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Multiple-input multiple-output layer adaptation

Abstract

Various aspects of the present disclosure generally relate to wireless communication. In some aspects, a user equipment (UE) may identify a maximum number of multiple-input multiple-output (MIMO) layers for a communication based at least in part on at least one of a number of channel state information reference signal (CSI-RS) ports associated with a network node, or a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state. The UE may perform the communication in accordance with the maximum number of MIMO layers. Numerous other aspects are described.

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Background/Summary

FIELD OF THE DISCLOSURE

(1) Aspects of the present disclosure generally relate to wireless communication and to techniques and apparatuses for multiple-input multiple-output (MIMO) layer adaptation.

BACKGROUND

(2) Wireless communication systems are widely deployed to provide various telecommunication services such as telephony, video, data, messaging, and broadcasts. Typical wireless communication systems may employ multiple-access technologies capable of supporting communication with multiple users by sharing available system resources (e.g., bandwidth, transmit power, or the like). Examples of such multiple-access technologies include code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, orthogonal frequency division multiple access (OFDMA) systems, single-carrier frequency division multiple access (SC-FDMA) systems, time division synchronous code division multiple access (TD-SCDMA) systems, and Long Term Evolution (LTE). LTE/LTE-Advanced is a set of enhancements to the Universal Mobile Telecommunications System (UMTS) mobile standard promulgated by the Third Generation Partnership Project (3GPP).

(3) A wireless network may include one or more network nodes that support communication for wireless communication devices, such as a user equipment (UE) or multiple UEs. A UE may communicate with a network node via downlink communications and uplink communications. "Downlink" (or "DL") refers to a communication link from the network node to the UE, and "uplink" (or "UL") refers to a communication link from the UE to the network node. Some wireless networks may support device-to-device communication, such as via a local link (e.g., a sidelink (SL), a wireless local area network (WLAN) link, and/or a wireless personal area network (WPAN) link, among other examples).

(4) The above multiple access technologies have been adopted in various telecommunication standards to provide a common protocol that enables different UEs to communicate on a municipal, national, regional, and/or global level. New Radio (NR), which may be referred to as 5G, is a set of enhancements to the LTE mobile standard promulgated by the 3GPP. NR is designed to better support mobile broadband internet access by improving spectral efficiency, lowering costs, improving services, making use of new spectrum, and better integrating with other open standards using orthogonal frequency division multiplexing (OFDM) with a cyclic prefix (CP) (CP-OFDM) on the downlink, using CP-OFDM and/or single-carrier frequency division multiplexing (SC-FDM) (also known as discrete Fourier transform spread OFDM (DFT-s-OFDM)) on the uplink, as well as supporting beamforming, multiple-input multiple-output (MIMO) antenna technology, and carrier aggregation. As the demand for mobile broadband access continues to increase, further improvements in LTE, NR, and other radio access technologies remain useful.

SUMMARY

(5) Some aspects described herein relate to a method of wireless communication performed by a user equipment (UE). The method may include identifying a maximum number of multiple-input multiple-output (MIMO) layers for a communication based at least in part on at least one of a number of channel state information reference signal (CSI-RS) ports associated with a network node, or a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state. The method may include performing the communication in accordance with the maximum number of MIMO layers.

(6) Some aspects described herein relate to a method of wireless communication performed by a network node. The method may include transmitting at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state. The method may include performing a communication in accordance with a maximum number of MIMO layers, wherein the

maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state.

(7) Some aspects described herein relate to an apparatus of a UE for wireless communication. The apparatus may include a memory and one or more processors coupled to the memory. The one or more processors may be configured to identify a maximum number of MIMO layers for a communication based at least in part on at least one of a number of CSI-RS ports associated with a network node, or a transition of a TRP associated with the network node to or from a dormancy state. The one or more processors may be configured to perform the communication in accordance with the maximum number of MIMO layers.

(8) Some aspects described herein relate to a network node for wireless communication. The network node may include a memory and one or more processors coupled to the memory. The one or more processors may be configured to transmit at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state. The one or more processors may be configured to perform a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state.

(9) Some aspects described herein relate to a non-transitory computer-readable medium that stores a set of instructions for wireless communication by a UE. The set of instructions, when executed by one or more processors of the UE, may cause the UE to identify a maximum number of MIMO layers for a communication based at least in part on at least one of a number of CSI-RS ports associated with a network node, or a transition of a TRP associated with the network node to or from a dormancy state. The set of instructions, when executed by one or more processors of the UE, may cause the UE to perform the communication in accordance with the maximum number of MIMO layers.

(10) Some aspects described herein relate to a non-transitory computer-readable medium that stores a set of instructions for wireless communication by a network node. The set of instructions, when executed by one or more processors of the network node, may cause the network node to transmit at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state. The set of instructions, when executed by one or more processors of the network node, may cause the network node to perform a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state.

(11) Some aspects described herein relate to an apparatus for wireless communication. The apparatus may include means for identifying a maximum number of MIMO layers for a communication based at least in part on at least one of a number of CSI-RS ports associated with a network node, or a transition of a TRP associated with the network node to or from a dormancy state. The apparatus may include means for performing the communication in accordance with the maximum number of MIMO layers.

(12) Some aspects described herein relate to an apparatus for wireless communication. The apparatus may include means for transmitting at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state. The apparatus may include means for performing a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state.

(13) Aspects generally include a method, apparatus, system, computer program product, non-transitory computer-readable medium, user equipment, base station, network entity, network node, wireless communication device, and/or processing system as substantially described herein with

reference to and as illustrated by the drawings.

(14) The foregoing has outlined rather broadly the features and technical advantages of examples according to the disclosure in order that the detailed description that follows may be better understood. Additional features and advantages will be described hereinafter. The conception and specific examples disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present disclosure. Such equivalent constructions do not depart from the scope of the appended claims. Characteristics of the concepts disclosed herein, both their organization and method of operation, together with associated advantages, will be better understood from the following description when considered in connection with the accompanying figures. Each of the figures is provided for the purposes of illustration and description, and not as a definition of the limits of the claims.

(15) While aspects are described in the present disclosure by illustration to some examples, those skilled in the art will understand that such aspects may be implemented in many different arrangements and scenarios. Techniques described herein may be implemented using different platform types, devices, systems, shapes, sizes, and/or packaging arrangements. For example, some aspects may be implemented via integrated chip embodiments or other non-module-component based devices (e.g., end-user devices, vehicles, communication devices, computing devices, industrial equipment, retail/purchasing devices, medical devices, and/or artificial intelligence devices). Aspects may be implemented in chip-level components, modular components, non-modular components, non-chip-level components, device-level components, and/or system-level components. Devices incorporating described aspects and features may include additional components and features for implementation and practice of claimed and described aspects. For example, transmission and reception of wireless signals may include one or more components for analog and digital purposes (e.g., hardware components including antennas, radio frequency (RF) chains, power amplifiers, modulators, buffers, processors, interleavers, adders, and/or summers). It is intended that aspects described herein may be practiced in a wide variety of devices, components, systems, distributed arrangements, and/or end-user devices of varying size, shape, and constitution.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) So that the above-recited features of the present disclosure can be understood in detail, a more particular description, briefly summarized above, may be had by reference to aspects, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only certain typical aspects of this disclosure and are therefore not to be considered limiting of its scope, for the description may admit to other equally effective aspects. The same reference numbers in different drawings may identify the same or similar elements.

(2) FIG. **1** is a diagram illustrating an example of a wireless network, in accordance with the present disclosure.

(3) FIG. **2** is a diagram illustrating an example of a network node in communication with a user equipment (UE) in a wireless network, in accordance with the present disclosure.

(4) FIG. **3** is a diagram illustrating an example disaggregated base station architecture, in accordance with the present disclosure.

(5) FIG. **4** is a diagram illustrating examples of channel state information reference signal (CSI-RS) beam management procedures, in accordance with the present disclosure.

(6) FIG. **5** is a diagram illustrating an example of dynamic network-side antenna adaptation, in accordance with the present disclosure.

(7) FIG. **6** illustrates an example logical architecture of a distributed radio access network (RAN),

in accordance with the present disclosure.

(8) FIG. **7** is a diagram illustrating an example of multiple transmission reception point (TRP) communication, in accordance with the present disclosure.

(9) FIG. **8** is a diagram illustrating an example of multiple-input multiple-output (MIMO) communication, in accordance with the present disclosure.

(10) FIG. **9** is a diagram illustrating an example of adaptation of a maximum number of MIMO layers based at least in part on a number of CSI-RS ports associated with a network node, in accordance with the present disclosure.

(11) FIG. **10** is a diagram illustrating an example of adaptation of a maximum number of MIMO layers based at least in part on a transition of a TRP to a dormancy state, in accordance with the present disclosure.

(12) FIG. **11** is a diagram illustrating an example process performed, for example, by a UE, in accordance with the present disclosure.

(13) FIG. **12** is a diagram illustrating an example process performed, for example, by a network node, in accordance with the present disclosure.

(14) FIG. **13** is a diagram of an example apparatus for wireless communication, in accordance with the present disclosure.

(15) FIG. **14** is a diagram of an example apparatus for wireless communication, in accordance with the present disclosure.

DETAILED DESCRIPTION

(16) Various aspects of the disclosure are described more fully hereinafter with reference to the accompanying drawings. This disclosure may, however, be embodied in many different forms and should not be construed as limited to any specific structure or function presented throughout this disclosure. Rather, these aspects are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. One skilled in the art should appreciate that the scope of the disclosure is intended to cover any aspect of the disclosure disclosed herein, whether implemented independently of or combined with any other aspect of the disclosure. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, the scope of the disclosure is intended to cover such an apparatus or method which is practiced using other structure, functionality, or structure and functionality in addition to or other than the various aspects of the disclosure set forth herein. It should be understood that any aspect of the disclosure disclosed herein may be embodied by one or more elements of a claim.

(17) Several aspects of telecommunication systems will now be presented with reference to various apparatuses and techniques. These apparatuses and techniques will be described in the following detailed description and illustrated in the accompanying drawings by various blocks, modules, components, circuits, steps, processes, algorithms, or the like (collectively referred to as "elements"). These elements may be implemented using hardware, software, or combinations thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system.

(18) While aspects may be described herein using terminology commonly associated with a 5G or New Radio (NR) radio access technology (RAT), aspects of the present disclosure can be applied to other RATs, such as a 3G RAT, a 4G RAT, and/or a RAT subsequent to 5G (e.g., 6G).

(19) FIG. **1** is a diagram illustrating an example of a wireless network **100**, in accordance with the present disclosure. The wireless network **100** may be or may include elements of a 5G (e.g., NR) network and/or a 4G (e.g., Long Term Evolution (LTE)) network, among other examples. The wireless network **100** may include one or more network nodes **110** (shown as a network node **110***a*, a network node **110***b*, a network node **110***c*, and a network node **110***d*), a user equipment (UE) **120** or multiple UEs **120** (shown as a UE **120***a*, a UE **120***b*, a UE **120***c*, a UE **120***d*, and a UE **120***e*), and/or other entities. A network node **110** is a network node that communicates with UEs **120**. As

shown, a network node **110** may include one or more network nodes. For example, a network node **110** may be an aggregated network node, meaning that the aggregated network node is configured to utilize a radio protocol stack that is physically or logically integrated within a single radio access network (RAN) node (e.g., within a single device or unit). As another example, a network node **110** may be a disaggregated network node (sometimes referred to as a disaggregated base station), meaning that the network node **110** is configured to utilize a protocol stack that is physically or logically distributed among two or more nodes (such as one or more central units (CUs), one or more distributed units (DUs), or one or more radio units (RUs)).

(20) In some examples, a network node **110** is or includes a network node that communicates with UEs **120** via a radio access link, such as an RU. In some examples, a network node **110** is or includes a network node that communicates with other network nodes **110** via a fronthaul link or a midhaul link, such as a DU. In some examples, a network node **110** is or includes a network node that communicates with other network nodes **110** via a midhaul link or a core network via a backhaul link, such as a CU. In some examples, a network node **110** (such as an aggregated network node **110** or a disaggregated network node **110**) may include multiple network nodes, such as one or more RUs, one or more CUs, and/or one or more DUs. A network node **110** may include, for example, an NR base station, an LTE base station, a Node B, an eNB (e.g., in 4G), a gNB (e.g., in 5G), an access point, a transmission reception point (TRP), a DU, an RU, a CU, a mobility element of a network, a core network node, a network element, a network equipment, a RAN node, or a combination thereof. In some examples, the network nodes **110** may be interconnected to one another or to one or more other network nodes **110** in the wireless network **100** through various types of fronthaul, midhaul, and/or backhaul interfaces, such as a direct physical connection, an air interface, or a virtual network, using any suitable transport network.

(21) In some examples, a network node **110** may provide communication coverage for a particular geographic area. In the Third Generation Partnership Project (3GPP), the term "cell" can refer to a coverage area of a network node **110** and/or a network node subsystem serving this coverage area, depending on the context in which the term is used. A network node **110** may provide communication coverage for a macro cell, a pico cell, a femto cell, and/or another type of cell. A macro cell may cover a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by UEs **120** with service subscriptions. A pico cell may cover a relatively small geographic area and may allow unrestricted access by UEs **120** with service subscriptions. A femto cell may cover a relatively small geographic area (e.g., a home) and may allow restricted access by UEs **120** having association with the femto cell (e.g., UEs **120** in a closed subscriber group (CSG)). A network node **110** for a macro cell may be referred to as a macro network node. A network node **110** for a pico cell may be referred to as a pico network node. A network node **110** for a femto cell may be referred to as a femto network node or an in-home network node. In the example shown in FIG. **1**, the network node **110***a* may be a macro network node for a macro cell **102***a*, the network node **110***b* may be a pico network node for a pico cell **102***b*, and the network node **110***c* may be a femto network node for a femto cell **102***c*. A network node may support one or multiple (e.g., three) cells. In some examples, a cell may not necessarily be stationary, and the geographic area of the cell may move according to the location of a network node **110** that is mobile (e.g., a mobile network node). In some examples, "cell" can refer to a carrier, such as a component carrier of a carrier aggregation configuration (e.g., a primary cell, a secondary cell, etc.). In some examples, "cell" can refer to a TRP.

