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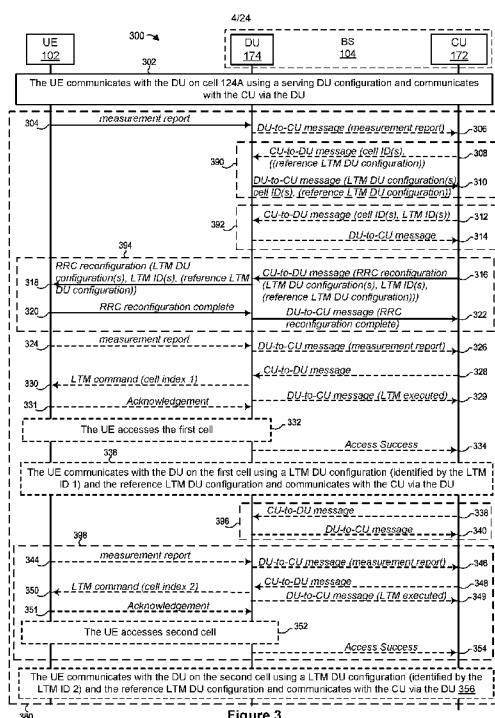


Figure 3

(57) Abstract: Methods and apparatuses operate within a radio access network to facilitate a fast serving cell change using a lower-layer triggered mobility, LTM, procedure, reducing latency, and overhead relative to an L3-triggered cell-switching procedures. LTM procedure's execution is triggered by an L1 measurement report. Distributed entities of a base station exchange information (1204) for preparing a UE to switch from a current serving cell to another cell for using an LTM procedure and convey (1210) an LTM configuration generated (1206) in one of the distributed entities to the UE. Additionally, one or more transmission configuration indicator (TCI) state configurations may be generated (1208) and transmitted (1210) between the various distributed entities and the UE.

**METHODS AND APPARATUSES FOR CONFIGURING PARAMETERS FOR
LOWER LAYER TRIGGERED MOBILITY USING TRANSMISSION
CONFIGURATION INDICATORS**

FIELD OF THE DISCLOSURE

[0001] This disclosure relates to wireless communications and, more particularly, to configuring parameters for lower-layer triggered cell changes between a user equipment (UE) and a radio access network (RAN) using transmission configuration indicators (TCIs).

BACKGROUND

[0002] This background description is provided for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description that may not otherwise qualify as prior art at the time of filing, are neither expressly nor impliedly admitted as prior art against the present disclosure.

[0003] In telecommunication systems, the Packet Data Convergence Protocol (PDCP) sublayer of the radio protocol stack provides services such as transfer of user-plane data, ciphering, integrity protection, etc. For example, the PDCP layer defined for the Evolved Universal Terrestrial Radio Access (EUTRA) radio interface (see 3GPP technical specification (TS) 36.323) and New Radio (NR) (see 3GPP TS 38.323) provides sequencing of protocol data units (PDUs) in the uplink direction (from a user device, also known as a UE, to a base station (BS)) as well as in the downlink direction (from the BS to the UE). Further, the PDCP sublayer provides signaling radio bearers (SRBs) and data radio bearers (DRBs) to the Radio Resource Control (RRC) sublayer. The UE and BS may use SRBs to exchange RRC messages as well as non-access stratum (NAS) messages, and may use DRBs to transport data on a user plane.

[0004] The UE may use several types of SRBs and DRBs. When operating in dual connectivity (DC), the cells associated with the BS operating as the master node (MN) define a master cell group (MCG), and the cells associated with the BS operating as the secondary node (SN) define the secondary cell group (SCG). The so-called SRB1 resources carry RRC messages, which in some cases include NAS messages over the dedicated control channel (DCCH), and SRB2 resources support RRC messages that include logged measurement information or NAS messages, also over the DCCH but with lower priority than SRB1

resources. More generally, SRB1 and SRB2 resources allow the UE and the MN to exchange RRC messages related to the MN and embed RRC messages related to the SN, and SRB1 and SRB2 may be referred to as MCG SRBs. SRB3 resources allow the UE and the SN to exchange RRC messages related to the SN and SRB3 may be referred to as SCG SRBs. Further, DRBs using the lower-layer resources of only the MN may be referred to as MCG DRBs. DRBs using the lower-layer resources of only the SN may be referred to as SCG DRBs. DRBs using the lower-layer resources of both the MCG and the SCG may be referred to as split DRBs. Split SRBs allow the UE to exchange RRC messages directly with the MN via lower layer resources of the MN and the SN.

