

METHODS AND APPARATUSES FOR CSI REPORTING

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to methods and apparatuses for channel state information (CSI) reporting based on CSI reference signal (CSI-RS) with more than 32 CSI-RS ports.

BACKGROUND

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

SUMMARY

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

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

[0004] Some implementations of the methods and apparatuses described herein may include a UE for wireless communication. The UE may include: at least one memory; and at least one processor coupled with the at least one memory and configured to cause the UE to: receive configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determine a number of CSI processing units (CPUs) occupied by the first CSI-RS resource for processing CSI reporting.

[0005] In some implementations of the UE described herein, the at least one processor is further configured to cause the UE to transmit capability information indicating that one CPU is supportive to process CSI reporting based on a CSI-RS resource with a second number of CSI-RS ports before receiving the configuration information.

[0006] In some implementations of the UE described herein, the at least one processor is configured to cause the UE to determine the number of CPUs occupied by the first CSI-RS resource to be 1 in the case that the second number is equal to or larger than the first number.

[0007] In some implementations of the UE described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the at least one processor is configured to cause the UE to determine the number of CPUs occupied by the first CSI-RS resource based on a third number, wherein the third number is a number of the multiple second CSI-RS resources or a specified value.

[0008] In some implementations of the UE described herein, the at least one processor is configured to cause the UE to determine the number of CPUs occupied by the first CSI-RS resource based on the third number and a scaling factor, wherein the scaling factor is equal to or larger than 1.

[0009] In some implementations of the UE described herein, the at least one processor is further configured to cause the UE to transmit capability information indicating the scaling factor.

[0010] In some implementations of the UE described herein, the at least one processor is configured to cause the UE to determine the number of CPUs occupied by the first CSI-RS resource based on the third number and an offset, wherein the offset is a positive integer.

[0011] In some implementations of the UE described herein, the at least one processor is further configured to cause the UE to transmit capability information indicating the offset.

[0012] In some implementations of the UE described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and in the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the at least one processor is further configured to cause the UE to determine a number of CPUs occupied for CSI reporting by counting a CPU occupied by the second CSI-RS resource X times.

[0013] In some implementations of the UE described herein, in the case that a CSI-RS resource set for channel measurement is configured with M CSI-RS resources for channel measurement of single transmit-receive point (TRP) transmission and N resource pairs for channel measurement of multiple TRP transmission, and there are M_3 CSI-RS resources with more than 32 CSI-RS ports in the M CSI-RS resources, the at least one processor is further configured to cause the UE to determine a total number of CPUs occupied for CSI reporting based on the CSI-RS resource set to be a sum of a number of CPUs occupied by the N resource pairs, a number of CPUs occupied by $M-M_3$ CSI-RS resources with no more than 32 CSI-RS ports, and a number of CPUs occupied by M_3 CSI-RS resources with more than 32 CSI-RS ports.

[0014] In some implementations of the UE described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the at least one processor is further configured to cause the UE to determine a unified CPU occupation time for all of the multiple second CSI-RS resources.

[0015] In some implementations of the UE described herein, the unified CPU occupation time is determined based on a first symbol of the earliest one or the latest one in the multiple second CSI-RS resources in the time domain.

[0016] In some implementations of the UE described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS

resource, and the at least one processor is further configured to cause the UE to determine a corresponding CPU occupation time for each of the multiple second CSI-RS resources.

[0017] In some implementations of the UE described herein, in the multiple second CSI-RS resources, each second CSI-RS resource other than the latest second CSI-RS resource(s) in the time domain occupies one CPU of the CPUs occupied by the first CSI-RS resource and the latest second CSI-RS resource(s) occupies remaining CPU(s) of the CPUs occupied by the first CSI-RS resource.

[0018] In some implementations of the UE described herein, in the latest second CSI-RS resource(s), a second CSI-RS resource with a largest CSI-RS index occupies $O_{CPU} - N_{CSI_RS} + 1$ CPUs and each of the other second CSI-RS resource(s) occupies one CPU, wherein O_{CPU} is the number of CPUs occupied by the first CSI-RS resource and N_{CSI_RS} is a number of the multiple second CSI-RS resources.

[0019] In some implementations of the UE described herein, the at least one processor is further configured to cause the UE to perform at least one of: counting the first CSI-RS resource as one active CSI-RS resource; or counting the first number of CSI-RS ports as the first number of active CSI-RS ports for one active CSI-RS resource.

[0020] In some implementations of the UE described herein, the at least one processor is further configured to cause the UE to transmit capability information indicating a maximum number of CSI-RS resources with more than 32 ports per band.

[0021] In some implementations of the UE described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the at least one processor is further configured to cause the UE to perform at least one of: counting the first CSI-RS resource as N_{CSI_RS} active CSI-RS resources, wherein N_{CSI_RS} is a number of the multiple second CSI-RS resources; or counting a number of CSI-RS ports of each of the multiple second CSI-RS resources as a number of active CSI-RS ports for a corresponding active CSI-RS resource

[0022] In some implementations of the UE described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and in the case that a second CSI-RS resource in the multiple second CSI-RS resources

is referred to X times for deriving CSI for reporting, the at least one processor is further configured to cause the UE to perform at least one of: counting the second CSI-RS resource X times for determining a number of active CSI-RS resources; or counting a number of CSI-RS ports of the second CSI-RS resource X times for determining a number of active CSI-RS ports.

[0023] Some implementations of the methods and apparatuses described herein may include a processor for wireless communication. The processor may include: at least one controller coupled with at least one memory and configured to cause the processor to: receive configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determine a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting.

[0024] 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, to a UE, configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determine a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting.

[0025] In some implementations of the BS described herein, the at least one processor is further configured to cause the BS to receive, from the UE, capability information indicating that one CPU is supportive to process CSI reporting based on a CSI-RS resource with a second number of CSI-RS ports before transmitting the configuration information.

[0026] In some implementations of the BS described herein, the at least one processor is further configured to cause the BS to determine the number of CPUs occupied by the first CSI-RS resource to be 1 in the case that the second number is equal to or larger than the first number.

[0027] In some implementations of the BS described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the at least one processor is configured to cause the BS to determine the number of CPUs occupied by the first CSI-RS resource based on a third number, wherein the third number is a number of the multiple second CSI-RS resources or a specified value.

[0028] In some implementations of the BS described herein, the at least one processor is configured to cause the BS to determine the number of CPUs occupied by the first CSI-RS resource based on the third number and a scaling factor, wherein the scaling factor is equal to or larger than 1.

[0029] In some implementations of the BS described herein, the at least one processor is further configured to cause the BS to receive capability information indicating the scaling factor.

[0030] In some implementations of the BS described herein, the at least one processor is configured to cause the BS to determine the number of CPUs occupied by the first CSI-RS resource based on the third number and an offset, wherein the offset is a positive integer.

[0031] In some implementations of the BS described herein, the at least one processor is further configured to cause the BS to receive capability information indicating the offset.

[0032] In some implementations of the BS described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and in the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the at least one processor is further configured to cause the BS to determine a number of CPUs occupied for CSI reporting by counting a CPU occupied by the second CSI-RS resource X times.

[0033] In some implementations of the BS described herein, in the case that a CSI-RS resource set for channel measurement is configured with M CSI-RS resources for channel measurement of single TRP transmission and N resource pairs for channel measurement of multiple TRP transmission, and there are M_3 CSI-RS resources with more than 32 CSI-RS ports in the M CSI-RS resources, the at least one processor is further configured to cause the BS to determine a total number of CPUs occupied for CSI reporting based on the CSI-RS resource set to be a sum of a number of CPUs occupied by the N resource pairs, a number of CPUs occupied by $M - M_3$ CSI-RS resources with no more than 32 CSI-RS ports, and a number of CPUs occupied by M_3 CSI-RS resources with more than 32 CSI-RS ports.