(22) In some aspects, the term "base station" or "network node" may refer to an aggregated base station, a disaggregated base station, an integrated access and backhaul (IAB) node, a relay node, or one or more components thereof. For example, in some aspects, "base station" or "network node" may refer to a CU, a DU, an RU, a Near-Real Time (Near-RT) RAN Intelligent Controller (RIC), or a Non-Real Time (Non-RT) RIC, or a combination thereof. In some aspects, the term "base station" or "network node" may refer to one device configured to perform one or more

functions, such as those described herein in connection with the network node **110**. In some aspects, the term "base station" or "network node" may refer to a plurality of devices configured to perform the one or more functions. For example, in some distributed systems, each of a quantity of different devices (which may be located in the same geographic location or in different geographic locations) may be configured to perform at least a portion of a function, or to duplicate performance of at least a portion of the function, and the term "base station" or "network node" may refer to any one or more of those different devices. In some aspects, the term "base station" or "network node" may refer to one or more virtual base stations or one or more virtual base station functions. For example, in some aspects, two or more base station functions may be instantiated on a single device. In some aspects, the term "base station" or "network node" may refer to one of the base station functions and not another. In this way, a single device may include more than one base station.

(23) The wireless network **100** may include one or more relay stations. A relay station is a network node that can receive a transmission of data from an upstream node (e.g., a network node **110** or a UE **120**) and send a transmission of the data to a downstream node (e.g., a UE **120** or a network node **110**). A relay station may be a UE **120** that can relay transmissions for other UEs **120**. In the example shown in FIG. **1**, the network node **110***d* (e.g., a relay network node) may communicate with the network node **110***a* (e.g., a macro network node) and the UE **120***d* in order to facilitate communication between the network node **110***a* and the UE **120***d*. A network node **110** that relays communications may be referred to as a relay station, a relay base station, a relay network node, a relay node, a relay, or the like.

(24) The wireless network **100** may be a heterogeneous network that includes network nodes **110** of different types, such as macro network nodes, pico network nodes, femto network nodes, relay network nodes, or the like. These different types of network nodes **110** may have different transmit power levels, different coverage areas, and/or different impacts on interference in the wireless network **100**. For example, macro network nodes may have a high transmit power level (e.g., 5 to 40 watts) whereas pico network nodes, femto network nodes, and relay network nodes may have lower transmit power levels (e.g., 0.1 to 2 watts).

(25) A network controller **130** may couple to or communicate with a set of network nodes **110** and may provide coordination and control for these network nodes **110**. The network controller **130** may communicate with the network nodes **110** via a backhaul communication link or a midhaul communication link. The network nodes **110** may communicate with one another directly or indirectly via a wireless or wireline backhaul communication link. In some aspects, the network controller **130** may be a CU or a core network device, or may include a CU or a core network device.

(26) The UEs **120** may be dispersed throughout the wireless network **100**, and each UE **120** may be stationary or mobile. A UE **120** may include, for example, an access terminal, a terminal, a mobile station, and/or a subscriber unit. A UE **120** may be a cellular phone (e.g., a smart phone), a personal digital assistant (PDA), a wireless modem, a wireless communication device, a handheld device, a laptop computer, a cordless phone, a wireless local loop (WLL) station, a tablet, a camera, a gaming device, a netbook, a smartbook, an ultrabook, a medical device, a biometric device, a wearable device (e.g., a smart watch, smart clothing, smart glasses, a smart wristband, smart jewelry (e.g., a smart ring or a smart bracelet)), an entertainment device (e.g., a music device, a video device, and/or a satellite radio), a vehicular component or sensor, a smart meter/sensor, industrial manufacturing equipment, a global positioning system device, a UE function of a network node, and/or any other suitable device that is configured to communicate via a wireless or wired medium.

(27) Some UEs **120** may be considered machine-type communication (MTC) or evolved or enhanced machine-type communication (eMTC) UEs. An MTC UE and/or an eMTC UE may include, for example, a robot, a drone, a remote device, a sensor, a meter, a monitor, and/or a

location tag, that may communicate with a network node, another device (e.g., a remote device), or some other entity. Some UEs **120** may be considered Internet-of-Things (IoT) devices, and/or may be implemented as NB-IoT (narrowband IoT) devices. Some UEs **120** may be considered a Customer Premises Equipment. A UE **120** may be included inside a housing that houses components of the UE **120**, such as processor components and/or memory components. In some examples, the processor components and the memory components may be coupled together. For example, the processor components (e.g., one or more processors) and the memory components (e.g., a memory) may be operatively coupled, communicatively coupled, electronically coupled, and/or electrically coupled.

(28) In general, any number of wireless networks **100** may be deployed in a given geographic area. Each wireless network **100** may support a particular RAT and may operate on one or more frequencies. A RAT may be referred to as a radio technology, an air interface, or the like. A frequency may be referred to as a carrier, a frequency channel, or the like. Each frequency may support a single RAT in a given geographic area in order to avoid interference between wireless networks of different RATs. In some cases, NR or 5G RAT networks may be deployed.

(29) In some examples, two or more UEs **120** (e.g., shown as UE **120***a* and UE **120***e*) may communicate directly using one or more sidelink channels (e.g., without using a network node **110** as an intermediary to communicate with one another). For example, the UEs **120** may communicate using peer-to-peer (P2P) communications, device-to-device (D2D) communications, a vehicle-to-everything (V2X) protocol (e.g., which may include a vehicle-to-vehicle (V2V) protocol, a vehicle-to-infrastructure (V2I) protocol, or a vehicle-to-pedestrian (V2P) protocol), and/or a mesh network. In such examples, a UE **120** may perform scheduling operations, resource selection operations, and/or other operations described elsewhere herein as being performed by the network node **110**.

(30) Devices of the wireless network **100** may communicate using the electromagnetic spectrum, which may be subdivided by frequency or wavelength into various classes, bands, channels, or the like. For example, devices of the wireless network **100** may communicate using one or more operating bands. In 5G NR, two initial operating bands have been identified as frequency range designations FR1 (410 MHz-7.125 GHz) and FR2 (24.25 GHz-52.6 GHz). It should be understood that although a portion of FR1 is greater than 6 GHz, FR1 is often referred to (interchangeably) as a "Sub-6 GHz" band in various documents and articles. A similar nomenclature issue sometimes occurs with regard to FR2, which is often referred to (interchangeably) as a "millimeter wave" band in documents and articles, despite being different from the extremely high frequency (EHF) band (30 GHz-300 GHz) which is identified by the International Telecommunications Union (ITU) as a "millimeter wave" band.

(31) The frequencies between FR1 and FR2 are often referred to as mid-band frequencies. Recent 5G NR studies have identified an operating band for these mid-band frequencies as frequency range designation FR3 (7.125 GHz-24.25 GHz). Frequency bands falling within FR3 may inherit FR1 characteristics and/or FR2 characteristics, and thus may effectively extend features of FR1 and/or FR2 into mid-band frequencies. In addition, higher frequency bands are currently being explored to extend 5G NR operation beyond 52.6 GHz. For example, three higher operating bands have been identified as frequency range designations FR4a or FR4-1 (52.6 GHz-71 GHz), FR4 (52.6 GHz-114.25 GHz), and FR5 (114.25 GHz-300 GHz). Each of these higher frequency bands falls within the EHF band.

(32) With the above examples in mind, unless specifically stated otherwise, it should be understood that the term "sub-6 GHz" or the like, if used herein, may broadly represent frequencies that may be less than 6 GHz, may be within FR1, or may include mid-band frequencies. Further, unless specifically stated otherwise, it should be understood that the term "millimeter wave" or the like, if used herein, may broadly represent frequencies that may include mid-band frequencies, may be within FR2, FR4, FR4-a or FR4-1, and/or FR5, or may be within the EHF band. It is contemplated that the frequencies included in these operating bands (e.g., FR1, FR2, FR3, FR4, FR4-a, FR4-1,

and/or FR5) may be modified, and techniques described herein are applicable to those modified frequency ranges.

(33) In some aspects, the UE **120** may include a communication manager **140**. As described in more detail elsewhere herein, the communication manager **140** may identify a maximum number of multiple-input multiple-output (MIMO) layers for a communication based at least in part on at least one of a number of channel state information reference signal (CSI-RS) ports associated with a network node, or a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state; and perform the communication in accordance with the maximum number of MIMO layers. Additionally, or alternatively, the communication manager **140** may perform one or more other operations described herein.

(34) In some aspects, the network node may include a communication manager **150**. As described in more detail elsewhere herein, the communication manager **150** may transmit at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state; and perform a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state. Additionally, or alternatively, the communication manager **150** may perform one or more other operations described herein.

(35) As indicated above, FIG. **1** is provided as an example. Other examples may differ from what is described with regard to FIG. **1**.

(36) FIG. **2** is a diagram illustrating an example **200** of a network node **110** in communication with a user equipment (UE) **120** in a wireless network **100**, in accordance with the present disclosure. The network node **110** may be equipped with a set of antennas **234a** through **234t**, such as T antennas (T≥1). The UE **120** may be equipped with a set of antennas **252a** through **252r**, such as R antennas (R≥1). The network node **110** of example **200** includes one or more radio frequency components, such as antennas **234** and a modem **232**. In some examples, a network node **110** may include an interface, a communication component, or another component that facilitates communication with the UE **120** or another network node. Some network nodes **110** may not include radio frequency components that facilitate direct communication with the UE **120**, such as one or more CUs, or one or more DUs.

(37) At the network node **110**, a transmit processor **220** may receive data, from a data source **212**, intended for the UE **120** (or a set of UEs **120**). The transmit processor **220** may select one or more modulation and coding schemes (MCSs) for the UE **120** based at least in part on one or more channel quality indicators (CQIs) received from that UE **120**. The network node **110** may process (e.g., encode and modulate) the data for the UE **120** based at least in part on the MCS(s) selected for the UE **120** and may provide data symbols for the UE **120**. The transmit processor **220** may process system information (e.g., for semi-static resource partitioning information (SRPI)) and control information (e.g., CQI requests, grants, and/or upper layer signaling) and provide overhead symbols and control symbols. The transmit processor **220** may generate reference symbols for reference signals (e.g., a cell-specific reference signal (CRS) or a demodulation reference signal (DMRS)) and synchronization signals (e.g., a primary synchronization signal (PSS) or a secondary synchronization signal (SSS)). A transmit (TX) multiple-input multiple-output (MIMO) processor **230** may perform spatial processing (e.g., precoding) on the data symbols, the control symbols, the overhead symbols, and/or the reference symbols, if applicable, and may provide a set of output symbol streams (e.g., T output symbol streams) to a corresponding set of modems **232** (e.g., T modems), shown as modems **232a** through **232t**. For example, each output symbol stream may be provided to a modulator component (shown as MOD) of a modem **232**. Each modem **232** may use a respective modulator component to process a respective output symbol stream (e.g., for OFDM) to obtain an output sample stream. Each modem **232** may further use a respective modulator component to process (e.g., convert to analog, amplify, filter, and/or upconvert) the output sample

stream to obtain a downlink signal. The modems **232***a* through **232***t* may transmit a set of downlink signals (e.g., T downlink signals) via a corresponding set of antennas **234** (e.g., T antennas), shown as antennas **234***a* through **234***t.*

(38) At the UE **120**, a set of antennas **252** (shown as antennas **252***a* through **252***r*) may receive the downlink signals from the network node **110** and/or other network nodes **110** and may provide a set of received signals (e.g., R received signals) to a set of modems **254** (e.g., R modems), shown as modems **254***a* through **254***r*. For example, each received signal may be provided to a demodulator component (shown as DEMOD) of a modem **254**. Each modem **254** may use a respective demodulator component to condition (e.g., filter, amplify, downconvert, and/or digitize) a received signal to obtain input samples. Each modem **254** may use a demodulator component to further process the input samples (e.g., for OFDM) to obtain received symbols. A MIMO detector **256** may obtain received symbols from the modems **254**, may perform MIMO detection on the received symbols if applicable, and may provide detected symbols. A receive processor **258** may process (e.g., demodulate and decode) the detected symbols, may provide decoded data for the UE **120** to a data sink **260**, and may provide decoded control information and system information to a controller/processor **280**. The term "controller/processor" may refer to one or more controllers, one or more processors, or a combination thereof. A channel processor may determine a reference signal received power (RSRP) parameter, a received signal strength indicator (RSSI) parameter, a reference signal received quality (RSRQ) parameter, and/or a CQI parameter, among other examples. In some examples, one or more components of the UE **120** may be included in a housing **284**.

(39) The network controller **130** may include a communication unit **294**, a controller/processor **290**, and a memory **292**. The network controller **130** may include, for example, one or more devices in a core network. The network controller **130** may communicate with the network node **110** via the communication unit **294**.

(40) One or more antennas (e.g., antennas **234***a* through **234***t* and/or antennas **252***a* through **252***r*) may include, or may be included within, one or more antenna panels, one or more antenna groups, one or more sets of antenna elements, and/or one or more antenna arrays, among other examples. An antenna panel, an antenna group, a set of antenna elements, and/or an antenna array may include one or more antenna elements (within a single housing or multiple housings), a set of coplanar antenna elements, a set of non-coplanar antenna elements, and/or one or more antenna elements coupled to one or more transmission and/or reception components, such as one or more components of FIG. **2**.

(41) On the uplink, at the UE **120**, a transmit processor **264** may receive and process data from a data source **262** and control information (e.g., for reports that include RSRP, RSSI, RSRQ, and/or CQI) from the controller/processor **280**. The transmit processor **264** may generate reference symbols for one or more reference signals. The symbols from the transmit processor **264** may be precoded by a TX MIMO processor **266** if applicable, further processed by the modems **254** (e.g., for DFT-s-OFDM or CP-OFDM), and transmitted to the network node **110**. In some examples, the modem **254** of the UE **120** may include a modulator and a demodulator. In some examples, the UE **120** includes a transceiver. The transceiver may include any combination of the antenna(s) **252**, the modem(s) **254**, the MIMO detector **256**, the receive processor **258**, the transmit processor **264**, and/or the TX MIMO processor **266**. The transceiver may be used by a processor (e.g., the controller/processor **280**) and the memory **282** to perform aspects of any of the methods described herein (e.g., with reference to FIGS. **3-14**).