[0005] The UE, in some scenarios, may concurrently utilize resources of multiple RAN nodes (e.g., BSs or components of a distributed BS), interconnected by a backhaul. When these network nodes support different radio access technologies (RATs), this type of connectivity is referred to as Multi-Radio Dual Connectivity (MR-DC). When a UE operates in MR-DC, one BS operates as a master node (MN) that covers a primary cell (PCell), and the other BS operates as a secondary node (SN) that covers a primary secondary cell (PSCell). The UE communicates with the MN (via the PCell) and the SN (via the PSCell). In other scenarios, the UE utilizes resources of one BS at a time. One BS and/or the UE determines that the UE should establish a radio connection with another BS. For example, one BS may determine to hand the UE over to the second BS and initiate a handover procedure.

[0006] When the UE moves from a coverage area of one cell to a coverage area of another cell in a RAN, a serving cell change is performed for the UE. To perform the serving cell change, the RAN configures the UE to transmit Layer 3 (L3) measurement results. Based on L3 measurement results received from the UE, the RAN transmits an RRC reconfiguration message to the UE. The RRC reconfiguration message triggers a Reconfiguration with Synchronization (e.g., the RRC reconfiguration message includes a *ReconfigurationWithSync* IE) for changing/switching the serving cell (e.g., PCell or PSCell). In cases where the UE operates in carrier aggregation (CA) of at least one secondary cell (SCell) with the PCell or PSCell, the RAN releases the at least one SCell due to the change of the PCell or PSCell. The serving cell change involves complete Layer 2 (L2) (and Layer 1 (L1)) resets, leading to long latency, large overhead, and a long interruption time. Recently developed lower-layer triggered mobility (LTM) techniques do not use L3 reporting. These techniques reduce latency and overhead, thereby enabling faster serving cell switching. Configuring the LTM

parameters for such a case remains an issue, which, if not solved efficiently, diminishes the LTM technique's advantages. For example, when a UE moves from one cell to another, the UE may need to switch to a different beam to maintain a connection with the RAN. However, current procedures do not provide for how the RAN and the UE seamlessly switch to different beams (i.e., transmission configuration indicator (TCI) states) from one cell to another during LTM or providing transmission configurations to distributed network entities.

SUMMARY

[0007] The LTM techniques reduce conventional cell switching latency and overhead because, for the LTM, the UE does not require explicit RRC signaling and lower layer resets. The network may initiate an LTM cell change procedure based on an L1 measurement report. According to various embodiments, a BS, which includes a centralized unit (CU) and a distributed unit (DU), transmits information related to lower-layer measurements and reporting (e.g., a reference signal configuration and/or an L1 measurement report configuration), to the UE, together with an LTM DU configuration. Upon receiving the L1 measurement report, the BS may direct the UE to change a serving cell used for communication. According to embodiments, the LTM DU configuration and a TCI state configuration are exchanged between various entities (e.g., UEs, DUs, CUs, etc.) to configure parameters for the LTM cell switch and to enable seamless communications.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0008] FIG. 1A is a block diagram of an example system in which a RAN and a UE implement various techniques of this disclosure for transmitting LTM and TCI state configurations between an UE and a distributed BS.
- [0009] FIG. 1B is a block diagram of an example base station including a CU and a DU that can operate in the system of FIG. 1A.
- [0010] FIG. 2A is a block diagram of an example protocol stack according to which the UE of FIG. 1A communicates with the BS.
- [0011] FIG. 2B is a block diagram of an example protocol stack according to which the UE of FIG. 1A communicates with a CU and a DU of the BS.
- [0012] FIG. 2C is a block diagram illustrating structural elements of a network element and/or a BS configured to perform methods for managing LTM configurations and TCI state configurations according to an embodiment.
- [0013] FIG. 3 illustrates a signaling diagram of a first scenario for a UE and an BS having a single DU operating according to an embodiment.
- [0014] FIG. 4 illustrates a signaling diagram of a second scenario for a UE and an BS having plural DUs operating according to another embodiment.
- [0015] FIGs. 5A and 5B illustrate signaling diagrams of a third scenario for a UE and plural BSs operating according to other embodiments.
- [0016] FIGs. 6A and 6B illustrate signaling diagrams of a fourth scenario for a UE and plural BSs, at least one BS having plural DUs, operating according to yet other embodiments.
- [0017] FIGs. 7A and 7B illustrate signaling diagrams of a fifth scenario for UE operating in dual connectivity with two DUs of an BS according to some embodiments.
- [0018] FIGs. 8A and 8B illustrate signaling diagrams of a sixth scenario for UE operating in dual connectivity with two of plural DUs of an BS according to some other embodiments.
- [0019] FIGs. 9A and 9B are flowcharts of CU methods for generating and transmitting TCI state configurations for LTM according to various embodiments.
- [0020] FIG. 10 is a flowchart of a CU method for transmitting a TCI state configuration for LTM according to an embodiment.