[0034] In some implementations of the BS described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS

resource, and the at least one processor is further configured to cause the BS to determine a unified CPU occupation time for all of the multiple second CSI-RS resources.

[0035] In some implementations of the BS described herein, the unified CPU occupation time is determined based on a first symbol of the earliest one or the latest one in the multiple second CSI-RS resources in the time domain.

[0036] In some implementations of the BS described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the at least one processor is further configured to cause the BS to determine a corresponding CPU occupation time for each of the multiple second CSI-RS resources.

[0037] In some implementations of the BS described herein, in the multiple second CSI-RS resources, each second CSI-RS resource other than the latest second CSI-RS resource(s) in the time domain occupies one CPU of the CPUs occupied by the first CSI-RS resource and the latest second CSI-RS resource(s) occupies remaining CPU(s) of the CPUs occupied by the first CSI-RS resource.

[0038] In some implementations of the BS described herein, in the latest second CSI-RS resource(s), a second CSI-RS resource with a largest CSI-RS index occupies $O_{CPU} - N_{CSI-RS} + 1$ CPUs and each of the other second CSI-RS resource(s) occupies one CPU, wherein O_{CPU} is the number of CPUs occupied by the first CSI-RS resource and N_{CSI-RS} is a number of the multiple second CSI-RS resources.

[0039] In some implementations of the BS described herein, the at least one processor is further configured to cause the BS to perform at least one of: counting the first CSI-RS resource as one active CSI-RS resource; or counting the first number of CSI-RS ports as the first number of active CSI-RS ports for one active CSI-RS resource.

[0040] In some implementations of the BS described herein, the at least one processor is further configured to cause the BS to receive capability information indicating a maximum number of CSI-RS resources with more than 32 ports per band.

[0041] In some implementations of the BS described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS

resource, and the at least one processor is further configured to cause the UE to perform at least one of: counting the first CSI-RS resource as N_{CSI_RS} active CSI-RS resources, wherein N_{CSI_RS} is a number of the multiple second CSI-RS resources; or counting a number of CSI-RS ports of each of the multiple second CSI-RS resources as a number of active CSI-RS ports for a corresponding active CSI-RS resource.

[0042] In some implementations of the BS described herein, the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and in the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the at least one processor is further configured to cause the BS to perform at least one of: counting the second CSI-RS resource X times for determining a number of active CSI-RS resources; or counting a number of CSI-RS ports of the second CSI-RS resource X times for determining a number of active CSI-RS ports.

[0043] Some implementations of the methods and apparatuses described herein may include a method performed by a UE. The method may include: receiving configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determining a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting.

[0044] Some implementations of the methods and apparatuses described herein may include a method performed by a BS. The method may include: transmitting, to a UE, configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determining a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] 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.

[0046] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0047] Figure 2 illustrates a flowchart of an exemplary method performed by a UE in accordance with aspects of the present disclosure.

[0048] Figure 3 illustrates a flowchart of an exemplary method performed by a BS in accordance with aspects of the present disclosure.

[0049] Figure 4 illustrates an example of a UE in accordance with aspects of the present disclosure.

[0050] Figure 5 illustrates an example of a processor in accordance with aspects of the present disclosure.

[0051] Figure 6 illustrates an example of a BS in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0052] The detailed description of the appended drawings is intended as a description of preferred embodiments of the present disclosure and is not intended to represent the only form in which the present disclosure 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 disclosure.

[0053] 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.

[0054] 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.

[0055] Aspects of the present disclosure are described in the context of a wireless communications system.

[0056] 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 a 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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 TRPs.

[0062] 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.

[0063] 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).

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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., orthogonal frequency division multiplexing (OFDM) symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., $\mu=0$) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0068] 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.

[0069] 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.

[0070] 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 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.

[0071] For CSI-RS with more than 32 ports, there may exist some issues. For example, first, how to determine/count the number of CPUs (also referred to as "CPU number" herein) for CSI reporting based on CSI-RS with more than 32 ports needs to be solved. Second, how to determine the CPU occupation time for periodic or semi-persistent CSI reporting based on CSI-RS with more than 32 ports needs to be solved. In addition, in any slot, a UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active bandwidth parts (BWPs) than its reported capability. Then, for a CSI-RS resource with more than 32 ports, how to determine the number of active CSI-RS resource(s) and/or the number of active CSI-RS port(s) also needs to be solved.

[0072] Embodiments of the present disclosure provide solutions for CSI reporting based on CSI-RS with more than 32 ports, which can solve at least one of the aforementioned issues. In the present disclosure, CSI-RS with more than 32 ports may refer to CSI-RS on a CSI-RS resource with more than 32 ports, and "CSI reporting based on CSI-RS with a number of ports," "CSI reporting based on a CSI-RS resource with a number of ports" and "CSI reporting with a number of ports" may be used interchangeably. More details will be described in the following text in combination with the appended drawings.

[0073] In existing 5G system, CSI-RS may be transmitted on a CSI-RS resource with no more than 32 CSI-RS ports. In the time domain, the CSI-RS resource may be within a slot and

include no more than 4 OFDM symbols of the slot. If CSI-RS with more than 32 CSI-RS ports are introduced for a large antenna array, additional time-frequency resources may be needed. Such time-frequency resources may include at least one of: OFDM symbols, slots, or physical resource blocks (PRBs).

[0074] According to some embodiments of the present disclosure, CSI-RS may be transmitted on a CSI-RS resource with more than 32 CSI-RS ports. Such resource may be referred to as a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is larger than 32. The first CSI-RS resource may be configured as a channel measurement resource and a UE may derive CSI based on CSI-RS on the first CSI-RS resource.

[0075] In some embodiments of the present disclosure, the first CSI-RS resource may be generated by aggregating multiple (i.e., at least two) second CSI-RS resources (e.g., legacy CSI-RS resources with no more than 32 ports). Accordingly, the first CSI-RS resource may be referred to as an aggregated CSI-RS resource. Each of the multiple second CSI-RS resources may be referred to as a component CSI-RS resource. The multiple component CSI-RS resources may use the same or different analog or digital beamforming schemes. In some examples, the multiple component CSI-RS resources may be aggregated via a time-division multiplexing (TDM) scheme, or aggregated via a frequency-division multiplexing (FDM) scheme, etc.

[0076] In some examples, each component CSI-RS resource may have no more than 32 ports. In some other examples, at least one of the multiple component CSI-RS resources may have more than 32 ports. In some examples, the multiple component CSI-RS resources may have the same number of ports. In some examples, the multiple component CSI-RS resources may have different numbers of ports.

[0077] As an example, in the case of the aggregated CSI-RS resource with 48 ports, the multiple component CSI-RS resources may include two component CSI-RS resources with 24 ports or three component CSI-RS resources with 16 ports.

[0078] As another example, in the case of the aggregated CSI-RS resource with 64 ports, the multiple component CSI-RS resources may include two component CSI-RS resources with 32 ports or four component CSI-RS resources with 16 ports.

[0079] As yet another example, in the case of the aggregated CSI-RS resource with 72 ports, the multiple component CSI-RS resources may include three component CSI-RS resources with 24 ports.

[0080] As yet another example, in the case of the aggregated CSI-RS resource with 96 ports, the multiple component CSI-RS resources may include three component CSI-RS resources with 32 ports.

[0081] As yet another example, in the case of the aggregated CSI-RS resource with 128 ports, the multiple component CSI-RS resources may include two component CSI-RS resources with 64 ports or four component CSI-RS resources with 32 ports.