(42) At the network node **110**, the uplink signals from UE **120** and/or other UEs may be received by the antennas **234**, processed by the modem **232** (e.g., a demodulator component, shown as DEMOD, of the modem **232**), detected by a MIMO detector **236** if applicable, and further processed by a receive processor **238** to obtain decoded data and control information sent by the UE **120**. The receive processor **238** may provide the decoded data to a data sink **239** and provide

the decoded control information to the controller/processor **240**. The network node **110** may include a communication unit **244** and may communicate with the network controller **130** via the communication unit **244**. The network node **110** may include a scheduler **246** to schedule one or more UEs **120** for downlink and/or uplink communications. In some examples, the modem **232** of the network node **110** may include a modulator and a demodulator. In some examples, the network node **110** includes a transceiver. The transceiver may include any combination of the antenna(s) **234**, the modem(s) **232**, the MIMO detector **236**, the receive processor **238**, the transmit processor **220**, and/or the TX MIMO processor **230**. The transceiver may be used by a processor (e.g., the controller/processor **240**) and the memory **242** to perform aspects of any of the methods described herein (e.g., with reference to FIGS. **3-14**).

(43) The controller/processor **240** of the network node **110**, the controller/processor **280** of the UE **120**, and/or any other component(s) of FIG. **2** may perform one or more techniques associated with MIMO communication, as described in more detail elsewhere herein. For example, the controller/processor **240** of the network node **110**, the controller/processor **280** of the UE **120**, and/or any other component(s) of FIG. **2** may perform or direct operations of, for example, process **1100** of FIG. **11**, process **1200** of FIG. **12**, and/or other processes as described herein. The memory **242** and the memory **282** may store data and program codes for the network node **110** and the UE **120**, respectively. In some examples, the memory **242** and/or the memory **282** may include a non-transitory computer-readable medium storing one or more instructions (e.g., code and/or program code) for wireless communication. For example, the one or more instructions, when executed (e.g., directly, or after compiling, converting, and/or interpreting) by one or more processors of the network node **110** and/or the UE **120**, may cause the one or more processors, the UE **120**, and/or the network node **110** to perform or direct operations of, for example, process **1100** of FIG. **11**, process **1200** of FIG. **12**, and/or other processes as described herein. In some examples, executing instructions may include running the instructions, converting the instructions, compiling the instructions, and/or interpreting the instructions, among other examples.

(44) In some aspects, a UE (e.g., UE **120**) includes means for identifying a maximum number of multiple-input multiple-output (MIMO) layers for a communication based at least in part on at least one of a number of channel state information reference signal (CSI-RS) ports associated with a network node, or a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state; and/or means for performing the communication in accordance with the maximum number of MIMO layers. In some aspects, the means for the UE to perform operations described herein may include, for example, one or more of communication manager **140**, antenna **252**, modem **254**, MIMO detector **256**, receive processor **258**, transmit processor **264**, TX MIMO processor **266**, controller/processor **280**, or memory **282**.

(45) In some aspects, a network node (e.g., network node **110**) includes means for transmitting at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state; and/or means for performing a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state. In some aspects, the means for the network node to perform operations described herein may include, for example, one or more of communication manager **150**, transmit processor **220**, TX MIMO processor **230**, modem **232**, antenna **234**, MIMO detector **236**, receive processor **238**, controller/processor **240**, memory **242**, or scheduler **246**.

(46) While blocks in FIG. **2** are illustrated as distinct components, the functions described above with respect to the blocks may be implemented in a single hardware, software, or combination component or in various combinations of components. For example, the functions described with respect to the transmit processor **264**, the receive processor **258**, and/or the TX MIMO processor **266** may be performed by or under the control of the controller/processor **280**.

(47) As indicated above, FIG. **2** is provided as an example. Other examples may differ from what is described with regard to FIG. **2**.

(48) Deployment of communication systems, such as 5G NR systems, may be arranged in multiple manners with various components or constituent parts. In a 5G NR system, or network, a network node, a network entity, a mobility element of a network, a RAN node, a core network node, a network element, a base station, or a network equipment may be implemented in an aggregated or disaggregated architecture. For example, a base station (such as a Node B (NB), an evolved NB (eNB), an NR BS, a 5G NB, an access point (AP), a TRP, or a cell, among other examples), or one or more units (or one or more components) performing base station functionality, may be implemented as an aggregated base station (also known as a standalone base station or a monolithic base station) or a disaggregated base station. "Network entity" or "network node" may refer to a disaggregated base station, or to one or more units of a disaggregated base station (such as one or more CUs, one or more DUs, one or more RUs, or a combination thereof).

(49) An aggregated base station (e.g., an aggregated network node) may be configured to utilize a radio protocol stack that is physically or logically integrated within a single RAN node (e.g., within a single device or unit). A disaggregated base station (e.g., a disaggregated network node) may be configured to utilize a protocol stack that is physically or logically distributed among two or more units (such as one or more CUs, one or more DUs, or one or more RUs). In some examples, a CU may be implemented within a network node, and one or more DUs may be co-located with the CU, or alternatively, may be geographically or virtually distributed throughout one or multiple other network nodes. The DUs may be implemented to communicate with one or more RUs. Each of the CU, DU, and RU also can be implemented as virtual units, such as a virtual central unit (VCU), a virtual distributed unit (VDU), or a virtual radio unit (VRU), among other examples.

(50) Base station-type operation or network design may consider aggregation characteristics of base station functionality. For example, disaggregated base stations may be utilized in an IAB network, an open radio access network (O-RAN (such as the network configuration sponsored by the O-RAN Alliance)), or a virtualized radio access network (vRAN, also known as a cloud radio access network (C-RAN)) to facilitate scaling of communication systems by separating base station functionality into one or more units that can be individually deployed. A disaggregated base station may include functionality implemented across two or more units at various physical locations, as well as functionality implemented for at least one unit virtually, which can enable flexibility in network design. The various units of the disaggregated base station can be configured for wired or wireless communication with at least one other unit of the disaggregated base station.

(51) FIG. **3** is a diagram illustrating an example disaggregated base station architecture **300**, in accordance with the present disclosure. The disaggregated base station architecture **300** may include a CU **310** that can communicate directly with a core network **320** via a backhaul link, or indirectly with the core network **320** through one or more disaggregated control units (such as a Near-RT RIC **325** via an E2 link, or a Non-RT RIC **315** associated with a Service Management and Orchestration (SMO) Framework **305**, or both). A CU **310** may communicate with one or more DUs **330** via respective midhaul links, such as through F1 interfaces. Each of the DUs **330** may communicate with one or more RUs **340** via respective fronthaul links. Each of the RUs **340** may communicate with one or more UEs **120** via respective radio frequency (RF) access links. In some implementations, a UE **120** may be simultaneously served by multiple RUs **340**.

(52) Each of the units, including the CUs **310**, the DUs **330**, the RUs **340**, as well as the Near-RT RICs **325**, the Non-RT RICs **315**, and the SMO Framework **305**, may include one or more interfaces or be coupled with one or more interfaces configured to receive or transmit signals, data, or information (collectively, signals) via a wired or wireless transmission medium. Each of the units, or an associated processor or controller providing instructions to one or multiple communication interfaces of the respective unit, can be configured to communicate with one or more of the other units via the transmission medium. In some examples, each of the units can

include a wired interface, configured to receive or transmit signals over a wired transmission medium to one or more of the other units, and a wireless interface, which may include a receiver, a transmitter or transceiver (such as an RF transceiver), configured to receive or transmit signals, or both, over a wireless transmission medium to one or more of the other units.

(53) In some aspects, the CU **310** may host one or more higher layer control functions. Such control functions can include radio resource control (RRC) functions, packet data convergence protocol (PDCP) functions, or service data adaptation protocol (SDAP) functions, among other examples. Each control function can be implemented with an interface configured to communicate signals with other control functions hosted by the CU **310**. The CU **310** may be configured to handle user plane functionality (for example, Central Unit-User Plane (CU-UP) functionality), control plane functionality (for example, Central Unit-Control Plane (CU-CP) functionality), or a combination thereof. In some implementations, the CU **310** can be logically split into one or more CU-UP units and one or more CU-CP units. A CU-UP unit can communicate bidirectionally with a CU-CP unit via an interface, such as the E1 interface when implemented in an O-RAN configuration. The CU **310** can be implemented to communicate with a DU **330**, as necessary, for network control and signaling.

(54) Each DU **330** may correspond to a logical unit that includes one or more base station functions to control the operation of one or more RUs **340**. In some aspects, the DU **330** may host one or more of a radio link control (RLC) layer, a MAC layer, and one or more high physical (PHY) layers depending, at least in part, on a functional split, such as a functional split defined by the 3GPP. In some aspects, the one or more high PHY layers may be implemented by one or more modules for forward error correction (FEC) encoding and decoding, scrambling, and modulation and demodulation, among other examples. In some aspects, the DU **330** may further host one or more low PHY layers, such as implemented by one or more modules for a fast Fourier transform (FFT), an inverse FFT (iFFT), digital beamforming, or physical random access channel (PRACH) extraction and filtering, among other examples. Each layer (which also may be referred to as a module) can be implemented with an interface configured to communicate signals with other layers (and modules) hosted by the DU **330**, or with the control functions hosted by the CU **310**.

(55) Each RU **340** may implement lower-layer functionality. In some deployments, an RU **340**, controlled by a DU **330**, may correspond to a logical node that hosts RF processing functions or low-PHY layer functions, such as performing an FFT, performing an iFFT, digital beamforming, or PRACH extraction and filtering, among other examples, based on a functional split (for example, a functional split defined by the 3GPP), such as a lower layer functional split. In such an architecture, each RU **340** can be operated to handle over the air (OTA) communication with one or more UEs **120**. In some implementations, real-time and non-real-time aspects of control and user plane communication with the RU(s) **340** can be controlled by the corresponding DU **330**. In some scenarios, this configuration can enable each DU **330** and the CU **310** to be implemented in a cloud-based RAN architecture, such as a vRAN architecture.

(56) The SMO Framework **305** may be configured to support RAN deployment and provisioning of non-virtualized and virtualized network elements. For non-virtualized network elements, the SMO Framework **305** may be configured to support the deployment of dedicated physical resources for RAN coverage requirements, which may be managed via an operations and maintenance interface (such as an O1 interface). For virtualized network elements, the SMO Framework **305** may be configured to interact with a cloud computing platform (such as an open cloud (O-Cloud) platform **390**) to perform network element life cycle management (such as to instantiate virtualized network elements) via a cloud computing platform interface (such as an O2 interface). Such virtualized network elements can include, but are not limited to, CUs **310**, DUs **330**, RUs **340**, non-RT RICs **315**, and Near-RT RICs **325**. In some implementations, the SMO Framework **305** can communicate with a hardware aspect of a 4G RAN, such as an open eNB (O-eNB) **311**, via an O1 interface. Additionally, in some implementations, the SMO Framework **305** can communicate directly with

each of one or more RUs **340** via a respective O1 interface. The SMO Framework **305** also may include a Non-RT RIC **315** configured to support functionality of the SMO Framework **305**.

(57) The Non-RT RIC **315** may be configured to include a logical function that enables non-real-time control and optimization of RAN elements and resources, Artificial Intelligence/Machine Learning (AI/ML) workflows including model training and updates, or policy-based guidance of applications/features in the Near-RT RIC **325**. The Non-RT RIC **315** may be coupled to or communicate with (such as via an A1 interface) the Near-RT RIC **325**. The Near-RT RIC **325** may be configured to include a logical function that enables near-real-time control and optimization of RAN elements and resources via data collection and actions over an interface (such as via an E2 interface) connecting one or more CUs **310**, one or more DUs **330**, or both, as well as an O-eNB, with the Near-RT RIC **325**.

(58) In some implementations, to generate AI/ML models to be deployed in the Near-RT RIC **325**, the Non-RT RIC **315** may receive parameters or external enrichment information from external servers. Such information may be utilized by the Near-RT RIC **325** and may be received at the SMO Framework **305** or the Non-RT RIC **315** from non-network data sources or from network functions. In some examples, the Non-RT MC **315** or the Near-RT RIC **325** may be configured to tune RAN behavior or performance. For example, the Non-RT MC **315** may monitor long-term trends and patterns for performance and employ AI/ML models to perform corrective actions through the SMO Framework **305** (such as reconfiguration via an O1 interface) or via creation of RAN management policies (such as A1 interface policies).

(59) As indicated above, FIG. **3** is provided as an example. Other examples may differ from what is described with regard to FIG. **3**.

(60) FIG. **4** is a diagram illustrating examples **400**, **410**, and **420** of CSI-RS beam management procedures, in accordance with the present disclosure. As shown in FIG. **4**, examples **400**, **410**, and **420** include a UE **120** in communication with a network node **110** in a wireless network (e.g., wireless network **100**). However, the devices shown in FIG. **4** are provided as examples, and the wireless network may support communication and beam management between other devices (e.g., between a UE **120** and a network node **110** or transmission reception point (TRP), between a mobile termination node and a control node, between an integrated access and backhaul (IAB) child node and an IAB parent node, and/or between a scheduled node and a scheduling node). In some aspects, the UE **120** and the network node **110** may be in a connected state (e.g., an RRC connected state).