[0021] FIG. 11 is a flowchart of a DU method for transmitting a TCI state configuration for LTM according to an embodiment.

[0022] FIGs. 12A and 12B are flowcharts of DU methods for generating and transmitting TCI state configurations for LTM according to various embodiments.

[0023] FIGs. 13A and 13B are flowcharts of DU methods for generating a TCI state configuration based on a received TCI state configuration for LTM according to various embodiments.

[0024] FIGs. 14A and 14B are flowcharts of DU methods for generating a TCI state configuration based on a received TCI state configuration and generating an LTM DU configuration according to various embodiments.

[0025] FIG. 15 is a flowchart of a DU method for generating an additional serving DU configuration based on an LTM DU configuration and TCI state configuration according to an embodiment.

[0026] FIG. 16 is a flowchart of a DU method for generating an LTM DU configuration based on a received LTM DU configuration according to an embodiment.

[0027] FIG. 17 is a flowchart of a CU method for transmitting an LTM DU configuration based on reference signal resource configuration according to an embodiment.

[0028] FIG. 18 is a flowchart of a CU method for instructing a DU to generate an LTM DU configuration based on a sent LTM DU configuration according to an embodiment.

DETAILED DESCRIPTION OF THE DRAWINGS

[0029] Methods and devices described in this section embody techniques for preparing a UE and/or a corresponding DU of a BS for LTM based cell change while using TCI state configuration. Prior to discussing these techniques, an example wireless communication system 100 is introduced.

[0030] FIG. 1A depicts the wireless communication system 100 in which communication devices may implement the techniques discussed in this disclosure. The wireless communication system 100 includes a UE 102, a first BS 104, a second BS 106, and a core network (CN) 110. The UE 102 initially connects to the first BS 104. In some scenarios, the first BS 104 may perform an SN addition to configure the UE 102 to operate in dual connectivity (DC) with the first BS 104 and the second BS 106. The BSs 104 and 106 operate as an MN and an SN, respectively, for the UE 102.

[0031] In various configurations of the wireless communication system 100, the first BS 104 may be implemented as a master eNB (MeNB) or a master gNB (MgNB), and the second BS 106 may be implemented as a secondary gNB (SgNB). The UE 102 may communicate with the first BS 104 and the second BS 106 via the same RAT such as EUTRA or NR, or different RATs. When the first BS 104 is an MeNB and the second BS 106 is a SgNB, the UE 102 may be in EUTRA-NR DC (EN-DC) with the MeNB and the SgNB.