[0082] In existing 5G system, if a UE supports N_{CPU} simultaneous CSI calculations, it is said to have N_{CPU} CPUs for processing CSI reporting. For a CSI-RS resource set for channel measurement which includes one or more legacy CSI-RS resources with no more than 32 ports, the number of CPUs (e.g., denoted as O_{CPU}) occupied for processing CSI reporting based on CSI-RS on the one or more legacy CSI-RS resources in the CSI-RS resource set may be equal to the number (e.g., denoted as K_s) of the legacy CSI-RS resources included in the CSI-RS resource set. In other words, one CPU may be occupied by a legacy CSI-RS resource for processing CSI reporting. However, for a CSI-RS resource with more than 32 CSI-RS ports, the number of CPUs occupied by the CSI-RS resource for processing CSI reporting may be redefined.

[0083] In the present disclosure, the number of CPUs occupied by a CSI-RS resource set for processing CSI reporting may refer to the number of CPUs occupied for processing CSI reporting (e.g., performing CSI calculation) based on CSI-RS on all the CSI-RS resource(s) included in the CSI-RS resource set, and the number of CPUs occupied by a CSI-RS resource (regardless of a legacy CSI-RS resource with no more than 32 ports or a CSI-RS resource with more than 32 ports) for processing CSI reporting may refer to the number of CPUs occupied for processing CSI reporting (e.g., performing CSI calculation) based on CSI-RS on the CSI-RS resource.

[0084] The following Schemes 1 and 2 provide several solutions for determining/counting a number of CPUs occupied by a CSI-RS resource with more than 32 ports.

[0085] Scheme 1

[0086] In Scheme 1, a CSI-RS resource with more than 32 ports may occupy one CPU for processing CSI reporting. This scheme is simple but can only be applied for a UE with a high capability. It requires the UE to have the capability to process CSI reporting based on CSI-RS with more than 32 ports in one CPU.

[0087] Accordingly, in some embodiments of the present disclosure, the UE may transmit (e.g., to a BS) capability information indicating that one CPU is supportive to process CSI reporting based on a CSI-RS resource with a second number of CSI-RS ports. In some examples, the second number may be a value selected from {48, 64, 72, 96, 128}.

[0088] After transmitting the capability information, the UE may receive (e.g., from the BS) configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32.

[0089] In the case that the second number is equal to or larger than the first number, which means that the UE has the capability to process CSI reporting based on the first CSI-RS resource in one CPU, the UE and the BS may determine the number of CPUs occupied by the first CSI-RS resource for processing CSI reporting to be 1. In the case that the second number is smaller than the first number, which means that the UE does not have the capability to process CSI reporting based on the first CSI-RS resource in one CPU, the UE and the BS may determine the number of CPUs occupied by the first CSI-RS resource for processing CSI reporting based on other schemes, for example, Scheme 2 as described below. In some cases, Scheme 2 can also be served as a common scheme used to determine the number of CPUs occupied by a CSI-RS resource with more than 32 CSI-RS ports for all UEs with different processing capabilities.

[0090] Scheme 2

[0091] In Scheme 2, a CSI-RS resource with more than 32 ports may occupy more than one CPU for processing CSI reporting.

[0092] In some embodiments of the present disclosure, a BS may transmit, to a UE, configuration information for a first CSI-RS resource with a first number of CSI-RS ports,

wherein the first number is more than 32. The configuration information may indicate multiple component CSI-RS resources which are aggregated to generate the first CSI-RS resource.

[0093] Like legacy CSI-RS resources with no more than 32 ports, each component CSI-RS resource may be deemed to occupy one CPU. However, on account of non-linear increasing on computation complexity, the number of CPUs occupied by the first CSI-RS resource may be larger than the total number of the multiple component CSI-RS resources which are aggregated to generate the first CSI-RS resource.

[0094] Given the above, in Scheme 2, the UE and the BS may determine the number of CPUs occupied by the first CSI-RS resource based on a third number, e.g., denoted as N'_{CSI-RS} .

[0095] In some embodiments, N'_{CSI-RS} may be a number of the multiple component CSI-RS resources which are aggregated to generate the first CSI-RS resource.

[0096] In some other embodiments, N'_{CSI-RS} may be a specified value. Using a specified value may eliminate the impact caused by different numbers of component CSI-RS resources for aggregated CSI-RS resources with the same number of ports from radio resource control (RRC) configuration (for example, a CSI-RS resource with 48 ports may be generated by aggregating two component CSI-RS resources with 24 ports or three component CSI-RS resources with 16 ports). As an example, the specific value may be defined as P_{CSI-RS}/P , wherein P_{CSI-RS} is the first number (i.e., the total number of ports across all the component CSI-RS resources of the first CSI-RS resource), and P is a fixed value, e.g., $P = 32$.

[0097] In some examples, the UE and the BS may determine the number of CPUs occupied by the first CSI-RS resource based on N'_{CSI-RS} and a scaling factor, wherein the scaling factor is equal to or larger than 1. In an example, the scaling factor may be selected or determined by the UE based on the UE's processing capability and realization algorithm. In such example, the UE may transmit, to the BS, capability information indicating the scaling factor. In another example, the scaling factor may be a predefined value, and the UE does not need to report it to the BS.

[0098] As an example, the number of CPUs occupied by the first CSI-RS resource may be defined as $O_{CPU} = \text{ceil}(X \times N'_{CSI-RS})$, wherein X is the aforementioned scaling factor. For

example, X may be a value selected from $\{1, 1.5, 2\}$, and the UE may transmit capability information indicating the selected value to the BS.

[0099] In some other examples, the UE and the BS may determine the number of CPUs occupied by the first CSI-RS resource based on N'_{CSI-RS} and an offset, wherein the offset is a positive integer. In an example, the offset may be selected or determined by the UE based on the UE's processing capability and realization algorithm. In such example, the UE may transmit, to the BS, capability information indicating the offset. In another example, the offset may be a predefined value, and the UE does not need to report it to the BS.

[0100] As an example, the number of CPUs occupied by the first CSI-RS resource may be defined as $O_{CPU} = N'_{CSI-RS} + \delta$, wherein δ is the aforementioned offset. For example, δ may be a value selected from $\{1, 2, 3, 4\}$, and the UE may transmit capability information indicating the selected value to the BS.

[0101] Although it is mentioned in Scheme 1 that Scheme 2 may be adopted in the case that the capability information transmitted by the UE shows that the UE does not have the capability to process CSI reporting based on the first CSI-RS resource in one CPU, it is contemplated that, for Scheme 2, it is not necessary for the UE to transmit the capability information as described in Scheme 1.

[0102] According to some embodiments of the present disclosure, a BS may transmit configuration information for a CSI-RS resource set for channel measurement to a UE. The BS and the UE may determine the number of CPUs occupied by the CSI-RS resource set to be a sum of a number of CPUs occupied by each CSI-RS resource included in the CSI-RS resource set. For example, the CSI-RS resource set may include one or more CSI-RS resources with more than 32 ports and one or more legacy CSI-RS resources with no more than 32 ports. The number of CPUs occupied by a CSI-RS resource with more than 32 ports may be determined based on the aforementioned Scheme 1 or 2. The number of CPUs occupied by a legacy CSI-RS resource with no more than 32 ports may be 1. As an example, a CSI-RS resource set may include K_s CSI-RS resources for CSI reporting. Among them, there are K_1 ($K_1 \geq 0$) CSI-RS resources with no more than 32 CSI-RS ports and K_2 (i.e., $K_1 + K_2 = K_s$) CSI-RS resources with more than 32 CSI-RS ports. Then, the number of CPUs occupied by the CSI-RS resource set is

$K_1 + K_2 O_{CPU}$, where O_{CPU} is the number of CPUs occupied by one CSI-RS resource with more than 32 CSI-RS ports (for simplicity, it is assumed that each CSI-RS resource with more than 32 ports occupies the same number of CPUs) determined based on the aforementioned Scheme 1 or 2.