(61) As shown in FIG. **4**, example **400** may include a network node **110** (e.g., one or more network node devices such as an RU, a DU, and/or a CU, among other examples) and a UE **120** communicating to perform beam management using CSI-RSs. Example **400** depicts a first beam management procedure (e.g., P1 CSI-RS beam management). The first beam management procedure may be referred to as a beam selection procedure, an initial beam acquisition procedure, a beam sweeping procedure, a cell search procedure, and/or a beam search procedure. As shown in FIG. **4** and example **400**, CSI-RSs may be configured to be transmitted from the network node **110** to the UE **120**. The CSI-RSs may be configured to be periodic (e.g., using RRC signaling), semi-persistent (e.g., using media access control (MAC) control element (MAC-CE) signaling), and/or aperiodic (e.g., using downlink control information (DCI)).

(62) The first beam management procedure may include the network node **110** performing beam sweeping over multiple transmit (Tx) beams. The network node **110** may transmit a CSI-RS using each transmit beam for beam management. To enable the UE **120** to perform receive (Rx) beam sweeping, the network node may use a transmit beam to transmit (e.g., with repetitions) each CSI-RS at multiple times within the same RS resource set so that the UE **120** can sweep through receive beams in multiple transmission instances. For example, if the network node **110** has a set of N transmit beams and the UE **120** has a set of M receive beams, the CSI-RS may be transmitted on each of the N transmit beams M times so that the UE **120** may receive M instances of the CSI-RS

per transmit beam. In other words, for each transmit beam of the network node **110**, the UE **120** may perform beam sweeping through the receive beams of the UE **120**. As a result, the first beam management procedure may enable the UE **120** to measure a CSI-RS on different transmit beams using different receive beams to support selection of network node **110** transmit beams/UE **120** receive beam(s) beam pair(s). The UE **120** may report the measurements to the network node **110** to enable the network node **110** to select one or more beam pair(s) for communication between the network node **110** and the UE **120**. While example **400** has been described in connection with CSI-RSs, the first beam management process may also use synchronization signal blocks (SSBs) for beam management in a similar manner as described above.

(63) As shown in FIG. **4**, example **410** may include a network node **110** and a UE **120** communicating to perform beam management using CSI-RSs. Example **410** depicts a second beam management procedure (e.g., P2 CSI-RS beam management). The second beam management procedure may be referred to as a beam refinement procedure, a network node beam refinement procedure, a TRP beam refinement procedure, and/or a transmit beam refinement procedure. As shown in FIG. **4** and example **410**, CSI-RSs may be configured to be transmitted from the network node **110** to the UE **120**. The CSI-RSs may be configured to be aperiodic (e.g., using DCI). The second beam management procedure may include the network node **110** performing beam sweeping over one or more transmit beams. The one or more transmit beams may be a subset of all transmit beams associated with the network node **110** (e.g., determined based at least in part on measurements reported by the UE **120** in connection with the first beam management procedure). The network node **110** may transmit a CSI-RS using each transmit beam of the one or more transmit beams for beam management. The UE **120** may measure each CSI-RS using a single (e.g., a same) receive beam (e.g., determined based at least in part on measurements performed in connection with the first beam management procedure). The second beam management procedure may enable the network node **110** to select a best transmit beam based at least in part on measurements of the CSI-RSs (e.g., measured by the UE **120** using the single receive beam) reported by the UE **120**.

(64) As shown in FIG. **4**, example **420** depicts a third beam management procedure (e.g., P3 CSI-RS beam management). The third beam management procedure may be referred to as a beam refinement procedure, a UE beam refinement procedure, and/or a receive beam refinement procedure. As shown in FIG. **4** and example **420**, one or more CSI-RSs may be configured to be transmitted from the network node **110** to the UE **120**. The CSI-RSs may be configured to be aperiodic (e.g., using DCI). The third beam management process may include the network node **110** transmitting the one or more CSI-RSs using a single transmit beam (e.g., determined based at least in part on measurements reported by the UE **120** in connection with the first beam management procedure and/or the second beam management procedure). To enable the UE **120** to perform receive beam sweeping, the network node may use a transmit beam to transmit (e.g., with repetitions) CSI-RS at multiple times within the same RS resource set so that UE **120** can sweep through one or more receive beams in multiple transmission instances. The one or more receive beams may be a subset of all receive beams associated with the UE **120** (e.g., determined based at least in part on measurements performed in connection with the first beam management procedure and/or the second beam management procedure). The third beam management procedure may enable the network node **110** and/or the UE **120** to select a best receive beam based at least in part on reported measurements received from the UE **120** (e.g., of the CSI-RS of the transmit beam using the one or more receive beams).

(65) The above description of CSI-RS measurement relates to beam management procedures using CSI-RSs. CSI-RSs can also be used for other purposes, such as CSI reporting (in which the UE provides CSI reports to the network based at least in part on measurements of the CSI-RS), mobility (in which the UE is triggered to report a measurement that triggers handover of the UE), radio link failure detection, interference measurement, and synchronization.

(66) A CSI-RS can be transmitted using a number of antenna ports. For example, different physical antennas of a transmitter may transmit information via different channels (where, in this context, a channel represents the signal path and propagation characteristics encountered by a signal transmitted or received by a physical antenna). Such information may be conveyed via a logical antenna port, which may represent some combination of the physical antennas and/or channels. In some cases, a transmitter or a receiver may not have knowledge of the channels associated with the physical antennas, and may only operate based on knowledge of the channels associated with antenna ports, as defined below. An antenna port may be defined such that a channel, over which a symbol on the antenna port is conveyed, can be inferred from a channel over which another symbol on the same antenna port is conveyed. Weighting factors may be applied to the channels associated with a set of antennas to improve signal power and/or signal quality at one or more receivers. Applying such weighting factors to channel transmissions may be referred to as precoding, and "precoder" may refer to a specific set of weighting factors applied to a set of channels. A CSI-RS is configured with a number of CSI-RS ports. As used herein, "CSI-RS port" refers to an antenna port used for CSI-RS transmission or reception. For example, a higher layer (e.g., RRC) parameter may indicate a number of CSI-RS ports configured for a CSI-RS such as an nrofPorts parameter in a CSI-RS-ResourceMapping information element (IE). In some aspects described herein, a network node may increase or decrease the number of CSI-RS ports used for CSI-RS transmission, such as for the purpose of power saving. Techniques described herein provide adaptation of a maximum number of MIMO layers based at least in part on a change in the number of CSI-RS ports used for CSI-RS transmission (among other examples).

(67) As indicated above, FIG. **4** is provided as an example of beam management procedures. Other examples of beam management procedures may differ from what is described with respect to FIG. **4**. For example, the UE **120** and the network node **110** may perform the third beam management procedure before performing the second beam management procedure, and/or the UE **120** and the network node **110** may perform a similar beam management procedure to select a UE transmit beam.

(68) FIG. **5** is a diagram illustrating an example **500** of dynamic network-side antenna adaptation, in accordance with the present disclosure.

(69) For various reasons, including climate change mitigation and network cost reduction, energy-saving and/or energy efficiency measures are expected to have increasing importance in wireless network operations. For example, although NR generally offers a significant energy-efficiency improvement per gigabyte over previous generations (e.g., LTE), new NR use cases and/or the adoption of millimeter wave frequencies require more network sites and more network antennas, which could potentially lead to a more efficient cellular network that nonetheless has higher energy requirements and/or causes more emissions than previous generations owing to increased traffic. Furthermore, energy accounts for a significant proportion of the cost to operate a cellular network. For example, according to some estimates, energy costs are nearly 23% of the total cost to operate a cellular network, with selling, general, and administrative (SG&A) expenses and other costs accounting for about 75%, and over 90% of network operating costs are spent on energy (e.g., fuel and electricity consumption). Most energy consumption and/or energy costs are associated with powering a radio access network (RAN), which accounts for about 50% of the energy consumed by a wireless network, with data centers and fiber transport accounting for smaller shares. Accordingly, measures to increase energy savings and/or energy efficiency in a wireless network are important factors that may drive adoption and/or expansion of cellular networks.

(70) One way to increase energy efficiency in a RAN may be to use dynamic antenna adaptation in a base station that communicates using massive MIMO technology, which tends to consume significant power. For example, in an LTE network, a base station that supports massive MIMO technology may communicate using a baseband unit (BBU) that processes baseband signals and communicates with a core network through a physical interface and a remote radio unit (RRU) that

performs transmit and receive radio frequency (RF) functions. In an LTE network, the per-cell power consumption (e.g., in watts) is slightly larger for the RRU compared to the BBU, and the per-cell power consumption does not vary significantly with cell load. In an NR network, however, a base station that supports massive MIMO technology may communicate using a BBU and an active antenna unit (AAU) that consumes significantly more power than the BBU and the RRU in an LTE base station (e.g., because NR operates at a higher data rate and/or a higher bandwidth than LTE). For example, the BBU and the AAU in an NR base station may consume 2.4 times the power of the BBU and RRU in an LTE base station when the cell load is low (e.g., 0%), 2.6 times the power of the BBU and RRU in an LTE base station when the cell load is moderate (e.g., 50%), or 3 times the power of the BBU and RRU in an LTE base station when the cell load is high (e.g., 100%), where "cell load" generally refers to the proportion of frequency resources within a carrier that are being utilized at a given time. Furthermore, in an NR base station, the AAU generally consumes more power than the BBU, and the proportion of power consumption attributable to the AAU increases as the cell loading increases (e.g., because the BBU has a relatively static power consumption regardless of cell loading). Accordingly, in an NR base station that supports massive MIMO technology, the AAU represents the most power-hungry component.

(71) Accordingly, as shown in FIG. **5**, and by reference number **510**, a base station that supports massive MIMO communication may enable dynamic antenna adaptation based on a current and/or predicted cell load in order to improve energy efficiency. For example, to enable massive MIMO communication, a base station may generally need to have multiple co-located antenna panels that each include multiple antenna ports. For example, in FIG. **5**, reference number **520** depicts an example antenna panel that includes four (4) sub-panels, each of which includes several antenna ports (shown as gray and black intersecting lines) that each map to one or more physical antennas, where each diagonal line in FIG. **5** corresponds to one (1) antenna port. In general, each antenna panel is equipped with various power amplifiers and an antenna subsystem, which consume significant power. Accordingly, in order to save power or otherwise utilize energy more efficiently, the base station may dynamically adapt an antenna configuration based on a current and/or predicted cell load. For example, when the cell load is high, the base station may turn all (or most) antenna panels, sub-panels, and/or ports on to increase capacity, and the base station may turn off some antenna panels, sub-panels, and/or ports to reduce energy consumption when the cell load is low. Dynamically adapting the base station's antenna configuration may impact MIMO communication performance of the network node, since the number of MIMO layers supportable by a communication link is generally related to the number of antenna ports used to communicate on the communication link (e.g., a larger number of antenna ports may support a larger number of MIMO layers). Techniques described herein provide adaptation of a maximum number of MIMO layers based at least in part on dynamic antenna adaptation, such as based at least in part on a number of CSI-RS ports active at the network node (among other examples).

(72) As indicated above, FIG. **5** is provided as an example. Other examples may differ from what is described with regard to FIG. **5**.

(73) FIG. **6** illustrates an example logical architecture of a distributed RAN **600**, in accordance with the present disclosure.

(74) A 5G access node **605** may include an access node controller **610**. The access node controller **610** may be a central unit (CU) of the distributed RAN **600**. In some aspects, a backhaul interface to a 5G core network **615** may terminate at the access node controller **610**. The 5G core network **615** may include a 5G control plane component **620** and a 5G user plane component **625** (e.g., a 5G gateway), and the backhaul interface for one or both of the 5G control plane and the 5G user plane may terminate at the access node controller **610**. Additionally, or alternatively, a backhaul interface to one or more neighbor access nodes **630** (e.g., another 5G access node **605** and/or an LTE access node) may terminate at the access node controller **610**.

(75) The access node controller **610** may include and/or may communicate with one or more TRPs

635 (e.g., via an F1 Control (F1-C) interface and/or an F1 User (F1-U) interface). A TRP **635** may be a distributed unit (DU) of the distributed RAN **600**. In some aspects, a TRP **635** may correspond to a network node **110** described above in connection with FIG. **1**. For example, different TRPs **635** may be included in different network nodes **110**. Additionally, or alternatively, multiple TRPs **635** may be included in a single network node **110**. In some aspects, a network node **110** may include a CU (e.g., access node controller **610**) and/or one or more DUs (e.g., one or more TRPs **635**). In some cases, a TRP **635** may be referred to as a cell, a panel, an antenna array, or an array.

(76) A TRP **635** may be connected to a single access node controller **610** or to multiple access node controllers **610**. In some aspects, a dynamic configuration of split logical functions may be present within the architecture of distributed RAN **600**. For example, a packet data convergence protocol (PDCP) layer, a radio link control (RLC) layer, and/or a medium access control (MAC) layer may be configured to terminate at the access node controller **610** or at a TRP **635**.

(77) In some aspects, multiple TRPs **635** may transmit communications (e.g., the same communication or different communications) in the same transmission time interval (TTI) (e.g., a slot, a mini-slot, a subframe, or a symbol) or different TTIs using different quasi co-location (QCL) relationships (e.g., different spatial parameters, different transmission configuration indicator (TCI) states, different precoding parameters, and/or different beamforming parameters). In some aspects, a TCI state may be used to indicate one or more QCL relationships. A TRP **635** may be configured to individually (e.g., using dynamic selection) or jointly (e.g., using joint transmission with one or more other TRPs **635**) serve traffic to a UE **120**.

(78) As indicated above, FIG. **6** is provided as an example. Other examples may differ from what was described with regard to FIG. **6**.

(79) FIG. **7** is a diagram illustrating an example **700** of multiple TRP (multi-TRP) communication (sometimes referred to as multi-panel communication), in accordance with the present disclosure. As shown in FIG. **7**, multiple TRPs **705** may communicate with the same UE **120**. A TRP **705** may correspond to a TRP **635** described above in connection with FIG. **6**.