[0032] In some cases, an MeNB or an SeNB is implemented as an ng-eNB rather than an eNB. When the BS 104 is a Master ng-eNB (Mng-eNB) and the BS 106 is a SgNB, the UE 102 may be in next generation (NG) EUTRA-NR DC (NGEN-DC) with the Mng-eNB and the SgNB. When the BS 104 is an MgNB and the BS 106 is an SgNB, the UE 102 may be in NR-NR DC (NR-DC) with the MgNB and the SgNB. When the BS 104 is an MgNB and the BS 106 is a Secondary ng-eNB (Sng-eNB), the UE 102 may be in NR-EUTRA DC (NE-DC) with the MgNB and the Sng-eNB.

[0033] In the embodiments where the UE 102 hands over from the first BS 104 to the second BS 106, the BSs 104 and 106 operate as the source BS (S-BS) and a target BS (T-BS), respectively. The UE 102 may operate in DC with the first BS 104 and an additional BS (not shown in FIG. 1A), for example, prior to the handover. The UE 102 may continue to operate in DC with the second BS 106 and the additional BS or operate in single connectivity (SC) with the second BS 106, after completing the handover. The BSs 104 and 106 in this case operate as a source MN (S-MN) and a target MN (T-MN), respectively.

[0034] The CN 110 may be an evolved packet core (EPC) 111 or a fifth-generation core (5GC) 160, both of which are depicted in FIG. 1A. The first BS 104 may be an eNB supporting an S1 interface for communicating with the EPC 111, an ng-eNB supporting an NG interface for communicating with the 5GC 160, or a gNB that supports an NR radio interface as well as an NG interface for communicating with the 5GC 160. To directly exchange messages with each other during the embodiments discussed below, the BSs 104 and 106 may support an X2 or Xn interface. Among other components, the EPC 111 may include a Serving Gateway (SGW) 112, a Mobility Management Entity (MME) 114, and a Packet Data Network Gateway (PGW) 116. The SGW 112 is generally configured to transfer user-plane packets related to audio calls, video calls, Internet traffic, etc., and the MME 114 is configured to manage authentication, registration, paging, and other related functions. The PGW 116 provides connectivity from the UE to one or more external packet data networks, e.g., an Internet network and/or an Internet Protocol (IP) Multimedia Subsystem (IMS) network. The 5GC 160 includes a User Plane Function (UPF) 162 and an Access and Mobility Management (AMF) 164, and/or Session Management Function (SMF) 166. The UPF 162 is generally configured to transfer user-plane packets related to audio calls, video calls, Internet traffic, etc. The AMF 164 is configured to manage authentication, registration, paging, and other related functions. The SMF 166 is configured to manage PDU sessions.

[0035] As illustrated in FIG. 1A, the first BS 104 supports cell 124A (called serving cell in this disclosure), and the second BS 106 supports a cell 126. The cells 124A and 126 may partially overlap, so that the UE 102 may communicate in DC with the first BS 104 and the second BS 106, where one of the BSs 104 and 106 is an MN and the other is an SN. The first BS 104 may support additional cell(s) such as cells 124B and 124C, and the second BS 106 may support additional cell(s) (not shown in FIG. 1A). The cells 124A, 124B, and 124C may partially overlap, so that the UE 102 communicates with the first BS 104 using CA. The first BS 104 may operate cells 124A, 124B, and 124C via one or more transmit and receive points (TRPs). More particularly, when UE 102 is in DC with the first BS 104 and the second BS 106, one of the BSs 104 and 106 operates as an MeNB, an Mng-eNB, or an MgNB, and the other operates as an SgNB or an Sng-eNB.

[0036] In general, the wireless communication network 100 may include any suitable number of BSs supporting NR cells and/or EUTRA cells. More particularly, the EPC 111 or the 5GC 160 may be connected to any suitable number of BSs supporting NR cells and/or EUTRA cells. Although the examples below refer specifically to specific CN types (EPC,

5GC) and RAT types (5G NR and EUTRA), in general the techniques of this disclosure also may apply to other suitable radio access and/or core network technologies such as sixth generation (6G) radio access and/or 6G core network or 5G NR-6G DC.