[0103] According to some embodiments of the present disclosure, CSI reporting may be associated with multiple different transmission assumptions, and the number of CPUs occupied for CSI reporting may be determined or counted as a sum of the CPU number for each transmission assumption. As a result, in the case that a component CSI-RS resource of a CSI-RS resource with more than 32 ports is used for CSI computation based on several transmission assumptions associated with CSI reporting, the number of CPUs occupied by the component CSI-RS resource may be counted several times. For example, in the case that a component CSI-RS resource is referred to X times for deriving CSI for reporting, when the BS or the UE determines a number of CPUs occupied for CSI reporting, a CPU occupied by the component CSI-RS resource may be counted X times. As an example, the UE may select to report CSI from two candidate CSI, wherein one candidate CSI is determined based on a joint transmission on a CSI-RS resource with more than 32 ports which is generated by aggregating multiple component CSI-RS resources (i.e., based on all component CSI-RS resources of the CSI-RS resource), and the other candidate CSI is determined based on a fallback transmission on a first component CSI-RS resource in the multiple component CSI-RS resources. In such example, the number of CPUs occupied for CSI reporting may be determined to be the number of CPUs occupied by the CSI-RS resource (e.g., determined based on the aforementioned Scheme 1 or 2) plus 1 additional CPU used for CSI computation based on the fallback transmission on the first component CSI-RS resource (i.e., the CPU occupied by the first component CSI-RS resource). Accordingly, the CPU occupied by the first component CSI-RS resource are counted two times.

[0104] According to some embodiments of the present disclosure, a non-coherent joint transmission (NCJT) scheme may be used for multiple TRP transmission with at least one TRP using a CSI-RS resource with more than 32 ports. In such embodiments, a CSI-RS resource set for channel measurement may be configured with M CSI-RS resources for channel measurement of single TRP transmission (i.e., M is equal to the number of CSI-RS resource indicators (CRIs) in multiple CSI-RS resource groups corresponding to multiple TRPs) and N resource pairs for

channel measurement of multiple TRP transmission, and there are M_3 CSI-RS resources with more than 32 CSI-RS ports in the M CSI-RS resources. The BS and the UE may determine a total number of CPUs occupied for CSI reporting based on the CSI-RS resource set to be a sum of a number of CPUs occupied by the N resource pairs, a number of CPUs occupied by $M-M_3$ CSI-RS resources with no more than 32 CSI-RS ports, and a number of CPUs occupied by M_3 CSI-RS resources with more than 32 CSI-RS ports.

[0105] For example, the total number of CPUs may be defined as $X \cdot N + (M - M_3) + Y \cdot M_3$, wherein X is a number of CPUs occupied by each of the N resource pairs (e.g., as defined in TS 38.214), Y is a number of CPUs occupied by a CSI-RS resource with more than 32 ports (for simplicity, it is assumed that each CSI-RS resource with more than 32 ports occupies the same number of CPUs), which may be determined based on the aforementioned Scheme 1 or 2.

[0106] In existing 5G system, a periodic or semi-persistent CSI report (excluding an initial semi-persistent CSI report on physical uplink shared channel (PUSCH) after the physical downlink control channel (PDCCH) triggering the CSI report) may occupy CPU(s) from the first (starting) symbol (e.g., OFDM symbol) of the earliest one of each CSI-RS/CSI interference measurement (CSI-IM)/synchronization signal block (SSB) resource for channel measurement or interference measurement, respective latest CSI-RS/CSI-IM/SSB occasion no later than the corresponding CSI reference resource, until the last symbol of the configured PUSCH/PUCCH carrying the CSI report. That is, a CPU occupation time of a periodic or semi-persistent CSI report (excluding an initial semi-persistent CSI report on PUSCH after the PDCCH triggering the CSI report) is related to a location of the first symbol of CSI-RS for channel measurement.

[0107] However, for a CSI-RS resource with more than 32 CSI-RS ports for channel measurement, it may have multiple component CSI-RS resources and the first symbol of each component CSI-RS resource may be different. Accordingly, how to determine CPU occupation time for periodic or semi-persistent CSI reporting with more than 32 ports needs to be solved.

[0108] The following Schemes 3 and 4 provide several solutions for determining CPU occupation time for periodic or semi-persistent CSI reporting with more than 32 ports.

[0109] **Scheme 3**

[0110] In Scheme 3, a CSI-RS resource with more than 32 CSI-RS ports for channel measurement may be generated by aggregating multiple component CSI-RS resources, and the UE and the BS may determine a unified CPU occupation time for all of the multiple component CSI-RS resources.

[0111] In some embodiments, the unified CPU occupation time may be determined based on a first symbol of the earliest component CSI-RS resource in the multiple component CSI-RS resources in the time domain. For example, a periodic or semi-persistent CSI report (excluding an initial semi-persistent CSI report on PUSCH after the PDCCH triggering the report) may occupy CPU(s) from the first symbol of the earliest CSI-RS resource of all the component CSI-RS resources/CSI-IM resources/SSB resources for channel measurement or interference measurement, respective latest CSI-RS occasion no later than the corresponding CSI reference resource, until the last symbol of the configured PUSCH/PUCCH carrying the report.

[0112] In such embodiments, the UE may perform CSI processing after receiving the earliest component CSI-RS resource. However, the occupied CPU number may be not accurate because the UE cannot fully utilize all the CPUs until it receives CSI-RS on all the component CSI-RS resources, e.g., UE may perform rank indication (RI)/precoding matrix indicator (PMI)/channel quality indicator (CQI) computation only after getting CSI of all the ports.

[0113] In some other embodiments, the unified CPU occupation time may be determined based on a first symbol of the latest component CSI-RS resource in the multiple component CSI-RS resources in the time domain. For example, a periodic or semi-persistent CSI report (excluding an initial semi-persistent CSI report on PUSCH after the PDCCH triggering the report) may occupy CPU(s) from the first symbol of the latest CSI-RS resource of all the component CSI-RS resources/CSI-IM resources/SSB resources for channel measurement or interference measurement, respective latest CSI-RS occasion no later than the corresponding CSI reference resource, until the last symbol of the configured PUSCH/PUCCH carrying the report.

[0114] In such embodiments, the UE may perform CSI processing after receiving CSI-RS on all the component CSI-RS resources. Accordingly, the occupied CPU number is accurate but additional CSI processing delay is introduced.

[0115] Scheme 4

[0116] In Scheme 4, a CSI-RS resource with more than 32 CSI-RS ports for channel measurement may be generated by aggregating multiple component CSI-RS resources, the UE and the BS may determine a corresponding CPU occupation time for each of the multiple component CSI-RS resources.

[0117] In the multiple component CSI-RS resources, each component CSI-RS resource other than the latest component CSI-RS resource(s) in the time domain may occupy one CPU of the CPUs occupied by the CSI-RS resource, and the latest component CSI-RS resource(s) may occupy remaining CPU(s) of the CPUs occupied by the CSI-RS resource. It is contemplated that, in some cases, there may exist more than one latest component CSI-RS resource which have the same starting symbol.