(80) The multiple TRPs **705** (shown as TRP A and TRP B) may communicate with the same UE **120** in a coordinated manner (e.g., using coordinated multipoint transmissions) to improve reliability and/or increase throughput. The TRPs **705** may coordinate such communications via an interface between the TRPs **705** (e.g., a backhaul interface and/or an access node controller **610**). The interface may have a smaller delay and/or higher capacity when the TRPs **705** are co-located at the same network node **110** (e.g., when the TRPs **705** are different antenna arrays or panels of the same network node **110**), and may have a larger delay and/or lower capacity (as compared to co-location) when the TRPs **705** are located at different network nodes **110**. The different TRPs **705** may communicate with the UE **120** using different QCL relationships (e.g., different TCI states), different demodulation reference signal (DMRS) ports, and/or different layers (e.g., of a multi-layer communication).

(81) In a first multi-TRP transmission mode (e.g., Mode 1), a single physical downlink control channel (PDCCH) may be used to schedule downlink data communications for a single physical downlink shared channel (PDSCH). In this case, multiple TRPs **705** (e.g., TRP A and TRP B) may transmit communications to the UE **120** on the same PDSCH. For example, a communication may be transmitted using a single codeword with different spatial layers for different TRPs **705** (e.g., where one codeword maps to a first set of layers transmitted by a first TRP **705** and maps to a second set of layers transmitted by a second TRP **705**). As another example, a communication may be transmitted using multiple codewords, where different codewords are transmitted by different TRPs **705** (e.g., using different sets of layers). In either case, different TRPs **705** may use different QCL relationships (e.g., different TCI states) for different DMRS ports corresponding to different layers. For example, a first TRP **705** may use a first QCL relationship or a first TCI state for a first set of DMRS ports corresponding to a first set of layers, and a second TRP **705** may use a second (different) QCL relationship or a second (different) TCI state for a second (different) set of DMRS

ports corresponding to a second (different) set of layers. In some aspects, a TCI state in downlink control information (DCI) (e.g., transmitted on the PDCCH, such as DCI format 1_0 or DCI format 1_1) may indicate the first QCL relationship (e.g., by indicating a first TCI state) and the second QCL relationship (e.g., by indicating a second TCI state). The first and the second TCI states may be indicated using a TCI field in the DCI. In general, the TCI field can indicate a single TCI state (for single-TRP transmission) or multiple TCI states (for multi-TRP transmission as discussed here) in this multi-TRP transmission mode (e.g., Mode 1).

(82) In a second multi-TRP transmission mode (e.g., Mode 2), multiple PDCCHs may be used to schedule downlink data communications for multiple corresponding PDSCHs (e.g., one PDCCH for each PDSCH). In this case, a first PDCCH may schedule a first codeword to be transmitted by a first TRP **705**, and a second PDCCH may schedule a second codeword to be transmitted by a second TRP **705**. Furthermore, first DCI (e.g., transmitted by the first TRP **705**) may schedule a first PDSCH communication associated with a first set of DMRS ports with a first QCL relationship (e.g., indicated by a first TCI state) for the first TRP **705**, and second DCI (e.g., transmitted by the second TRP **705**) may schedule a second PDSCH communication associated with a second set of DMRS ports with a second QCL relationship (e.g., indicated by a second TCI state) for the second TRP **705**. In this case, DCI (e.g., having DCI format 1_0 or DCI format 1_1) may indicate a corresponding TCI state for a TRP **705** corresponding to the DCI. The TCI field of a DCI indicates the corresponding TCI state (e.g., the TCI field of the first DCI indicates the first TCI state and the TCI field of the second DCI indicates the second TCI state).

(83) A network node may dynamically transition one or more TRPs into a dormant state, such as to achieve network energy savings. For example, a network node may dynamically switch between a multi-TRP communication mode and a single-TRP communication mode, such as using a multi-TRP dormancy configuration or a secondary cell (SCell) dormancy configuration. In some examples, TRP dormancy can be indicated explicitly. In some examples, TRP dormancy can be indicated jointly with an SCell dormancy indication. In some examples, SCell dormancy may extend to one or more TRPs in a primary cell. For example, TRP dormancy may be indicated by an SCell dormancy indication applying to a TRP of a primary cell. TRP dormancy may provide network power savings with small signaling overhead and potential UE power usage reduction. The switching of a TRP to a dormant state may impact MIMO communication, since each TRP of a multi-TRP communication mode may support one or more MIMO layers of a multi-layer communication. Thus, when a TRP is transitioned to a dormant state, the number of MIMO layers supportable in the multi-TRP communication mode may decrease. Some techniques described herein enable adaptation of a maximum number of MIMO layers based at least in part on a transition of a TRP to a dormant state.

(84) As indicated above, FIG. **7** is provided as an example. Other examples may differ from what is described with respect to FIG. **7**.

(85) FIG. **8** is a diagram illustrating an example **800** of MIMO communication, in accordance with the present disclosure. As shown, example **800** includes a transmitter **810** (e.g., network node **110**, UE **120**, a TRP, or the like) and a receiver **820** (e.g., network node **110**, UE **120**, a TRP, or the like). A channel between the transmitter **810** and the receiver **820** is shown by reference number **830**. In this context, the channel is the propagation channel between the transmitter **810** and the receiver **820**.

(86) MIMO configurations benefit from multiple antenna elements at the transmitter **810** and multiple antenna elements at the receiver **820**. The transmitter may transmit simultaneously into the channel from multiple antenna elements, and the receiver may receive simultaneously on multiple antenna elements. The number of antenna elements at the transmitter **810** and the number of antenna elements at the receiver **820** can be the same number, or can be different numbers. MIMO provides diversity gain, array gain, and spatial multiplexing gain.

(87) A MIMO communication can carry multiple parallel streams of data. A stream of data of a

MIMO communication is referred to as a MIMO layer (or just a "layer"). A MIMO communication carrying **2** parallel streams of data has 2 MIMO layers. Using information regarding the state of the channel (which may be derived from a CSI-RS, a demodulation reference signal, or the like), the receiver **820** can reconstruct the MIMO layers of the MIMO communication. The receiver **820** may be configured with a maximum number, of MIMO layers, that indicates a largest number of MIMO layers usable by the transmitter **810**.

(88) In some deployments, a maximum number of MIMO layers is RRC configured per cell for downlink transmissions (such as using a maxMIMO-Layers parameter in a PDSCH-ServingCellConfig IE). In some deployments, a maximum number of MIMO layers is RRC configured per downlink bandwidth part (BWP) (such as using a maxMIMO-Layers parameter in a PDSCH-Config IE, where a BWP is a configured set of frequency resources that can be activated or deactivated via dynamic or semi-static signaling). Per-BWP configuration of the maximum number of MIMO layers can allow the possibility for the receiver **820** to operate with a reduced number of antennas and/or receive chains, which can save power in certain scenarios such as low traffic. For example, the network can configure the receiver **820** with two BWPs for different scenarios. A first BWP (e.g., a wideband BWP) may have a larger maximum number of MIMO layers (e.g., **4**) suitable for a high data rate, and a second BWP (e.g., a narrowband BWP) may have a smaller maximum number of MIMO layers (e.g., **2**) suitable for low traffic and power savings. The receiver **820** may perform BWP switching between these BWPs in different scenarios.

(89) A maximum number of MIMO layers can also be configured for uplink communications. In this example, the transmitter **810** may be a UE and the receiver **820** may be a network node. An uplink communication can include (for example) a codebook-based physical uplink shared channel (PUSCH) communication or a non-codebook-based (NCB) PUSCH transmission. A codebook-based PUSCH communication may use a precoder matrix specified by a codebook. An NCB PUSCH communication may use a precoder matrix derived by the transmitter **810** based at least in part on a sounding reference signal (SRS) resource indicator. In some deployments, the configuration of the maximum number of MIMO layers may be supported per BWP for codebook-based PUSCH transmission using a maxRank field in a pusch-Configs IE. However, for NCB PUSCH transmission, the maximum number of MIMO layers may be configured on a per-cell level using the maxMIMO-Layers field of the PUSCH-ServingCellConfig IE.

(90) A per-BWP MIMO configuration can be implicitly achieved for NCB PUSCH transmission. For example, for NCB uplink transmission, the number of uplink ports from which to transmit is determined based at least in part on one or more indicated SRS resource indicators (SRIs) when multiple SRS resources are configured. The SRI indication depends on a parameter L.sub.max (which is defined by maxMIMO-Layers in PUSCH-ServingCellConfig or if not provided, by the UE capability), and the number of SRS resources (N.sub.SRS), in the associated SRS resource set. The configurations of the number of SRS resources (N.sub.SRS) with usage "nonCodeBook" may be allowed per each BWP, which implicitly limits the maximum scheduled uplink rank. A "rank" is a value indicating a number of MIMO layers. Thus, for a BWP configured with N.sub.SRS=2, the maximum uplink rank that can be scheduled is limited to 2.

(91) As noted above, some deployments support per-downlink-BWP configuration of a maximum number of downlink MIMO layers for UE power savings. The per-BWP maxMIMO-layers configuration can allow the possibility for a UE to operate with a reduced number of antennas and/or receive chains and save power in certain scenarios such as low traffic. BWP switching facilitates dynamic switching between the different configurations of the maximum number of downlink MIMO layers.

(92) As described above, a network may support dynamic antenna adaptation, such as for the purpose of achieving network energy savings. As used herein, "dynamic antenna adaptation" can refer to deactivating one or more antenna elements, ports, sub-panels, or panels (as described in connection with FIG. **5**), or to transitioning one or more TRPs to a dormant state (as described in

connection with FIG. **7**). Dynamic antenna adaptation may allow the network to turn off some antenna ports or a TRP in an efficient and dynamic manner when there is no or low user traffic (which itself is dynamic).

(93) As the number of transmit antenna ports or the number of TRPs is reduced (for example, due to dynamic antenna adaptation), the maximum number of MIMO layers supportable on a communication link between a network node and a UE may decrease. In some deployments, the network node may reduce the maximum number of MIMO layers via dynamic BWP switching (between BWPs with different configured maximum numbers of MIMO layers). However, if the network node and/or the UE supports only one BWP, then the reduction of the maximum number of MIMO layers via BWP switching may not work. Furthermore, frequent BWP switching at the UE may be undesirable at the UE, for example, due to the overhead associated with BWP switching and increased scheduling complexity.

(94) Some techniques described herein enable adaptation of a maximum number of MIMO layers, such as in association with dynamic antenna adaptation at a network node. In some examples, the adaptation of the maximum number of MIMO layers may be independent of BWP switching. For example, the adaptation of the maximum number of MIMO layers may be implemented without the UE performing BWP switching (e.g., while the UE remains on a same BWP). In some aspects, the adaptation of the maximum number of MIMO layers is based at least in part on a number of CSI-RS ports associated with the network node (as described in connection with FIG. **9**). In some aspects, the adaptation of the maximum number of MIMO layers is based at least in part on a transition of a TRP associated with the network node to or from a dormancy state (as described in connection with FIG. **10**). In this way, adaptation of a maximum number of MIMO layers is enabled, such as in connection with dynamic antenna adaptation. In some aspects, adaptation of the maximum number of MIMO layers is enabled without BWP switching, which reduces overhead associated with BWP switching and enables adaptation of the maximum number of MIMO layers for UEs and/or network nodes supporting only a single BWP. In some aspects, adaptation of the maximum number of MIMO layers is enabled without RRC reconfiguration, which reduces overhead and delay associated with adapting the maximum number of MIMO layers.

(95) As indicated above, FIG. **8** is provided as an example. Other examples may differ from what is described with regard to FIG. **8**.

(96) FIG. **9** is a diagram illustrating an example **900** of adaptation of a maximum number of MIMO layers based at least in part on a number of CSI-RS ports associated with a network node, in accordance with the present disclosure. As shown, example **900** includes a UE (e.g., UE **120**, transmitter **810**, receiver **820**) and a network node (e.g., network node **110**, CU **310**, DU **330**, RU **340**, the network node of FIG. **5**, 5G access node **605**, access node controller (ANC) **610**, one or more TRPs **635**, one or more TRPs **705**, transmitter **810**, receiver **820**, or a combination thereof).

(97) As shown by reference number **910**, in some aspects, the network node may transmit, and the UE may receive, configuration information (e.g., via RRC or medium access control (MAC) signaling). In some aspects, the configuration information may indicate a mapping between a number of CSI-RS ports and a maximum number of MIMO layers. For example, the mapping may indicate, for a given number of CSI-RS ports associated with the network node, a maximum number of MIMO layers or a rule used to determine the maximum number of MIMO layers. In some aspects, the mapping may be fixed. In some aspects, the mapping may be indicated by a table. Two examples of such a table are provided below. In the below examples, "M" indicates a UE capability for a maximum number of MIMO layers. For example, a UE may have a capability for a maximum number of MIMO layers, and may signal UE capability information indicating the maximum number of MIMO layers. The maximum number of MIMO layers supported by a UE can be related to various factors, such as a number of antennas of the UE, a number of transmit chains of the UE, a processing capability of the UE, and so on. These tables are just examples, and different mappings between a number of CSI-RS ports and a maximum number of MIMO layers

may be used without departing from the scope of this disclosure.

(98) TABLE-US-00001

Number of CSI-RS ports	Max MIMO layers
32	M (per UE capability)
16	M-1
8	M-2
4	M-3
2	1

Example 1

(99) TABLE-US-00002

Number of CSI-RS ports	Max MIMO layers
32	M (per UE capability)
16	M/2
8	M/2
4	M/4
2	1

Example 2

(100) Thus, a first number of CSI-RS ports (e.g., 32 CSI-RS ports) is mapped to a first number of MIMO layers (e.g., M layers) and a second number of CSI-RS ports (e.g., 16 CSI-RS ports) is mapped to a second number of MIMO layers (e.g., M−1 layers or M/2 layers), wherein the first number of MIMO layers is larger than the second number of MIMO layers and the first number of CSI-RS ports is larger than the second number of CSI-RS ports. The UE may receive information indicating (e.g., updating) an active number of CSI-RS ports from the first number of CSI-RS ports to the second number of CSI-RS ports (as described below), and may identify a maximum number of MIMO layers as the second number of MIMO layers based at least in part on the information. In some aspects, the mapping may be used to determine an adjustment to a maximum number of MIMO layers. For example, the UE may be configured with an initial maximum number of MIMO layers, or may determine the initial maximum number of MIMO layers according to a configuration of the UE. Upon receiving an indication updating or indicating an active number of CSI-RS ports of the network node, the UE may identify a maximum number of MIMO layers using the mapping.