[0037] With continued reference to FIG. 1A, the first BS 104 is equipped with processing hardware 130 that may include one or more general-purpose processors (e.g., CPUs) and a non-transitory computer-readable memory storing instructions that the one or more general-purpose processors execute. Additionally, or alternatively, the processing hardware 130 may include special-purpose processing units. The processing hardware 130 may include a PHY controller 132 configured to transmit data and control signal on physical downlink (DL) channels and DL reference signals with one or more user devices (e.g., UE 102) via one or more cells (e.g., cell(s) 124A, 124B, and/or 124C) and/or one or more TRPs. The PHY controller 132 is also configured to receive data and control signal on physical uplink (UL) channels and/or UL reference signals with the one or more user devices via one or more cells (e.g., cell(s) 124A, 124B, and/or 124C) and/or one or more TRPs. The processing hardware 130 may include a MAC controller 134 configured to perform MAC functions with one or more user devices. The MAC functions include a random access (RA) procedure, managing UL timing advance for the one or more user devices, and/or communicating UL/DL MAC PDUs with the one or more user devices. The processing hardware 130 may further include an RRC controller 136 configured to implement procedures and messaging at the RRC sublayer of the protocol communication stack. For example, the RRC controller 136 may be configured to support RRC messaging associated with handover procedures, and/or to support the necessary operations when the first BS 104 operates as an MN relative to an SN or as an SN relative to an MN. The second BS 106 may include processing hardware 140 that is similar to processing hardware 130. In particular, components 142, 144, and 146 may be similar to the components 132, 134, and 136, respectively.

[0038] The UE 102 is equipped with processing hardware 150 that may include one or more general-purpose processors such as CPUs and non-transitory computer-readable memory storing machine-readable instructions executable on the one or more general-purpose processors, and/or special-purpose processing units. The PHY controller 152 is also configured to receive data and control signal on physical DL channels and/or DL reference signals with the first BS 104 or second BS 106 via one or more cells (e.g., the cell(s) 124A, 124B, 124C and/or 126) and/or one or more TRPs. The PHY controller 152 is also configured to transmit data and control signal on physical UL channels and/or UL reference

signals with the first BS 104 or second BS 106 via one or more cells (e.g., cell(s) 124A, 124B, 124C, and/or 126) and/or one or more TRPs. The processing hardware 150 in an example embodiment includes a MAC controller 154 configured to perform MAC functions with first BS 104 or second BS 106. For example, the MAC functions include a random access procedure, managing UL timing advance for the one or more user devices, and communicating UL/DL MAC PDUs with the first BS 104 or second BS 106. The processing hardware 150 may further include an RRC controller 156 to implement procedures and messaging at the RRC sublayer of the protocol communication stack.

[0039] In operation, the UE 102 in DC may use a radio bearer (e.g., a DRB or an SRB) that at different times terminates at MN 104 or the SN 106. The UE 102 may apply one or more security keys when communicating on the radio bearer, in the UL (from the UE 102 to a BS) and/or DL (from a BS to the UE 102) direction.

[0040] FIG. 1B depicts an example of a distributed configuration of a BS 170 (can be either the first BS 104, or the second BS 106, or both, or another BS). The BS 170 in this embodiment may include a centralized unit (CU) 172 and one or more distributed units (DUs) 174. The CU 172 is equipped with processing hardware that may include one or more general-purpose processors such as CPUs and non-transitory computer-readable memory storing machine-readable instructions executable on the one or more general-purpose processors, and/or special-purpose processing units. In one example, the CU 172 is equipped with processing hardware 130. In another example, the CU 172 is equipped with processing hardware 140. The processing hardware 140 in an embodiment includes an SN RRC controller 142 configured to manage or control one or more RRC configurations and/or RRC procedures when the second BS 106 operates as an SN. The DU 174 is also equipped with processing hardware that may include one or more general-purpose processors such as CPUs and non-transitory computer-readable memory storing machine-readable instructions executable on the one or more general-purpose processors, and/or special-purpose processing units. In some embodiments, the processing hardware includes a MAC controller configured to manage or control one or more MAC operations or procedures (e.g., a random access procedure) and a radio link control (RLC) controller configured to manage or control one or more RLC operations or procedures when the second BS 106 operates as an MN or an SN. The process hardware may further include a physical layer controller configured to manage or control one or more physical layer operations or procedures.

