspects of the present disclosure. The BS 700 may include at least one processor 702 and at least one memory 704. Additionally, the BS 700 may also include one or more of at least one controller 706 or at least one transceiver 708. The processor 702, the memory 704, the controller 706, or the transceiver 708, 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.

[0219] The processor 702, the memory 704, the controller 706, or the transceiver 708, 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.

[0220] The processor 702 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 702 may be configured to operate the memory 704. In some other implementations, the memory 704 may be integrated into the processor 702. The processor 702 may be configured to execute computer-readable instructions stored in the memory 704 to cause the BS 700 to perform various functions of the present disclosure.

[0221] The memory 704 may include volatile or non-volatile memory. The memory 704 may store computer-readable, computer-executable code including instructions when executed by the processor 702 cause the BS 700 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 704 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.

[0222] In some implementations, the processor 702 and the memory 704 coupled with the processor 702 may be configured to cause the BS 700 to perform one or more of the functions described herein (e.g., executing, by the processor 702, instructions stored in the memory 704). For example, the processor 702 may support wireless communication at the BS 700 in accordance with examples as disclosed herein. The BS 700 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 702 may be configured to cause the BS 700 to:

transmit configuration information indicating a set of CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports; and transmit CSI-RS based on the configuration information.

[0223] The controller 706 may manage input and output signals for the BS 700. The controller 706 may also manage peripherals not integrated into the BS 700. In some implementations, the controller 706 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 706 may be implemented as part of the processor 702.

[0224] In some implementations, the BS 700 may include at least one transceiver 708. In some other implementations, the BS 700 may have more than one transceiver 708. The transceiver 708 may represent a wireless transceiver. The transceiver 708 may include one or more receiver chains 710, one or more transmitter chains 712, or a combination thereof.

[0225] A receiver chain 710 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 710 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 710 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 710 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 710 may include at least one decoder for decoding the demodulated signal to receive the transmitted data.

[0226] A transmitter chain 712 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 712 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 712 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 712 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0227] 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 indicating a set of channel
state information (CSI) reference signal (CSI-RS) resources for channel
measurement for CSI reporting based on an enhanced Type II codebook for
predicted precoding matrix indicator (PMI) using more than 32 CSI-RS
ports;
receive CSI-RS based on the configuration information; and
perform channel measurement based on the received CSI-RS.
2. The UE of Claim 1, wherein the configuration information indicates
that the set of CSI-RS resources includes a first number of aperiodic CSI-RS resource
subsets, and that each aperiodic CSI-RS resource subset includes a second number of
aperiodic CSI-RS resources.
3. The UE of Claim 2, wherein for aperiodic CSI-RS resources with a
same index in each aperiodic CSI-RS resource subset of the first number of aperiodic CSI-
RS resource subsets, the configuration information indicates at least one of:
a same number of CSI-RS ports;
same CSI-RS port index(es);
a same bandwidth (BW);
same resource element (RE) location(s); or
a same power control offset value.
4. The UE of Claim 2, wherein:
the configuration information further indicates a time spacing
between any two consecutive aperiodic CSI-RS resource subsets in the first

number of aperiodic CSI-RS resource subsets, wherein the time spacing between any two consecutive aperiodic CSI-RS resource subsets is 0 slot or 1 slot; or

a time spacing between any two consecutive aperiodic CSI-RS resource subsets is predefined or specified to be 0 slot.

5. The UE of Claim 2, wherein each aperiodic CSI-RS resource subset occupies a third number of consecutive slots, and the third number is 1 or 2.

6. The UE of Claim 5, wherein:

the at least one processor is configured to cause the UE to: determine a slot index for each aperiodic CSI-RS resource in an aperiodic CSI-RS resource subset based on an assumption that same orthogonal frequency division multiplexing (OFDM) symbols are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset in different slots or non-overlapping REs are configured for aperiodic CSI-RS resources in the aperiodic CSI-RS resource subset in a same slot; or

the configuration information further indicates that a fourth number of CSI-RS resources in each aperiodic CSI-RS resource subset are included in a first slot of the third number of consecutive slots.

7. The UE of Claim 2, wherein the configuration information further indicates a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in an aperiodic CSI-RS resource subset.