[0118] For example, assuming that the number of CPUs occupied by the CSI-RS resource with more than 32 CSI-RS ports is O_{CPU} , the CSI-RS resource includes N_{CSI_RS} component CSI-RS resources, and the number of the latest component CSI-RS resource(s) in the time domain which have the same starting symbol is N_x , then N_x latest component CSI-RS resources may occupy $O_{CPU} - (N_{CSI_RS} - N_x)$ CPUs, and each component CSI-RS resource other than the N_x latest component CSI-RS resources may occupy one CPU.

[0119] In some examples, in the N_x latest component CSI-RS resources, a component CSI-RS resource with a largest CSI-RS index may occupy $O_{CPU} - N_{CSI_RS} + 1$ CPUs and each of the other latest component CSI-RS resource(s) may occupy one CPU.

[0120] As an example, when the multiple component CSI-RS resources are aggregated via a TDM scheme, 1 CPU may be occupied from the starting symbol of the earliest component CSI-RS resource for channel measurement to the last symbol of the configured PUSCH/PUCCH carrying the report; 2 CPUs may be occupied from the starting symbol of the second earliest component CSI-RS resource for channel measurement until the last symbol of the configured PUSCH/PUCCH carrying the report, wherein the 2 CPUs may include 1 CPU occupied by the earliest component CSI-RS resource and 1 CPU occupied by the second earliest component CSI-RS resource; 3 CPUs may be occupied from the starting symbol of the third earliest component CSI-RS resource for channel measurement until the last symbol of the configured

PUSCH/PUCCH carrying the report, wherein the 3 CPUs may include 1 CPU occupied by the earliest component CSI-RS resource, 1 CPU occupied by the second earliest component CSI-RS resource, and 1 CPU occupied by the third earliest component CSI-RS resource; and so on, lastly all the CPU are occupied from the starting symbol of the latest component CSI-RS resource(s) for channel measurement until the last symbol of the configured PUSCH/PUCCH carrying the report.

[0121] According to some embodiments of the present disclosure, in any slot, a UE is not expected to have more active CSI-RS resources or active CSI-RS ports in active BWPs than its capability. The UE may report its capability to the BS, such that the BS may configure CSI-RS resource(s) based on the UE's capability.

[0122] In some embodiments, the capability information reported by the UE may include a first parameter (e.g., *maxNumberTxPortsPerResource* as specified in 3GPP standard documents) indicating a maximum number of CSI-RS ports in a resource of a band, a second parameter (e.g., *maxNumberResourcesPerBand* as specified in 3GPP standard documents) indicating a maximum number of CSI-RS resources across all component carriers (CCs) in a band, and a third parameter (e.g., *totalNumberTxPortsPerBand* as specified in 3GPP standard documents) indicating a total number of CSI-RS ports across all CCs in a band.

[0123] For a CSI-RS resource with more than 32 CSI-RS ports, schemes for determining a number of active CSI-RS resource(s) and a number of active CSI-RS port(s) needs to be aligned between the BS and the UE, such that the BS will not configure more active CSI-RS resources and/or active CSI-RS ports exceeding the UE's capability.

[0124] The following Schemes 5 and 6 provide several solutions for determining a number of active CSI-RS resource(s) and/or a number of active CSI-RS port(s) for a CSI-RS resource with more than 32 CSI-RS ports.

[0125] **Scheme 5**

[0126] In Scheme 5, for a CSI-RS resource with more than 32 CSI-RS ports, the UE and the BS may count such CSI-RS resource as one active CSI-RS resource. Alternatively or additionally, the UE and the BS may count the number of CSI-RS ports of the CSI-RS resource

(i.e., the total CSI-RS port number across all the component CSI-RS resources of the CSI-RS resource) as a number of active CSI-RS ports for one active CSI-RS resource.

[0127] In such scheme, there is no difference between a CSI-RS resource with more than 32 CSI-RS ports and a legacy CSI-RS resource with no more than 32 CSI-RS ports. However, the UE's processing capability for these two kinds of CSI-RS resources are different. Given this, in addition to the aforementioned three parameters, the UE may also transmit capability information indicating a maximum number of CSI-RS resources with more than 32 ports per band. For example, the capability information may include a fourth parameter (e.g., denoted as "*maxNumberResourcesPerBand2*") indicating the maximum number of CSI-RS resources with more than 32 ports per band. Such capability information may be used for the BS's configuration for CSI-RS. For example, the BS will not configure a number of CSI-RS resources with more than 32 ports exceeding the reported maximum number of CSI-RS resources with more than 32 ports per band.

[0128] **Scheme 6**

[0129] In Scheme 6, for a CSI-RS resource with more than 32 CSI-RS ports which is generated by aggregating N_{CSI_RS} component CSI-RS resources, the UE and the BS may count the CSI-RS resource as N_{CSI_RS} active CSI-RS resources. Alternatively or additionally, the UE and the BS may count the number of CSI-RS ports of each of the component CSI-RS resources as a number of active CSI-RS ports for a corresponding active CSI-RS resource. That is, if a component CSI-RS resource (which is counted as an active CSI-RS resource) has P_{CSI_RS} CSI-RS ports, the number of active CSI-RS ports for this active CSI-RS resource is determined/counted as P_{CSI_RS} .

[0130] As another example, for a CSI-RS resource with more than 32 CSI-RS ports which is generated by aggregating N_{CSI_RS} component CSI-RS resources, the UE and the BS may count each component CSI-RS resource as N active CSI-RS resources, wherein N is a value scalable with the number of antenna ports of the corresponding component CSI-RS resource. In some examples, N may be determined based on the number of antenna ports of the corresponding component CSI-RS resource and a number of antenna ports of a reference component CSI-RS resource. For example, one component CSI-RS resource with $P_{CSI_RS_ref}$ ports may be used as

a reference component CSI-RS resource for counting active CSI-RS resources, which may be counted as 1 active CSI-RS resource. Then, a component CSI-RS resource with P_{CSI_RS} ports may be counted as $\text{ceil}(P_{CSI_RS}/P_{CSI_RS_ref})$ active CSI-RS resources. In some examples, the component CSI-RS resource used as the reference component CSI-RS resource may be a component CSI-RS resource with a minimal port number or an average port number among the N_{CSI_RS} component CSI-RS resources.

[0131] According to some embodiments of the present disclosure, in the case that a component CSI-RS resource of a CSI-RS resource with more than 32 ports is used for CSI computation based on multiple different transmission assumptions associated with CSI reporting, the component CSI-RS resource and its CSI-RS ports may be counted multiple times in determining/counting the number of active CSI-RS resources and the number of active CSI-RS ports. For example, in the case that a component CSI-RS reference is referred to X times for deriving CSI for reporting, the UE and the BS may count the component CSI-RS resource X times for determining a number of active CSI-RS resources. Alternatively or additionally, the UE and the BS may count a number of CSI-RS ports of the component CSI-RS resource X times for determining a number of active CSI-RS ports. As an example, the UE may select to report CSI from two candidate CSI, wherein one candidate CSI is determined based on a joint transmission on a CSI-RS resource with more than 32 ports which is generated by aggregating multiple component CSI-RS resources (i.e., based on all component CSI-RS resources of the CSI-RS resource), and the other CSI is determined based on a fallback transmission on a first component CSI-RS resource in the multiple component CSI-RS resources. In such example, the number of active CSI-RS resources may be determined to be the number of active CSI-RS resources counted for the CSI-RS resource plus 1 additional active CSI-RS resource (i.e., the first component CSI-RS resource); alternatively or additionally, the number of active CSI-RS ports may be determined to be the number of active CSI-RS ports counted for the CSI-RS resource plus the number of CSI-RS ports of the first component CSI-RS resource. Accordingly the first component CSI-RS resource is counted two times for determining a number of active CSI-RS resources. Alternatively or additionally, the number of CSI-RS ports of the first component CSI-RS resource is counted two times for determining a number of active CSI-RS ports.