(101) As shown by reference number **920**, in some aspects, the network node may transmit, and the UE may receive, information (e.g., an RRC parameter, dynamic signaling, or another form of signaling) indicating a number of CSI-RS ports associated with the network node. The number of CSI-RS ports may be associated with the network node based at least in part on the number of CSI-RS ports being active (e.g., used for CSI-RS transmission) at the network node. For example, the network node may provide information indicating a number of CSI-RS ports, such as an explicit indication of a number of CSI-RS ports, an adjustment to a number of CSI-RS ports, or the like. In some aspects, the network node may transmit the information indicating the number of CSI-RS ports based at least in part on a modification to the number of CSI-RS ports. For example, the network node may perform dynamic antenna adaptation, thereby changing the number of CSI-RS ports associated with the network node (since the number of active antenna ports changes during dynamic antenna adaptation thereby changing the number of CSI-RS ports supportable by the network node), and may transmit the information indicating the number of CSI-RS ports based at least in part on the dynamic antenna adaptation. In some aspects, the UE may identify a maximum number of MIMO layers based at least in part on the number of CSI-RS ports and the transition of a TRP to or from a dormancy state. For example, the UE may receive an indication of the transition and a number of CSI-RS ports that are active after the transition, and may identify the maximum number of MIMO layers in accordance with the number of CSI-RS ports (as described above) and the reception of indication of the transition.

(102) As shown by reference number **930**, the UE (and optionally the network node) may identify a maximum number of MIMO layers for a communication based at least in part on the number of CSI-RS ports associated with the network node. For example, the UE may use a mapping, described in connection with reference number **910**, to identify the maximum number of MIMO layers. If, for example, the indication of the number of CSI-RS ports indicates 8 CSI-RS ports, the UE may identify a maximum number of MIMO layers as M−2 or M/2.

(103) In some aspects, the UE and/or the network node may perform adaptation of a maximum number of MIMO layers (e.g., may identify a maximum number of MIMO layers) at a per-BWP granularity or a per-cell granularity, where "cell," in this context, refers to either a TRP or a component carrier. For example, the maximum number of MIMO layers may be identified per

BWP, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured. This may be referred to as per-BWP granularity adaptation of the maximum number of MIMO layers. If per-BWP configuration of maximum numbers of MIMO layers is configured, then a BWP may be configured with a maximum number of MIMO layers, and different BWPs may be configured with different maximum number of MIMO layers (e.g., using an RRC parameter indicating a maximum number of MIMO layers for a BWP). As another example, the maximum number of MIMO layers may be identified per cell, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers not being configured if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured. This may be referred to as per-cell granularity adaptation of the maximum number of MIMO layers. If per-cell configuration of maximum numbers of MIMO layers is configured, then a cell (e.g., carrier, TRP) may be configured with a maximum number of MIMO layers, and different cells may be configured with different maximum number of MIMO layers (e.g., using an RRC parameter indicating a maximum number of MIMO layers for a cell). In some aspects, if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a bandwidth part, and if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a cell. Thus, the adaptation of the maximum number of MIMO is applicable to per-BWP configuration of maxMIMO-layers or the maxRank field of pusch-Configs if configured, and otherwise is applicable to the per-cell maxMIMO-layers configuration (if per-BWP configuration is not configured).

(104) As shown by reference number **940**, the UE and the network node may perform a communication in accordance with the maximum number of MIMO layers. For example, the UE may transmit an uplink communication (e.g., a PUSCH communication) using at most the maximum number of MIMO layers, and the network node may receive the uplink communication using at most the maximum number of MIMO layers. As another example, the network node may transmit or configure a downlink communication (e.g., a PDSCH communication) using at most the maximum number of MIMO layers, and the UE may receive the downlink communication using at most the maximum number of MIMO layers. In this way, the maximum number of MIMO layers can be adapted based at least in part on the number of CSI-RS ports (e.g., the number of antenna ports) active at the network node, such as without switching BWPs or RRC reconfiguring the UE.

(105) As indicated above, FIG. **9** is provided as an example. Other examples may differ from what is described with regard to FIG. **9**.

(106) FIG. **10** is a diagram illustrating an example **1000** of adaptation of a maximum number of MIMO layers based at least in part on a transition of a TRP to or from a dormancy state, in accordance with the present disclosure. As shown, example **1000** includes a UE (e.g., UE **120**, transmitter **810**, receiver **820**) and a network node (e.g., network node **110**, CU **310**, DU **330**, RU **340**, the network node of FIG. **5**, 5G access node **605**, ANC **610**, one or more TRPs **635**, one or more TRPs **705**, transmitter **810**, receiver **820**, or a combination thereof). The network node may be associated with two or more TRPs. Dashed arrows indicate optional steps.

(107) As shown by reference number **1010**, in some aspects, the network node may transmit, and the UE may receive, configuration information (such as via RRC or MAC signaling). In some aspects, the configuration information may include an indication of a scaling factor (e.g., a scaling factor K) associated with identifying a maximum number of MIMO layers. The UE may continue to use the unscaled maximum number of MIMO layers until an indication of a transition of a TRP associated with the network node to a dormancy state is received. For example, the UE and/or the network node may identify the maximum number of MIMO layers by applying the scaling factor to

a prior maximum number of MIMO layers based at least in part on a transition of a TRP associated with the network node to or from a dormancy state. In this example, if the prior maximum number of MIMO layers is 4 and the scaling factor is 2, the UE and/or the network node may identify a maximum number of MIMO layers, based at least in part on a transition of a TRP associated with the network node to or from a dormancy state, as 4/2=2. For another example, the UE and/or the network node may identify the maximum number of MIMO layers by applying the scaling factor to a prior maximum number of MIMO layers based at least in part on a transition of a TRP associated with the network node to an active (non-dormancy) state. In this example, if the prior maximum number of MIMO layers is 2 and the scaling factor is 2, the UE and/or the network node may identify a maximum number of MIMO layers, based at least in part on a transition of a TRP associated with the network node to an active state, as 2*2=4.

(108) As shown by reference number **1020**, in some aspects, the network node may transmit, and the UE may receive, information indicating a transition of a TRP to a dormancy state or a non-dormancy state. For example, the information may include or be associated with an SCell dormancy or activation indication, or may not be associated with an SCell dormancy or activation indication. In some aspects, the information may include a TRP dormancy or activation indication, which may be UE-specific or group-specific (e.g., DCI, a wakeup signal, etc.). "Group-specific" signaling is signaling directed to a group of recipients, such as a set of UEs associated with a group identifier, a set of UEs in a particular coverage area, or the like. The UE and/or the network node may identify a maximum number of MIMO layers based at least in part on the information, as described below.

(109) As shown by reference number **1030**, the UE may identify a maximum number of MIMO layers for a communication based at least in part on the transition of the TRP associated with the network node to the dormancy state or the active state. In some aspects, the UE and/or the network node may apply the scaling factor described in connection with reference number **1010** in order to identify the maximum number of MIMO layers.

(110) In some aspects, the UE and/or the network node may identify the maximum number of MIMO layers as a maximum number of MIMO layers of a non-dormant TRP associated with the network node. For example, the network node may be associated with two TRPs: a TRP associated with a dormancy state and a non-dormant TRP. In this example, the TRP associated with the dormancy state is associated with a first maximum number of MIMO layers and the non-dormant TRP is associated with a second maximum number of MIMO layers. The UE and the network node may identify the maximum number of MIMO layers for a communication as the second maximum number of MIMO layers (e.g., based at least in part on the information indicating the transition of the TRP to the dormancy state). Thus, the UE and/or the network node may identify the maximum number of MIMO layers based at least in part on a maximum number of MIMO layers associated with an active (e.g., non-dormant) TRP. For example, for a spatial division multiplexing (SDM) mTRP scheme with rank-4 PDSCH transmission by rank-2 (TRP0)+rank-2 (TRP1) or rank-3 (TRP0)+rank-1 (TRP1), if TRP 1 is dormant, the UE may use the rank associated with TRP0 (2 for the 2+2 case or 3 for the 3+1 case) for reception of a PDSCH and/or transmission of a PUSCH. If the network node is associated with more than two TRPs, the UE may identify the maximum number of MIMO layers for a communication as a sum of maximum numbers of MIMO layers of one or more non-dormant TRPs associated with the network node.

(111) In some aspects, the UE and/or the network node may perform adaptation of a maximum number of MIMO layers (e.g., may identify a maximum number of MIMO layers) at a per-BWP granularity or a per-cell granularity. For example, the maximum number of MIMO layers may be identified per BWP, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured. As another example, the maximum number of MIMO layers may be identified per cell, based at least in part on per-bandwidth-part configuration of

maximum numbers of MIMO layers not being configured if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured. In some aspects, if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a bandwidth part, and if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a cell. Thus, the adaptation of the maximum number of MIMO is applicable to per-BWP configuration of maxMIMO-layers if configured, and otherwise is applicable to the per-cell maxMIMO-layers configuration (if per-BWP configuration is not configured).

(112) As shown by reference number **1040**, the UE and the network node may perform a communication in accordance with the maximum number of MIMO layers. For example, the UE may transmit an uplink communication (e.g., an uplink PUSCH communication) using at most the maximum number of MIMO layers, and the network node may receive the uplink communication using at most the maximum number of MIMO layers. As another example, the network node may transmit or configure a downlink communication (e.g., a downlink PDSCH communication) using at most the maximum number of MIMO layers, and the UE may receive the downlink communication using at most the maximum number of MIMO layers. In this way, the maximum number of MIMO layers can be adapted based at least in part on a dormancy state (or a change in dormancy state) of a TRP, such as without switching BWPs or RRC reconfiguring the UE.

(113) As indicated above, FIG. **10** is provided as an example. Other examples may differ from what is described with regard to FIG. **10**.

(114) FIG. **11** is a diagram illustrating an example process **1100** performed, for example, by a UE, in accordance with the present disclosure. Example process **1100** is an example where the UE (e.g., UE **120**, transmitter **810**, receiver **820**) performs operations associated with MIMO layer adaptation.

(115) As shown in FIG. **11**, in some aspects, process **1100** may include identifying a maximum number of MIMO layers for a communication based at least in part on at least one of a number of CSI-RS ports associated with a network node, or a transition of a TRP associated with the network node to or from a dormancy state (block **1110**). For example, the UE (e.g., using communication manager **140** and/or identification component **1308**, depicted in FIG. **13**) may identify a maximum number of MIMO layers for a communication based at least in part on at least one of a number of CSI-RS ports associated with a network node, or a transition of a TRP associated with the network node to or from a dormancy state, as described above.

(116) As further shown in FIG. **11**, in some aspects, process **1100** may include performing the communication in accordance with the maximum number of MIMO layers (block **1120**). For example, the UE (e.g., using communication manager **140** and/or transmission component **1304** or reception component **1302**, depicted in FIG. **13**) may perform the communication in accordance with the maximum number of MIMO layers, as described above.

(117) Process **1100** may include additional aspects, such as any single aspect or any combination of aspects described below and/or in connection with one or more other processes described elsewhere herein.

(118) In a first aspect, process **1100** includes receiving information indicating the number of CSI-RS ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(119) In a second aspect, alone or in combination with the first aspect, process **1100** includes receiving information indicating the transition of the TRP to the dormancy state, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(120) In a third aspect, alone or in combination with one or more of the first and second aspects, identifying the maximum number of MIMO layers further comprises identifying the maximum

number of MIMO layers in accordance with a mapping between the number of CSI-RS ports and the maximum number of MIMO layers.

(121) In a fourth aspect, alone or in combination with one or more of the first through third aspects, a first number of CSI-RS ports is mapped to a first number of MIMO layers and a second number of CSI-RS ports is mapped to a second number of MIMO layers, wherein the first number of MIMO layers is larger than the second number of MIMO layers and the first number of CSI-RS ports is larger than the second number of CSI-RS ports.

(122) In a fifth aspect, alone or in combination with one or more of the first through fourth aspects, the maximum number of MIMO layers is the second number of MIMO layers and the number of CSI-RS ports associated with the network node is the second number of CSI-RS ports, and process **1100** includes receiving, from the network node, information indicating an active number of CSI-RS ports to the second number of CSI-RS ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(123) In a sixth aspect, alone or in combination with one or more of the first through fifth aspects, process **1100** includes receiving configuration information indicating the mapping.

(124) In a seventh aspect, alone or in combination with one or more of the first through sixth aspects, identifying the maximum number of MIMO layers further comprises identifying the maximum number of MIMO layers as a maximum number of MIMO layers of a non-dormant TRP associated with the network node.

(125) In an eighth aspect, alone or in combination with one or more of the first through seventh aspects, the TRP associated with the dormancy state is associated with a first maximum number of MIMO layers and the non-dormant TRP is associated with a second maximum number of MIMO layers, and the maximum number of MIMO layers for the communication is the second maximum number of MIMO layers.

(126) In a ninth aspect, alone or in combination with one or more of the first through eighth aspects, identifying the maximum number of MIMO layers further comprises identifying the maximum number of MIMO layers by applying a scaling factor to a prior maximum number of MIMO layers based at least in part on the transition of the TRP associated with the network node to the dormancy state.

(127) In a tenth aspect, alone or in combination with one or more of the first through ninth aspects, process **1100** includes receiving an indication of the scaling factor.

(128) In an eleventh aspect, alone or in combination with one or more of the first through tenth aspects, the maximum number of MIMO layers is identified per bandwidth part, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured.

(129) In a twelfth aspect, alone or in combination with one or more of the first through eleventh aspects, the maximum number of MIMO layers is identified per cell, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers not being configured if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured.

(130) In a thirteenth aspect, alone or in combination with one or more of the first through twelfth aspects, if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a bandwidth part, and if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a cell.