8. The UE of Claim 1,

wherein the set of CSI-RS resources includes a plurality of aperiodic CSI-RS resources, a time spacing between any two consecutive aperiodic CSI-RS resources is 0 slot or 1 slot, and the at least one processor is configured to cause the UE to: determine a slot index for each aperiodic CSI-RS resource in the plurality of aperiodic CSI-RS resources based on an assumption that same OFDM symbols are configured for aperiodic CSI-RS resources in different slots; or

wherein the set of CSI-RS resources includes a plurality of aperiodic CSI-RS resources, and the configuration information indicates a corresponding time spacing for each two consecutive aperiodic CSI-RS resources in the plurality of aperiodic CSI-RS resources.

9. The UE of Claim 2, wherein the configuration information includes the first number, and the first number is selected from a predefined set of aperiodic CSI-RS resource subset numbers.

10. The UE of Claim 2, wherein the at least one processor is configured to cause the UE to: transmit first capability information indicating an aperiodic CSI-RS resource subset number supported by the UE, wherein the aperiodic CSI-RS resource subset number supported by the UE is irrelevant with a CSI-RS port number or based on an assumed CSI-RS port number.

11. The UE of Claim 1, wherein the configuration information indicates that the set of CSI-RS resources includes a fifth number of aperiodic CSI-RS resources, and the fifth number is selected from a predefined set of aperiodic CSI-RS resource numbers.

12. The UE of Claim 1, wherein the at least one processor is configured to cause the UE to: transmit second capability information indicating an aperiodic CSI-RS resource number supported by the UE.

13. The UE of Claim 1, wherein the set of CSI-RS resources includes a plurality of periodic or semi-persistent CSI-RS resources or a CSI-RS resource subset including a plurality of periodic or semi-persistent CSI-RS resources.

14. The UE of Claim 13, wherein the plurality of periodic or semi-persistent CSI-RS resources have a common periodicity, and a time offset value between any two periodic or semi-persistent CSI-RS resources in the plurality of periodic or semi-persistent CSI-RS resources are smaller than the common periodicity.

15. The UE of Claim 1, wherein the configuration information indicates same values of a set of parameters for each of a plurality of periodic or semi-persistent CSI-

RS resources included in the set of CSI-RS resources, or for each of a plurality of periodic or semi-persistent CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, or for each of a plurality of aperiodic CSI-RS resources included in a CSI-RS resource subset in the set of CSI-RS resources, and the set of parameters includes at least one of:

- a first parameter indicating a number of ports;
- a second parameter indicating a code-division multiplexing (CDM) type;
- a third parameter indicating a CSI-RS frequency density of each CSI-RS port per physical resource block (PRB);
- a fourth parameter indicating a frequency band for CSI-RS;
- a fifth parameter indicating an assumed ratio of physical downlink shared channel (PDSCH) energy per resource element (EPRE) to non-zero-power (NZP) CSI-RS EPRE;
- a sixth parameter indicating an assumed ratio of NZP CSI-RS EPRE to synchronization signal block (SSB) EPRE;
- a seventh parameter indicating a scrambling identity (ID) of CSI-RS;
- an eighth parameter containing a reference to a transmission configuration indicator (TCI) state indicating quasi co-located (QCL) source reference signal(s) and QCL type(s); or
- a ninth parameter indicating a frequency domain resource allocation.

16. The UE of Claim 1, wherein only one NZP CSI-RS resource or only one CSI interference measurement (CSI-IM) resource is configured for interference measurement, and the one NZP CSI-RS resource or the one CSI-IM resource is associated with the set of CSI-RS resources for channel measurement.

17. The UE of Claim 1, wherein the configuration information only indicates a set of periodic or semi-persistent CSI-RS resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted PMI using more than 32 CSI-RS ports.

18. 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 indicating a set of channel state information (CSI) reference signal (CSI-RS) resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted precoding matrix indicator (PMI) using more than 32 CSI-RS ports; and
 - transmit CSI-RS based on the configuration information.
19. 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 indicating a set of channel state information (CSI) reference signal (CSI-RS) resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted precoding matrix indicator (PMI) using more than 32 CSI-RS ports;
 - receive CSI-RS based on the configuration information; and
 - perform channel measurement based on the received CSI-RS.
20. A method performed by a user equipment (UE), the method comprising:
- receiving configuration information indicating a set of channel state information (CSI) reference signal (CSI-RS) resources for channel measurement for CSI reporting based on an enhanced Type II codebook for predicted precoding matrix indicator (PMI) using more than 32 CSI-RS ports;
 - receiving CSI-RS based on the configuration information; and
 - performing channel measurement based on the received CSI-RS.