[0132] Figure 2 illustrates a flowchart of an exemplary method in accordance with aspects of the present disclosure. The operations of the method illustrated in Figure 2 may be performed by a UE (e.g., UE 104 in Figure 1) as described herein or other apparatus with the like functions. In some implementations, the UE may execute a set of instructions to control functional elements of the UE to perform the described operations or functions.

[0133] As shown in Figure 2, in step 202, the UE may receive, from a BS (e.g., NE 102 in Figure 1), configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32. In step 204, the UE may determine a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting. For example, the UE may determine the number of CPUs occupied by the first CSI-RS resource for processing CSI reporting based on the aforementioned Scheme 1 or 2.

[0134] In some embodiments of the present disclosure, in step 202, the UE may receive configuration information for a CSI-RS resource set (including the first CSI-RS resource) for channel measurement. In step 204, the UE may determine the number of CPUs occupied by the CSI-RS resource set for processing CSI reporting. For example, the UE may determine the number of CPUs occupied by the CSI-RS resource set to be a sum of a number of CPUs occupied by each CSI-RS resource included in the CSI-RS resource set. The number of CPUs occupied by a CSI-RS resource with more than 32 ports in the CSI-RS resource set may be determined based on the aforementioned Scheme 1 or 2. The number of CPUs occupied by a CSI-RS resource with no more than 32 ports in the CSI-RS resource set may be determined to be 1.

[0135] According to some embodiments of the present disclosure, before receiving the configuration information, the UE may transmit capability information indicating that one CPU is supportive to process CSI reporting based on a CSI-RS resource with a second number of CSI-RS ports. In the case that the second number is equal to or larger than the first number, the UE may determine the number of CPUs occupied by the first CSI-RS resource to be 1.

[0136] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the UE may determine the number of CPUs occupied by the first

CSI-RS resource based on a third number (e.g., denoted as N'_{CSI-RS}), wherein N'_{CSI-RS} is a number of the multiple second CSI-RS resources or a specified value.

[0137] In some embodiments, the UE may determine the number of CPUs occupied by the first CSI-RS resource based on N'_{CSI-RS} and a scaling factor, wherein the scaling factor is equal to or larger than 1. In an embodiment, the UE may transmit capability information indicating the scaling factor to the BS.

[0138] In some embodiments, the UE may determine the number of CPUs occupied by the first CSI-RS resource based on N'_{CSI-RS} and an offset, wherein the offset is a positive integer. In an embodiment, the UE may transmit capability information indicating the offset to the BS.

[0139] In some embodiments, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource. In the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the UE may determine a number of CPUs occupied for CSI reporting by counting a CPU occupied by the second CSI-RS resource X times.

[0140] According to some embodiments of the present disclosure, in the case that a CSI-RS resource set for channel measurement is configured with M CSI-RS resources for channel measurement of single TRP transmission and N resource pairs for channel measurement of multiple TRP transmission, and there are M_3 CSI-RS resources with more than 32 CSI-RS ports in the M CSI-RS resources, the UE may determine a total number of CPUs occupied for CSI reporting based on the CSI-RS resource set to be a sum of a number of CPUs occupied by the N resource pairs, a number of CPUs occupied by $M-M_3$ CSI-RS resources with no more than 32 CSI-RS ports, and a number of CPUs occupied by M_3 CSI-RS resources with more than 32 CSI-RS ports.

[0141] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the UE may determine a unified CPU occupation time for all of the multiple second CSI-RS resources.

[0142] In some embodiments, the unified CPU occupation time may be determined based on a first symbol of the earliest one or the latest one in the multiple second CSI-RS resources in the time domain.

[0143] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the UE may determine a corresponding CPU occupation time for each of the multiple second CSI-RS resources.

[0144] In some embodiments, in the multiple second CSI-RS resources, each second CSI-RS resource other than the latest second CSI-RS resource(s) in the time domain occupies one CPU of the CPUs occupied by the first CSI-RS resource and the latest second CSI-RS resource(s) occupies remaining CPU(s) of the CPUs occupied by the first CSI-RS resource.

[0145] In some embodiments, in the latest second CSI-RS resource(s), a second CSI-RS resource with a largest CSI-RS index occupies $O_{CPU} - N_{CSI_RS} + 1$ CPUs and each of the other second CSI-RS resource(s) occupies one CPU, wherein O_{CPU} is the number of CPUs occupied by the first CSI-RS resource and N_{CSI_RS} is a number of the multiple second CSI-RS resources.

[0146] According to some embodiments of the present disclosure, the UE may perform at least one of: counting the first CSI-RS resource as one active CSI-RS resource; or counting the first number of CSI-RS ports as the first number of active CSI-RS ports for one active CSI-RS resource.

[0147] In some embodiments, the UE may transmit, to the BS, capability information indicating a maximum number of CSI-RS resources with more than 32 ports per band.

[0148] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the UE may perform at least one of: counting the first CSI-RS resource as N_{CSI_RS} active CSI-RS resources, wherein N_{CSI_RS} is a number of the multiple second CSI-RS resources; or counting a number of CSI-RS ports of each of the multiple second CSI-RS resources as a number of active CSI-RS ports for a corresponding active CSI-RS resource.

[0149] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource. In the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the UE may perform at least one of: counting the second CSI-RS resource X times for determining a number of active CSI-RS resources; or counting a number of CSI-RS ports of the second CSI-RS resource X times for determining a number of active CSI-RS ports.

[0150] Figure 3 illustrates a flowchart of an exemplary method in accordance with aspects of the present disclosure. The operations of the method illustrated in Figure 3 may be performed by a BS (e.g., NE 102 in Figure 1) as described herein or other apparatus with the like functions. In some implementations, the BS may execute a set of instructions to control functional elements of the BS to perform the described operations or functions.

[0151] As shown in Figure 3, in step 302, the BS may transmit, to a UE (e.g., UE 104 in Figure 1), configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32. In step 304, the BS may determine a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting. For example, the BS may determine the number of CPUs occupied by the first CSI-RS resource for processing CSI reporting based on the aforementioned Scheme 1 or 2.

[0152] In some embodiments of the present disclosure, in step 302, the BS may transmit, to the UE, configuration information for a CSI-RS resource set (including the first CSI-RS resource) for channel measurement. In step 304, the BS may determine the number of CPUs occupied by the CSI-RS resource set for processing CSI reporting. For example, the BS may determine the number of CPUs occupied by the CSI-RS resource set to be a sum of the number of CPUs occupied by each CSI-RS resource included in the CSI-RS resource set. The number of CPUs occupied by a CSI-RS resource with more than 32 ports in the CSI-RS resource set may be determined based on the aforementioned Scheme 1 or 2. The number of CPUs occupied by a CSI-RS resource with no more than 32 ports in the CSI-RS resource set may be determined to be 1.

[0153] According to some embodiments of the present disclosure, before transmitting the configuration information, the BS may receive, from the UE, capability information indicating that one CPU is supportive to process CSI reporting based on a CSI-RS resource with a second number of CSI-RS ports. In the case that the second number is equal to or larger than the first number, the BS may determine the number of CPUs occupied by the first CSI-RS resource to be 1.

[0154] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the BS may determine the number of CPUs occupied by the first CSI-RS resource based on a third number (e.g., denoted as N'_{CSI-RS}), wherein N'_{CSI-RS} is a number of the multiple second CSI-RS resources or a specified value.

[0155] In some embodiments, the BS may determine the number of CPUs occupied by the first CSI-RS resource based on the N'_{CSI-RS} and a scaling factor, wherein the scaling factor is equal to or larger than 1. In an embodiment, the BS may receive capability information indicating the scaling factor from the UE.