(131) Although FIG. **11** shows example blocks of process **1100**, in some aspects, process **1100** may include additional blocks, fewer blocks, different blocks, or differently arranged blocks than those depicted in FIG. **11**. Additionally, or alternatively, two or more of the blocks of process **1100** may be performed in parallel.

(132) FIG. **12** is a diagram illustrating an example process **1200** performed, for example, by a network node, in accordance with the present disclosure. Example process **1200** is an example

where the network node (e.g., network node **110**, CU **310**, DU **330**, RU **340**, the network node of FIG. **5**, 5G access node **605**, ANC **610**, one or more TRPs **635**, one or more TRPs **705**, transmitter **810**, receiver **820**, or a combination thereof) performs operations associated with MIMO layer adaptation.

(133) As shown in FIG. **12**, in some aspects, process **1200** may include transmitting at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state (block **1210**). For example, the network node (e.g., using communication manager **150** and/or transmission component **1404**, depicted in FIG. **14**) may transmit at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state, as described above.

(134) As further shown in FIG. **12**, in some aspects, process **1200** may include performing a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state (block **1220**). For example, the network node (e.g., using communication manager **150**, transmission component **1404**, and/or reception component **1402**, depicted in FIG. **14**) may perform a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state, as described above.

(135) Process **1200** may include additional aspects, such as any single aspect or any combination of aspects described below and/or in connection with one or more other processes described elsewhere herein.

(136) In a first aspect, the maximum number of MIMO layers is based at least in part on a mapping between the number of CSI-RS ports and the maximum number of MIMO layers.

(137) In a second aspect, alone or in combination with the first aspect, a first number of CSI-RS ports is mapped to a first number of MIMO layers and a second number of CSI-RS ports is mapped to a second number of MIMO layers, wherein the first number of MIMO layers is larger than the second number of MIMO layers and the first number of CSI-RS ports is larger than the second number of CSI-RS ports.

(138) In a third aspect, alone or in combination with one or more of the first and second aspects, process **1200** includes transmitting configuration information indicating the mapping.

(139) In a fourth aspect, alone or in combination with one or more of the first through third aspects, the maximum number of MIMO layers is equal to a maximum number of MIMO layers of a non-dormant TRP associated with the network node.

(140) In a fifth aspect, alone or in combination with one or more of the first through fourth aspects, the TRP associated with the dormancy state is associated with a first maximum number of MIMO layers and the non-dormant TRP is associated with a second maximum number of MIMO layers, and the maximum number of MIMO layers for the communication is the second maximum number of MIMO layers.

(141) In a sixth aspect, alone or in combination with one or more of the first through fifth aspects, the maximum number of MIMO layers is determined by applying a scaling factor to a prior maximum number of MIMO layers based at least in part on the transition of the TRP associated with the network node to the dormancy state.

(142) In a seventh aspect, alone or in combination with one or more of the first through sixth aspects, process **1200** includes transmitting an indication of the scaling factor.

(143) In an eighth aspect, alone or in combination with one or more of the first through seventh aspects, the maximum number of MIMO layers is identified per bandwidth part, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured

if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured.

(144) In a ninth aspect, alone or in combination with one or more of the first through eighth aspects, the maximum number of MIMO layers is identified per cell, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured.

(145) In a tenth aspect, alone or in combination with one or more of the first through ninth aspects, if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a bandwidth part, and if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a cell.

(146) Although FIG. **12** shows example blocks of process **1200**, in some aspects, process **1200** may include additional blocks, fewer blocks, different blocks, or differently arranged blocks than those depicted in FIG. **12**. Additionally, or alternatively, two or more of the blocks of process **1200** may be performed in parallel.

(147) FIG. **13** is a diagram of an example apparatus **1300** for wireless communication, in accordance with the present disclosure. The apparatus **1300** may be a UE, or a UE may include the apparatus **1300**. In some aspects, the apparatus **1300** includes a reception component **1302** and a transmission component **1304**, which may be in communication with one another (for example, via one or more buses and/or one or more other components). As shown, the apparatus **1300** may communicate with another apparatus **1306** (such as a UE, a base station, or another wireless communication device) using the reception component **1302** and the transmission component **1304**. As further shown, the apparatus **1300** may include the communication manager **140**. The communication manager **140** may include one or more of a identification component **1308**, among other examples.

(148) In some aspects, the apparatus **1300** may be configured to perform one or more operations described herein in connection with FIGS. **3**-**10**. Additionally, or alternatively, the apparatus **1300** may be configured to perform one or more processes described herein, such as process **1100** of FIG. **11**, or a combination thereof. In some aspects, the apparatus **1300** and/or one or more components shown in FIG. **13** may include one or more components of the UE described in connection with FIG. **2**. Additionally, or alternatively, one or more components shown in FIG. **13** may be implemented within one or more components described in connection with FIG. **2**. Additionally, or alternatively, one or more components of the set of components may be implemented at least in part as software stored in a memory. For example, a component (or a portion of a component) may be implemented as instructions or code stored in a non-transitory computer-readable medium and executable by a controller or a processor to perform the functions or operations of the component.

(149) The reception component **1302** may receive communications, such as reference signals, control information, data communications, or a combination thereof, from the apparatus **1306**. The reception component **1302** may provide received communications to one or more other components of the apparatus **1300**. In some aspects, the reception component **1302** may perform signal processing on the received communications (such as filtering, amplification, demodulation, analog-to-digital conversion, demultiplexing, deinterleaving, de-mapping, equalization, interference cancellation, or decoding, among other examples), and may provide the processed signals to the one or more other components of the apparatus **1300**. In some aspects, the reception component **1302** may include one or more antennas, a modem, a demodulator, a MIMO detector, a receive processor, a controller/processor, a memory, or a combination thereof, of the UE described in connection with FIG. **2**.

(150) The transmission component **1304** may transmit communications, such as reference signals, control information, data communications, or a combination thereof, to the apparatus **1306**. In

some aspects, one or more other components of the apparatus **1300** may generate communications and may provide the generated communications to the transmission component **1304** for transmission to the apparatus **1306**. In some aspects, the transmission component **1304** may perform signal processing on the generated communications (such as filtering, amplification, modulation, digital-to-analog conversion, multiplexing, interleaving, mapping, or encoding, among other examples), and may transmit the processed signals to the apparatus **1306**. In some aspects, the transmission component **1304** may include one or more antennas, a modem, a modulator, a transmit MIMO processor, a transmit processor, a controller/processor, a memory, or a combination thereof, of the UE described in connection with FIG. **2**. In some aspects, the transmission component **1304** may be co-located with the reception component **1302** in a transceiver.

(151) The identification component **1308** may identify a maximum number of MIMO layers for a communication based at least in part on at least one of a number of CSI-RS ports associated with a network node, or a transition of a TRP associated with the network node to or from a dormancy state. The reception component **1302** or the transmission component **1304** may perform the communication in accordance with the maximum number of MIMO layers.

(152) The reception component **1302** may receive information indicating the number of CSI-RS ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(153) The reception component **1302** may receive information indicating the transition of the TRP to the dormancy state, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(154) The reception component **1302** may receive configuration information indicating the mapping.

(155) The reception component **1302** may receive an indication of the scaling factor.

(156) The number and arrangement of components shown in FIG. **13** are provided as an example. In practice, there may be additional components, fewer components, different components, or differently arranged components than those shown in FIG. **13**. Furthermore, two or more components shown in FIG. **13** may be implemented within a single component, or a single component shown in FIG. **13** may be implemented as multiple, distributed components. Additionally, or alternatively, a set of (one or more) components shown in FIG. **13** may perform one or more functions described as being performed by another set of components shown in FIG. **13**.

(157) FIG. **14** is a diagram of an example apparatus **1400** for wireless communication, in accordance with the present disclosure. The apparatus **1400** may be a network node, or a network node may include the apparatus **1400**. In some aspects, the apparatus **1400** includes a reception component **1402** and a transmission component **1404**, which may be in communication with one another (for example, via one or more buses and/or one or more other components). As shown, the apparatus **1400** may communicate with another apparatus **1406** (such as a UE, a base station, or another wireless communication device) using the reception component **1402** and the transmission component **1404**. As further shown, the apparatus **1400** may include the communication manager **150**. The communication manager **150** may include one or more of a configuration component **1408** or an identification component **1410**, among other examples.

(158) In some aspects, the apparatus **1400** may be configured to perform one or more operations described herein in connection with FIGS. **3-10**. Additionally, or alternatively, the apparatus **1400** may be configured to perform one or more processes described herein, such as process **1200** of FIG. **12**, or a combination thereof. In some aspects, the apparatus **1400** and/or one or more components shown in FIG. **14** may include one or more components of the network node described in connection with FIG. **2**. Additionally, or alternatively, one or more components shown in FIG. **14** may be implemented within one or more components described in connection with FIG. **2**. Additionally, or alternatively, one or more components of the set of components may be

implemented at least in part as software stored in a memory. For example, a component (or a portion of a component) may be implemented as instructions or code stored in a non-transitory computer-readable medium and executable by a controller or a processor to perform the functions or operations of the component.

(159) The reception component **1402** may receive communications, such as reference signals, control information, data communications, or a combination thereof, from the apparatus **1406**. The reception component **1402** may provide received communications to one or more other components of the apparatus **1400**. In some aspects, the reception component **1402** may perform signal processing on the received communications (such as filtering, amplification, demodulation, analog-to-digital conversion, demultiplexing, deinterleaving, de-mapping, equalization, interference cancellation, or decoding, among other examples), and may provide the processed signals to the one or more other components of the apparatus **1400**. In some aspects, the reception component **1402** may include one or more antennas, a modem, a demodulator, a MIMO detector, a receive processor, a controller/processor, a memory, or a combination thereof, of the network node described in connection with FIG. **2**.

(160) The transmission component **1404** may transmit communications, such as reference signals, control information, data communications, or a combination thereof, to the apparatus **1406**. In some aspects, one or more other components of the apparatus **1400** may generate communications and may provide the generated communications to the transmission component **1404** for transmission to the apparatus **1406**. In some aspects, the transmission component **1404** may perform signal processing on the generated communications (such as filtering, amplification, modulation, digital-to-analog conversion, multiplexing, interleaving, mapping, or encoding, among other examples), and may transmit the processed signals to the apparatus **1406**. In some aspects, the transmission component **1404** may include one or more antennas, a modem, a modulator, a transmit MIMO processor, a transmit processor, a controller/processor, a memory, or a combination thereof, of the network node described in connection with FIG. **2**. In some aspects, the transmission component **1404** may be co-located with the reception component **1402** in a transceiver.

(161) The transmission component **1404** may transmit at least one of: information indicating a number of CSI-RS ports associated with the network node, or information indicating a transition of a TRP associated with the network node to or from a dormancy state. The transmission component **1404** or the reception component **1402** may perform a communication in accordance with a maximum number of MIMO layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state.

(162) The configuration component **1408** may transmit configuration information indicating the mapping.

(163) The configuration component **1408** may transmit an indication of the scaling factor.

(164) The identification component **1410** may identify a maximum number of MIMO layers.

(165) The number and arrangement of components shown in FIG. **14** are provided as an example. In practice, there may be additional components, fewer components, different components, or differently arranged components than those shown in FIG. **14**. Furthermore, two or more components shown in FIG. **14** may be implemented within a single component, or a single component shown in FIG. **14** may be implemented as multiple, distributed components. Additionally, or alternatively, a set of (one or more) components shown in FIG. **14** may perform one or more functions described as being performed by another set of components shown in FIG. **14**.

(166) The following provides an overview of some Aspects of the present disclosure:

(167) Aspect 1: A method of wireless communication performed by a user equipment (UE), comprising: identifying a maximum number of multiple-input multiple-output (MIMO) layers for a communication based at least in part on at least one of a number of channel state information

reference signal (CSI-RS) ports associated with a network node, or a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state; and performing the communication in accordance with the maximum number of MIMO layers.

(168) Aspect 2: The method of Aspect 1, further comprising: receiving information indicating the number of CSI-RS ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(169) Aspect 3: The method of Aspect 1, further comprising: receiving information indicating the transition of the TRP to or from the dormancy state, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(170) Aspect 4: The method of any of Aspects 1-2, wherein identifying the maximum number of MIMO layers further comprises: identifying the maximum number of MIMO layers in accordance with a mapping between the number of CSI-RS ports and the maximum number of MIMO layers.

(171) Aspect 5: The method of Aspect 4, wherein a first number of CSI-RS ports is mapped to a first number of MIMO layers and a second number of CSI-RS ports is mapped to a second number of MIMO layers, wherein the first number of MIMO layers is larger than the second number of MIMO layers and the first number of CSI-RS ports is larger than the second number of CSI-RS ports.

(172) Aspect 6: The method of Aspect 5, wherein the maximum number of MIMO layers is the second number of MIMO layers and the number of CSI-RS ports associated with the network node is the second number of CSI-RS ports, wherein the method further comprises: receiving, from the network node, information indicating an active number of CSI-RS ports to the second number of CSI-RS ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

(173) Aspect 7: The method of any of Aspects 4-7, further comprising: receiving configuration information indicating the mapping.

(174) Aspect 8: The method of either of Aspects 1 or 3, wherein identifying the maximum number of MIMO layers further comprises: identifying the maximum number of MIMO layers as a sum of maximum numbers of MIMO layers of one or more non-dormant TRPs associated with the network node.

(175) Aspect 9: The method of Aspect 1, wherein the network node is associated with two TRPs, wherein a TRP associated with the dormancy state is associated with a first maximum number of MIMO layers and a non-dormant TRP is associated with a second maximum number of MIMO layers, and wherein the maximum number of MIMO layers for the communication is the second maximum number of MIMO layers.

(176) Aspect 10: The method of any of Aspects 1, 3, 8-9, wherein identifying the maximum number of MIMO layers further comprises: identifying the maximum number of MIMO layers by applying a scaling factor to a prior maximum number of MIMO layers based at least in part on the transition of the TRP associated with the network node to or from the dormancy state.

(177) Aspect 11: The method of Aspect 10, further comprising: receiving an indication of the scaling factor.