[0041] FIG. 2A illustrates, in a simplified manner, an example protocol stack 200 which the UE 102 may use to communicate with an eNB/ng-eNB 201A or a gNB/en-gNB 201B (e.g., one or more of the BSs 104, 106).

[0042] In the example stack 200, a physical layer (PHY) 202A of EUTRA provides transport channels to the EUTRA MAC sublayer 204A, which in turn provides logical channels to the EUTRA RLC sublayer 206A. The EUTRA RLC sublayer 206A in turn provides RLC channels to an EUTRA PDCP sublayer 208 and, in some cases, to an NR PDCP sublayer 210. Similarly, the NR PHY 202B provides transport channels to the NR MAC sublayer 204B, which in turn provides logical channels to the NR RLC sublayer 206B. The NR RLC sublayer 206B in turn provides data transfer services to the NR PDCP sublayer 210. The NR PDCP sublayer 210 in turn may provide data transfer services to Service Data Adaptation Protocol (SDAP) 212 or a radio resource control (RRC) sublayer (not shown in FIG. 2A). The UE 102, in some embodiments, supports both the EUTRA and the NR stack as shown in FIG. 2A, to support handover between EUTRA and NR BSs and/or to support DC over EUTRA and NR interfaces. Further, as illustrated in FIG. 2A, UE 102 may support layering of NR PDCP 210 over EUTRA RLC 206A, and SDAP sublayer 212 over the NR PDCP sublayer 210.

[0043] The EUTRA PDCP sublayer 208 and the NR PDCP sublayer 210 receive packets (e.g., from an IP layer, layered directly or indirectly over the PDCP layer 208 or 210) that may be referred to as service data units (SDUs), and output packets (e.g., to the RLC layer 206A or 206B) that may be referred to as protocol data units (PDUs). Except where the difference between SDUs and PDUs is relevant, this disclosure, for simplicity, refers to both SDUs and PDUs as “packets.”

[0044] On a control plane, the EUTRA PDCP sublayer 208 and the NR PDCP sublayer 210 may provide SRBs or RRC sublayer (not shown in FIG. 2A) to exchange RRC messages or NAS messages, for example. On a user plane, the EUTRA PDCP sublayer 208 and the NR PDCP sublayer 210 may provide DRBs to support data exchange. Data exchanged on the NR PDCP sublayer 210 may be SDAP PDUs, IP packets, or Ethernet packets.

[0045] FIG. 2B illustrates, in a simplified manner, an example protocol stack 250, which the UE 102 may use to communicate with a DU (e.g., DU 174) and a CU (e.g., CU 172). The radio protocol stack 200 is functionally split as shown by the radio protocol stack 250 in FIG. 2B. The CU at any of the BSs 104 or 106 may hold all the control and upper layer

functionalities (e.g., RRC 214, SDAP 212, and NR PDCP 210), while the lower layer operations (e.g., NR RLC 206B, NR MAC 204B, and NR PHY 202B) are delegated to the DU. To support connection to a 5GC, NR PDCP 210 provides SRBs to RRC 214, and NR PDCP 210 provides DRBs to SDAP 212 and SRBs to RRC 214.

[0046] The term network entity (NE) is introduced in this disclosure to be one of the first BS 104, second BS 106 in FIG. 1A, the BS 170 in FIG. 1B, the BSs 201A, 201B in FIG. 2A, or the units 174 or 172 in FIG. 2B). The NE communicates wirelessly with UE 102. While NE may be a BS, more generally, the term “network entity” stands for a wireless device with a well-defined network functionality (e.g., BS’s functionality is connecting UEs to the core network including managing communications to and from the UEs). NE and UE 102 may include additional functions and interfaces omitted from the figures in the interest of brevity.

[0047] The NE 170, which is schematically illustrated in FIG. 2C, may provide the functionality of an gNB (i.e., a 5G or 6G BS). NE’s functionality may be distributed across multiple entities (e.g., CU, DU, and a radio unit, RU). NE includes antennas, a Radio Frequency (RF) front end and a transceiver 282 for communicating with UE 102 and other UEs and NEs. NE’s antennas and RF front end may be tuned to one or more frequency bands (e.g., subcarriers), for example as defined by 3GPP LTE, 5G NR, and 6G communication standards and implemented by transceiver.