[0156] In some embodiments, the BS may determine the number of CPUs occupied by the first CSI-RS resource based on N'_{CSI-RS} and an offset, wherein the offset is a positive integer. In an embodiment, the BS may receive capability information indicating the offset from the UE.

[0157] In some embodiments, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource. In the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the BS may determine a number of CPUs occupied for CSI reporting by counting a CPU occupied by the second CSI-RS resource X times.

[0158] According to some embodiments of the present disclosure, in the case that a CSI-RS resource set for channel measurement is configured with M CSI-RS resources for channel measurement of single TRP transmission and N resource pairs for channel measurement of multiple TRP transmission, and there are M_3 CSI-RS resources with more than 32 CSI-RS ports in the M CSI-RS resources, the BS may determine a total number of CPUs occupied for CSI reporting based on the CSI-RS resource set to be a sum of a number of CPUs occupied by the

N resource pairs, a number of CPUs occupied by $M-M_3$ CSI-RS resources with no more than 32 CSI-RS ports, and a number of CPUs occupied by M_3 CSI-RS resources with more than 32 CSI-RS ports.

[0159] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the BS may determine a unified CPU occupation time for all of the multiple second CSI-RS resources.

[0160] In some embodiments, the unified CPU occupation time may be determined based on a first symbol of the earliest one or the latest one in the multiple second CSI-RS resources in the time domain.

[0161] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the BS may determine a corresponding CPU occupation time for each of the multiple second CSI-RS resources.

[0162] In some embodiments, in the multiple second CSI-RS resources, each second CSI-RS resource other than the latest second CSI-RS resource(s) in the time domain occupies one CPU of the CPUs occupied by the first CSI-RS resource and the latest second CSI-RS resource(s) occupies remaining CPU(s) of the CPUs occupied by the first CSI-RS resource.

[0163] In some embodiments, in the latest second CSI-RS resource(s), a second CSI-RS resource with a largest CSI-RS index occupies $O_{CPU} - N_{CSI_RS} + 1$ CPUs and each of the other second CSI-RS resource(s) occupies one CPU, wherein O_{CPU} is the number of CPUs occupied by the first CSI-RS resource and N_{CSI_RS} is a number of the multiple second CSI-RS resources.

[0164] According to some embodiments of the present disclosure, the BS may perform at least one of: counting the first CSI-RS resource as one active CSI-RS resource; or counting the first number of CSI-RS ports as the first number of active CSI-RS ports for one active CSI-RS resource.

[0165] In some embodiments, the BS may receive, from the UE, capability information indicating a maximum number of CSI-RS resources with more than 32 ports per band.

[0166] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the BS may perform at least one of: counting the first CSI-RS resource as N_{CSI_RS} active CSI-RS resources, wherein N_{CSI_RS} is a number of the multiple second CSI-RS resources; or counting a number of CSI-RS ports of each of the multiple second CSI-RS resources as a number of active CSI-RS ports for a corresponding active CSI-RS resource.

[0167] According to some embodiments of the present disclosure, the configuration information may indicate multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource. In the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the BS may perform at least one of: counting the second CSI-RS resource X times for determining a number of active CSI-RS resources; or counting a number of CSI-RS ports of the second CSI-RS resource X times for determining a number of active CSI-RS ports.

[0168] Figure 4 illustrates an example of a UE 400 in accordance with aspects of the present disclosure. The UE 400 may include at least one processor 402 and at least one memory 404. Additionally, the UE 400 may also include one or more of at least one controller 406 or at least one transceiver 408. The processor 402, the memory 404, the controller 406, or the transceiver 408, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0169] The processor 402, the memory 404, the controller 406, or the transceiver 408, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0170] The processor 402 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 402 may be configured to operate the memory 404. In some other implementations, the memory 404 may be integrated into the processor 402. The processor 402 may be configured to execute computer-readable instructions stored in the memory 404 to cause the UE 400 to perform various functions of the present disclosure.

[0171] The memory 404 may include volatile or non-volatile memory. The memory 404 may store computer-readable, computer-executable code including instructions when executed by the processor 402 cause the UE 400 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 404 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0172] In some implementations, the processor 402 and the memory 404 coupled with the processor 402 may be configured to cause the UE 400 to perform one or more of the functions described herein (e.g., executing, by the processor 402, instructions stored in the memory 404). For example, the processor 402 may support wireless communication at the UE 400 in accordance with examples as disclosed herein. The UE 400 may be configured to support a means for performing the operations of the methods described in the embodiments of the present disclosure. In an embodiment, the processor 402 may be configured to cause the UE 400 to: receive configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determine a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting.

[0173] The controller 406 may manage input and output signals for the UE 400. The controller 406 may also manage peripherals not integrated into the UE 400. In some implementations, the controller 406 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 406 may be implemented as part of the processor 402.

[0174] In some implementations, the UE 400 may include at least one transceiver 408. In some other implementations, the UE 400 may have more than one transceiver 408. The transceiver 408 may represent a wireless transceiver. The transceiver 408 may include one or more receiver chains 410, one or more transmitter chains 412, or a combination thereof.

[0175] A receiver chain 410 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 410 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 410 may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 410 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 410 may include at least one decoder for decoding the demodulated signal to receive the transmitted data.

[0176] A transmitter chain 412 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 412 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 412 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 412 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0177] Figure 5 illustrates an example of a processor 500 in accordance with aspects of the present disclosure. The processor 500 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 500 may include a controller 502 configured to perform various operations in accordance with examples as described herein. The processor 500 may optionally include at least one memory 504, which may be, for example, a layer 1 (L1), layer 2 (L2), or layer 3 (L3) cache. Additionally, or alternatively, the processor 500 may optionally include one or more arithmetic-logic units (ALUs) 506. One or more of these components may be in electronic communication or

otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0178] The processor 500 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g., receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 500) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[0179] The controller 502 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 500 to cause the processor 500 to support various operations in accordance with examples as described herein. For example, the controller 502 may operate as a control unit of the processor 500, generating control signals that manage the operation of various components of the processor 500. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0180] The controller 502 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 504 and determine subsequent instruction(s) to be executed to cause the processor 500 to support various operations in accordance with examples as described herein. The controller 502 may be configured to track memory address of instructions associated with the memory 504. The controller 502 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 502 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 500 to cause the processor 500 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 502 may be configured to manage flow of data within the processor 500. The

controller 502 may be configured to control transfer of data between registers, ALUs, and other functional units of the processor 500.

[0181] The memory 504 may include one or more caches (e.g., memory local to or included in the processor 500 or other memory, such as RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc.). In some implementations, the memory 504 may reside within or on a processor chipset (e.g., local to the processor 500). In some other implementations, the memory 504 may reside external to the processor chipset (e.g., remote to the processor 500).

[0182] The memory 504 may store computer-readable, computer-executable code including instructions that, when executed by the processor 500, cause the processor 500 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 502 and/or the processor 500 may be configured to execute computer-readable instructions stored in the memory 504 to cause the processor 500 to perform various functions. For example, the processor 500 and/or the controller 502 may be coupled with or to the memory 504, the processor 500, the controller 502, and the memory 504 may be configured to perform various functions described herein. In some examples, the processor 500 may include multiple processors and the memory 504 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0183] The one or more ALUs 506 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 506 may reside within or on a processor chipset (e.g., the processor 500). In some other implementations, the one or more ALUs 506 may reside external to the processor chipset (e.g., the processor 500). One or more ALUs 506 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 506 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 506 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 506 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND),

enabling the one or more ALUs 506 to handle conditional operations, comparisons, and bitwise operations.