(178) Aspect 12: The method of any of Aspects 1-11, wherein the maximum number of MIMO layers is identified per bandwidth part, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured.

(179) Aspect 13: The method of any of Aspects 1-11, wherein the maximum number of MIMO layers is identified per cell, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers not being configured.

(180) Aspect 14: The method of any of Aspects 1-11, wherein: if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a bandwidth part, and if per-bandwidth-part configuration of maximum numbers of MIMO layers is not

configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a cell.

(181) Aspect 15: A method of wireless communication performed by a network node, comprising: transmitting at least one of: information indicating a number of channel state information reference signal (CSI-RS) ports associated with the network node, or information indicating a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state; and performing a communication in accordance with a maximum number of multiple-input multiple-output (MIMO) layers, wherein the maximum number of MIMO layers is based at least in part on at least one of the number of CSI-RS ports or the transition of the TRP to the dormancy state.

(182) Aspect 16: The method of Aspect 15, wherein the maximum number of MIMO layers is based at least in part on a mapping between the number of CSI-RS ports and the maximum number of MIMO layers.

(183) Aspect 17: The method of Aspect 16, wherein a first number of CSI-RS ports is mapped to a first number of MIMO layers and a second number of CSI-RS ports is mapped to a second number of MIMO layers, wherein the first number of MIMO layers is larger than the second number of MIMO layers and the first number of CSI-RS ports is larger than the second number of CSI-RS ports.

(184) Aspect 18: The method of Aspect 16, further comprising: transmitting configuration information indicating the mapping.

(185) Aspect 19: The method of Aspect 15, wherein the maximum number of MIMO layers is equal to a sum of maximum numbers of MIMO layers of one or more non-dormant TRPs associated with the network node.

(186) Aspect 20: The method of Aspect 19, wherein network node is associated with two TRPs, wherein a the TRP associated with the dormancy state is associated with a first maximum number of MIMO layers and a non-dormant TRP is associated with a second maximum number of MIMO layers, and wherein the maximum number of MIMO layers for the communication is the second maximum number of MIMO layers.

(187) Aspect 21: The method of Aspect 15, wherein the maximum number of MIMO layers is determined by applying a scaling factor to a prior maximum number of MIMO layers based at least in part on the transition of the TRP associated with the network node to the dormancy state.

(188) Aspect 22: The method of Aspect 21, further comprising: transmitting an indication of the scaling factor.

(189) Aspect 23: The method of any of Aspects 15-22, wherein the maximum number of MIMO layers is identified per bandwidth part, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured.

(190) Aspect 24: The method of any of Aspects 15-22, wherein the maximum number of MIMO layers is identified per cell, based at least in part on per-bandwidth-part configuration of maximum numbers of MIMO layers being configured.

(191) Aspect 25: The method of any of Aspects 15-22, wherein: if per-bandwidth-part configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a bandwidth part, and if per-bandwidth-part configuration of maximum numbers of MIMO layers is not configured, the maximum number of MIMO layers is identified based at least in part on a configured maximum number of MIMO layers for a cell.

(192) Aspect 26: An apparatus for wireless communication at a device, comprising a processor; memory coupled with the processor; and instructions stored in the memory and executable by the processor to cause the apparatus to perform the method of one or more of Aspects 1-25.

(193) Aspect 27: A device for wireless communication, comprising a memory and one or more processors coupled to the memory, the one or more processors configured to perform the method of

one or more of Aspects 1-25.

(194) Aspect 28: An apparatus for wireless communication, comprising at least one means for performing the method of one or more of Aspects 1-25.

(195) Aspect 29: A non-transitory computer-readable medium storing code for wireless communication, the code comprising instructions executable by a processor to perform the method of one or more of Aspects 1-25.

(196) Aspect 30: A non-transitory computer-readable medium storing a set of instructions for wireless communication, the set of instructions comprising one or more instructions that, when executed by one or more processors of a device, cause the device to perform the method of one or more of Aspects 1-25.

(197) The foregoing disclosure provides illustration and description but is not intended to be exhaustive or to limit the aspects to the precise forms disclosed. Modifications and variations may be made in light of the above disclosure or may be acquired from practice of the aspects.

(198) As used herein, the term "component" is intended to be broadly construed as hardware and/or a combination of hardware and software. "Software" shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, and/or functions, among other examples, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. As used herein, a "processor" is implemented in hardware and/or a combination of hardware and software. It will be apparent that systems and/or methods described herein may be implemented in different forms of hardware and/or a combination of hardware and software. The actual specialized control hardware or software code used to implement these systems and/or methods is not limiting of the aspects. Thus, the operation and behavior of the systems and/or methods are described herein without reference to specific software code, since those skilled in the art will understand that software and hardware can be designed to implement the systems and/or methods based, at least in part, on the description herein.

(199) As used herein, "satisfying a threshold" may, depending on the context, refer to a value being greater than the threshold, greater than or equal to the threshold, less than the threshold, less than or equal to the threshold, equal to the threshold, not equal to the threshold, or the like.

(200) Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the disclosure of various aspects. Many of these features may be combined in ways not specifically recited in the claims and/or disclosed in the specification. The disclosure of various aspects includes each dependent claim in combination with every other claim in the claim set. As used herein, a phrase referring to "at least one of" a list of items refers to any combination of those items, including single members. As an example, "at least one of: a, b, or c" is intended to cover a, b, c, a+b, a+c, b+c, and a+b+c, as well as any combination with multiples of the same element (e.g., a+a, a+a+a, a+a+b, a+a+c, a+b+b, a+c+c, b+b, b+b+b, b+b+c, c+c, and c+c+c, or any other ordering of a, b, and c).

(201) No element, act, or instruction used herein should be construed as critical or essential unless explicitly described as such. Also, as used herein, the articles "a" and "an" are intended to include one or more items and may be used interchangeably with "one or more." Further, as used herein, the article "the" is intended to include one or more items referenced in connection with the article "the" and may be used interchangeably with "the one or more." Furthermore, as used herein, the terms "set" and "group" are intended to include one or more items and may be used interchangeably with "one or more." Where only one item is intended, the phrase "only one" or similar language is used. Also, as used herein, the terms "has," "have," "having," or the like are intended to be open-ended terms that do not limit an element that they modify (e.g., an element "having" A may also have B). Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise. Also, as used herein, the term "or" is intended to be

inclusive when used in a series and may be used interchangeably with "and/or," unless explicitly stated otherwise (e.g., if used in combination with "either" or "only one of").

Claims

1. An apparatus of a user equipment (UE) for wireless communication, comprising: one or more memories; and one or more processors, coupled to the one or more memories, configured to: identify a maximum number of multiple-input multiple-output (MIMO) layers for a communication based at least in part on a transition of a transmission reception point (TRP) associated with a network node to or from a dormancy state; and perform the communication in accordance with the maximum number of MIMO layers, wherein a first bandwidth part (BWP) is configured with the maximum number of MIMO layers and a second BWP is configured with a different maximum number of MIMO layers, or a first cell is configured with the maximum number of MIMO layers and a second cell is configured with the different maximum number of MIMO layers, or any combination thereof.

2. The apparatus of claim 1, wherein the one or more processors are further configured to: receive information indicating a number of channel state information reference signal (CSI-RS) ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

3. The apparatus of claim 1, wherein the one or more processors are further configured to: receive information indicating the transition of the TRP to or from the dormancy state, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

4. The apparatus of claim 1, wherein the one or more processors, to identify the maximum number of MIMO layers, are configured to: identify the maximum number of MIMO layers in accordance with a mapping between a number of channel state information reference signal (CSI-RS) ports and the maximum number of MIMO layers.

5. The apparatus of claim 4, wherein a first number of CSI-RS ports is mapped to a first number of MIMO layers and a second number of CSI-RS ports is mapped to a second number of MIMO layers, wherein the first number of MIMO layers is larger than the second number of MIMO layers and the first number of CSI-RS ports is larger than the second number of CSI-RS ports.

6. The apparatus of claim 5, wherein the maximum number of MIMO layers is the second number of MIMO layers and the number of CSI-RS ports is the second number of CSI-RS ports, wherein the one or more processors are configured to: receive, from the network node, information indicating an active number of CSI-RS ports to the second number of CSI-RS ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

7. The apparatus of claim 4, wherein the one or more processors are further configured to: receive configuration information indicating the mapping.

8. The apparatus of claim 1, wherein the one or more processors, to identify the maximum number of MIMO layers, are configured to: identify the maximum number of MIMO layers as a sum of maximum numbers of MIMO layers of one or more non-dormant TRPs associated with the network node.

9. The apparatus of claim 1, wherein the network node is associated with two TRPs, wherein a TRP associated with the dormancy state is associated with a first maximum number of MIMO layers and a non-dormant TRP is associated with a second maximum number of MIMO layers, and wherein the maximum number of MIMO layers for the communication is the second maximum number of MIMO layers.

10. The apparatus of claim 1, wherein the one or more processors, to identify the maximum number of MIMO layers, are configured to: identify the maximum number of MIMO layers by applying a scaling factor to a prior maximum number of MIMO layers based at least in part on the transition of the TRP associated with the network node to or from the dormancy state.

11. The apparatus of claim 10, wherein the one or more processors are further configured to: receive an indication of the scaling factor.

12. The apparatus of claim 1, wherein the maximum number of MIMO layers is per BWP, based at least in part on per-BWP configuration of maximum numbers of MIMO layers being configured.

13. The apparatus of claim 1, wherein the maximum number of MIMO layers is identified per cell, based at least in part on per-BWP configuration of maximum numbers of MIMO layers not being configured.

14. The apparatus of claim 1, wherein: if per-BWP configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is based at least in part on a configured maximum number of MIMO layers for the first BWP, and if the per-BWP configuration of maximum numbers of MIMO layers is not configured, the maximum number of MIMO layers is based at least in part on a configured maximum number of MIMO layers for the first cell.

15. A network node for wireless communication, comprising: one or more memories; and one or more processors, coupled to the one or more memories, configured to: transmit information indicating a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state; and perform a communication in accordance with a maximum number of multiple-input multiple-output (MIMO) layers, wherein the maximum number of MIMO layers is based at least in part on the transition of the TRP to the dormancy state, wherein a first bandwidth part (BWP) is configured with the maximum number of MIMO layers and a second BWP is configured with a different maximum number of MIMO layers, or a first cell is configured with the maximum number of MIMO layers and a second cell is configured with the different maximum number of MIMO layers, or any combination thereof.

16. The network node of claim 15, wherein the maximum number of MIMO layers is based at least in part on a mapping between a number of channel state information reference signal (CSI-RS) ports and the maximum number of MIMO layers.

17. The network node of claim 16, wherein a first number of CSI-RS ports is mapped to a first number of MIMO layers and a second number of CSI-RS ports is mapped to a second number of MIMO layers, wherein the first number of MIMO layers is larger than the second number of MIMO layers and the first number of CSI-RS ports is larger than the second number of CSI-RS ports.

18. The network node of claim 16, wherein the one or more processors are further configured to: transmit configuration information indicating the mapping.

19. The network node of claim 15, wherein the maximum number of MIMO layers is equal to a sum of maximum numbers of MIMO layers of one or more non-dormant TRPs associated with the network node.

20. The network node of claim 19, wherein the network node is associated with two TRPs, wherein a TRP associated with the dormancy state is associated with a first maximum number of MIMO layers and a non-dormant TRP is associated with a second maximum number of MIMO layers, and wherein the maximum number of MIMO layers for the communication is the second maximum number of MIMO layers.

21. The network node of claim 15, wherein the maximum number of MIMO layers is based at least in part on a scaling factor applied to a prior maximum number of MIMO layers based at least in part on the transition of the TRP associated with the network node to the dormancy state.

22. The network node of claim 21, wherein the one or more processors are further configured to: transmit an indication of the scaling factor.

23. The network node of claim 15, wherein the maximum number of MIMO layers is identified per BWP, based at least in part on per-BWP configuration of maximum numbers of MIMO layers being configured.

24. The network node of claim 15, wherein the maximum number of MIMO layers is per cell, based at least in part on per-BWP configuration of maximum numbers of MIMO layers not being

configured.

25. The network node of claim 15, wherein: if per-BWP configuration of maximum numbers of MIMO layers is configured, the maximum number of MIMO layers is based at least in part on a configured maximum number of MIMO layers for the first BWP, and if the per-BWP configuration of maximum numbers of MIMO layers is not configured, the maximum number of MIMO layers is based at least in part on a configured maximum number of MIMO layers for the first cell.

26. A method of wireless communication performed by a user equipment (UE), comprising: identifying a maximum number of multiple-input multiple-output (MIMO) layers for a communication based at least in part on a transition of a transmission reception point (TRP) associated with a network node to or from a dormancy state; and performing the communication in accordance with the maximum number of MIMO layers, wherein a first bandwidth part (BWP) is configured with the maximum number of MIMO layers and a second BWP is configured with a different maximum number of MIMO layers, or a first cell is configured with the maximum number of MIMO layers and a second cell is configured with the different maximum number of MIMO layers, or any combination thereof.

27. The method of claim 26, further comprising: receiving information indicating a number of channel state information reference signal (CSI-RS) ports, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

28. The method of claim 26, further comprising: receiving information indicating the transition of the TRP to or from the dormancy state, wherein identifying the maximum number of MIMO layers is based at least in part on the information.

29. A method of wireless communication performed by a network node, comprising: transmitting information indicating a transition of a transmission reception point (TRP) associated with the network node to or from a dormancy state; and performing a communication in accordance with a maximum number of multiple-input multiple-output (MIMO) layers, wherein the maximum number of MIMO layers is based at least in part on the transition of the TRP to the dormancy state, wherein a first bandwidth part (BWP) is configured with the maximum number of MIMO layers and a second BWP is configured with a different maximum number of MIMO layers, or a first cell is configured with the maximum number of MIMO layers and a second cell is configured with the different maximum number of MIMO layers, or any combination thereof.

30. The method of claim 29, wherein the maximum number of MIMO layers is based at least in part on a mapping between a number of channel state information reference signal (CSI-RS) ports and the maximum number of MIMO layers.