[0048] NE 170 further includes processor(s) 283 and computer-readable storage media (CRM) 284. Processor(s) 283 may include single or multiple-core processors, and CRM includes any suitable memory/storage except propagating signals. For example, memory/storage may include random-access memory (RAM), static RAM (SRAM), dynamic RAM (DRAM), non-volatile RAM (NVRAM), read-only memory (ROM), and/or flash memory. CRM 284 stores device data, which includes network scheduling data, radio resource management data, applications, and/or an operating system, which are executable by processor(s) to enable wireless communication with UE 102 as well as with other NEs and UEs.

[0049] CRM 284 also stores an L1 measurement configuration and LTM control-related executable instructions. NE also includes inter-BS interface and core-network interface. Inter-BS interface may be a standardized interface, such as an Xn and/or X2 interface, for exchanging user-plane and control-plane data with another NE (e.g., in case of a handover).

Core-network interface enables NE's user-plane data and control-plane information exchange with core network functions and/or entities.

[0050] In some embodiments, the NE's and the UE's L1 measurement and LTM execution may be implemented not only as software but also as hardware logic and/or circuitry.

[0051] Next, several scenarios are discussed in which the BS operating in the system of FIG. 1A transmits a configuration to the UE 102 and later activates a configuration for communication between the UE 102 and BS. The events presented in FIGs. 3-7B that are similar are labeled with similar reference numbers (e.g., event 316 is similar to event 416 of FIGs. 4A and 4B, event 516 of FIG. 5A, event 517 of FIG. 5B, event 616 of FIG. 6A, event 617 of FIG. 6B, event 716 of FIG. 7A, and event 717 of FIG. 7B; note that events yxx and zxx are similar, where y and z are associated with the figure number and thus, their description is omitted in later figures), with differences discussed below where appropriate. With the exception of the differences shown in the figures and discussed below, any of the alternative embodiments discussed with respect to a particular event (e.g., for messaging and processing) may apply to events labeled with similar reference numbers in other figures.

[0052] Referring first to FIG. 3, in a scenario 300, the first BS 104 includes a CU 172 and a DU 174, and the DU 174 operates the cell 124A (i.e., the serving cell). UE 102 initially communicates 302 with the DU 174 on the serving cell 124A using a serving DU configuration and communicates with the CU 172 via the DU 174, e.g., using a serving CU configuration. In other words, DU 174 is a serving DU that communicates with the UE 102. In some embodiments, the UE 102 communicates in CA with the DU 174 on the cell 124A and other cell(s) (e.g., cell 124D not shown in FIG. 1A) using the serving DU configuration. The DU 174 operates the other cell(s). In other embodiments, the UE 102 communicates with the DU 174 only on cell 124A. In some embodiments, the UE 102 communicates with the DU 174 on the cell 124A and/or other cell(s) via one or multiple TRPs. In some embodiments, cell 124A may be a PCell. In such cases, the other cell(s) include SCell(s) and/or additional cell(s) associated with the PCell or a SCell. In other embodiments, the cell 124A may be a SCell, and one of the other cell(s) is a PCell. In such cases, the rest? includes SCell(s) and/or additional cell(s) associated with the PCell or a SCell. In the following description, the first BS 104 may be the DU 174, the CU 172, or the DU 174 and CU 172.

[0053] In the event 302, the UE 102 may transmit UL PDUs and/or UL control signals to the first BS 104 on the cell 124A and/or other cell(s) via one or multiple TRPs. In some

embodiments, the UE 102 communicates UL PDUs and/or DL PDUs with the first BS 104 via radio bearers which may include SRBs and/or DRB(s). The first BS 104 may configure the radio bearers to the UE 102. In some embodiments, UL control signals include UL control information, channel state information, hybrid automatic repeat request (HARQ) acknowledgements (ACKs), HARQ negative ACKs, scheduling request(s) and/or sounding reference signal(s). Similarly, the UE 102 may receive DL PDUs and/or DL control signals from the first BS 104 on the cell 124A and/or other cell(s) via one or multiple TRPs. In some embodiments, the DL control signals include downlink control information (DCIs) and reference signals (e.g., synchronization signal block, channel state information reference signal(s) (CSI-RS(s)), and/or tracking reference signal(s)). The first BS 104 may transmit the DCIs on physical downlink control channel(s) (PDCCH(s)) monitored by the UE 102, on the cell 124A and/or other cell(s) via one or multiple TRPs.