[0184] The processor 500 may support wireless communication in accordance with examples as disclosed herein. The processor 500 may be configured to or operable to support a means for performing the operations of the methods described in the embodiments of the present disclosure. In an embodiment, the controller 502 may cause the processor 500 to: receive configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determine a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting.

[0185] Figure 11 illustrates an example of a BS 600 in accordance with aspects of the present disclosure. The BS 600 may include at least one processor 602 and at least one memory 604. Additionally, the BS 600 may also include one or more of at least one controller 606 or at least one transceiver 608. The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0186] The processor 602, the memory 604, the controller 606, or the transceiver 608, or various combinations or components thereof may be implemented in hardware (e.g., circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0187] The processor 602 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 602 may be configured to operate the memory 604. In some other implementations, the memory 604 may be integrated into the processor 602. The processor 602 may be configured to execute computer-readable instructions stored in the memory 604 to cause the BS 600 to perform various functions of the present disclosure.

[0188] The memory 604 may include volatile or non-volatile memory. The memory 604 may store computer-readable, computer-executable code including instructions when executed by the processor 602 cause the BS 600 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as the memory 604 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0189] In some implementations, the processor 602 and the memory 604 coupled with the processor 602 may be configured to cause the BS 600 to perform one or more of the functions described herein (e.g., executing, by the processor 602, instructions stored in the memory 604). For example, the processor 602 may support wireless communication at the BS 600 in accordance with examples as disclosed herein. The BS 600 may be configured to support a means for performing the operations of the methods described in the embodiments of the present disclosure. In an embodiment, the processor 602 may be configured to cause the BS 600 to: transmit, to a UE, configuration information for a first CSI-RS resource with a first number of CSI-RS ports, wherein the first number is more than 32; and determine a number of CPUs occupied by the first CSI-RS resource for processing CSI reporting.

[0190] The controller 606 may manage input and output signals for the BS 600. The controller 606 may also manage peripherals not integrated into the BS 600. In some implementations, the controller 606 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 606 may be implemented as part of the processor 602.

[0191] In some implementations, the BS 600 may include at least one transceiver 608. In some other implementations, the BS 600 may have more than one transceiver 608. The transceiver 608 may represent a wireless transceiver. The transceiver 608 may include one or more receiver chains 610, one or more transmitter chains 612, or a combination thereof.

[0192] A receiver chain 600 may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receiver chain 610 may include one or

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

[0193] A transmitter chain 612 may be configured to generate and transmit signals (e.g., control information, data, packets). The transmitter chain 612 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 612 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 612 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0194] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1. A user equipment (UE) for wireless communication, comprising:
at least one memory; and
at least one processor coupled with the at least one memory and
configured to cause the UE to:
receive configuration information for a first channel state
information reference signal (CSI-RS) resource with a first number of CSI-
RS ports, wherein the first number is more than 32; and
determine a number of channel state information (CSI)
processing units (CPUs) occupied by the first CSI-RS resource for
processing CSI reporting.
2. The UE of Claim 1, wherein the at least one processor is further
configured to cause the UE to transmit capability information indicating that one CPU is
supportive to process CSI reporting based on a CSI-RS resource with a second number of
CSI-RS ports before receiving the configuration information.
3. The UE of Claim 2, wherein the at least one processor is configured
to cause the UE to determine the number of CPUs occupied by the first CSI-RS resource to
be 1 in the case that the second number is equal to or larger than the first number.
4. The UE of Claim 1, wherein the configuration information indicates
multiple second CSI-RS resources which are aggregated to generate the first CSI-RS
resource, and the at least one processor is configured to cause the UE to determine the
number of CPUs occupied by the first CSI-RS resource based on a third number, wherein
the third number is a number of the multiple second CSI-RS resources or a specified value.
5. The UE of Claim 4, wherein the at least one processor is configured
to cause the UE to determine the number of CPUs occupied by the first CSI-RS resource

based on the third number and a scaling factor, wherein the scaling factor is equal to or larger than 1.

6. The UE of Claim 5, wherein the at least one processor is further configured to cause the UE to transmit capability information indicating the scaling factor.

7. The UE of Claim 4, wherein the at least one processor is configured to cause the UE to determine the number of CPUs occupied by the first CSI-RS resource based on the third number and an offset, wherein the offset is a positive integer.

8. The UE of Claim 7, wherein the at least one processor is further configured to cause the UE to transmit capability information indicating the offset.

9. The UE of Claim 1, wherein the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and wherein in the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the at least one processor is further configured to cause the UE to determine a number of CPUs occupied for CSI reporting by counting a CPU occupied by the second CSI-RS resource X times.

10. The UE of Claim 1, wherein the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and wherein the at least one processor is further configured to cause the UE to determine a unified CPU occupation time for all of the multiple second CSI-RS resources.

11. The UE of Claim 10, wherein the unified CPU occupation time is determined based on a first symbol of the earliest one or the latest one in the multiple second CSI-RS resources in the time domain.

12. The UE of Claim 1, wherein the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and wherein the at least one processor is further configured to cause the UE to determine a corresponding CPU occupation time for each of the multiple second CSI-RS resources.

13. The UE of Claim 12, wherein in the multiple second CSI-RS resources, each second CSI-RS resource other than the latest second CSI-RS resource(s) in the time domain occupies one CPU of the CPUs occupied by the first CSI-RS resource and the latest second CSI-RS resource(s) occupies remaining CPU(s) of the CPUs occupied by the first CSI-RS resource.

14. The UE of Claim 1, wherein the at least one processor is further configured to cause the UE to perform at least one of:
counting the first CSI-RS resource as one active CSI-RS resource; or
counting the first number of CSI-RS ports as the first number of active CSI-RS ports for one active CSI-RS resource.

15. The UE of Claim 14, wherein the at least one processor is further configured to cause the UE to transmit capability information indicating a maximum number of CSI-RS resources with more than 32 ports per band.

16. The UE of Claim 1, wherein the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and the at least one processor is further configured to cause the UE to perform at least one of:

counting the first CSI-RS resource as N_{CSI_RS} active CSI-RS resources, wherein N_{CSI_RS} is a number of the multiple second CSI-RS resources; or

counting a number of CSI-RS ports of each of the multiple second CSI-RS resources as a number of active CSI-RS ports for a corresponding active CSI-RS resource.

17. The UE of Claim 1, wherein the configuration information indicates multiple second CSI-RS resources which are aggregated to generate the first CSI-RS resource, and wherein in the case that a second CSI-RS resource in the multiple second CSI-RS resources is referred to X times for deriving CSI for reporting, the at least one processor is further configured to cause the UE to perform at least one of:

counting the second CSI-RS resource X times for determining a number of active CSI-RS resources; or

counting a number of CSI-RS ports of the second CSI-RS resource X times for determining a number of active CSI-RS ports.

18. A processor for wireless communication, comprising:

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

receive configuration information for a first channel state information reference signal (CSI-RS) resource with a first number of CSI-RS ports, wherein the first number is more than 32; and

determine a number of channel state information (CSI) processing units (CPUs) occupied by the first CSI-RS resource for processing CSI reporting.

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

at least one memory; and

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

transmit, to a user equipment (UE), configuration information for a first channel state information reference signal (CSI-RS) resource with a first number of CSI-RS ports, wherein the first number is more than 32; and

determine a number of channel state information (CSI) processing units (CPUs) occupied by the first CSI-RS resource for processing CSI reporting.

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

receiving configuration information for a first channel state information reference signal (CSI-RS) resource with a first number of CSI-RS ports, wherein the first number is more than 32; and

determining a number of channel state information (CSI) processing units (CPUs) occupied by the first CSI-RS resource for processing CSI reporting.