[0054] In some embodiments, the serving DU configuration includes physical layer configuration parameters, MAC configuration parameters, and/or RLC configuration parameters. In some embodiments, the DU 174 may transmit these configuration parameters to the CU 172. The CU 172 generates one or more messages (e.g., RRC reconfiguration message(s)) including the configuration parameters and transmits one or more messages to the UE 102 via the DU 174. In other embodiments, the DU 174 transmits the configuration parameters to the UE 102 directly. In some embodiments, the serving DU configuration is *CellGroupConfig* IE defined in 3GPP TS 38.331. In other embodiments, the serving DU configuration includes configuration parameters in the *CellGroupConfig* IE. In some embodiments, the serving CU configuration includes PDCP configuration parameters, measurement configuration parameters, and/or radio bearer configuration parameters. In some embodiments, the serving CU configuration includes a *MeasConfig* IE and/or a *RadioBearerConfig* IE defined in 3GPP TS 38.331 or includes configuration parameters in the *MeasConfig* IE and/or *RadioBearerConfig* IE. In some embodiments, the serving DU configuration includes a *CSI-MeasConfig* IE or configuration parameters for channel state information (CSI) measurement and reporting. In other embodiments, the serving CU configuration includes a *CSI-MeasConfig* IE or configuration parameters for CSI measurement and reporting. In some embodiments, UE 102 receives the serving CU configuration or the configuration parameters in the serving CU configuration from the CU 172 via the DU 174. In other embodiments, the UE 102 receives a portion of the serving CU

configuration and/or a portion of the serving DU configuration from a BS other than the first BS 104 and the remaining portion of these configuration parameters from the first BS 104.

[0055] While communicating with the first BS 104, the UE 102 may transmit 304 at least one measurement report to the DU 174. In some embodiments, the at least one measurement report includes Layer 1 (L1) measurement report(s) and/or Layer 3 (L3) measurement report(s) for at least one serving cell of the UE 102 and/or at least one non-serving cell. For each of the L3 measurement report(s), the DU 174 transmits 306 a DU-to-CU message including the L3 measurement report to the CU 172. In some embodiments, the DU-to-CU message(s) of the event 306 is/are F1 application protocol (F1AP) message(s) (e.g., *UL RRC Message Transfer* message(s)). In some embodiments, the DU 174 does not transmit or refrains from transmitting the L1 measurement report(s) to the CU 172. The at least one serving cell includes the cell 124A and/or other cell(s), and the at least one non-serving cell includes the cell 124B and/or cell 124C. In some embodiments, the serving DU configuration or the serving CU configuration includes at least one measurement configuration. In some embodiments, the UE 102 receives one or more RRC messages (e.g., *RRCReconfiguration* message(s)) including the at least one measurement configuration from the CU 172 via the DU 174 in the event 302. In accordance with the at least one measurement configuration, the UE 102 performs measurements and transmits 304 the at least one measurement report to the DU 174. In some embodiments, the at least one measurement configuration includes L3 measurement configuration(s) (e.g., *MeasConfig* IE(s)) and/or L1 measurement configuration(s). The L1 measurement configuration(s) (e.g., *CSI-MeasConfig* IE(s)) may include L1 measurement resource configuration(s) and/or L1 measurement reporting configuration(s). The L1 measurement resource configuration(s) may configure reference signal(s) and/or resources of the reference signal(s) for the UE 102 to measure and obtain L1 measurement results. In some embodiments, the reference signal(s) includes CSI-RS(s) and/or SSB(s). For example, the L1 measurement resource configuration(s) is/are *CSI-ResourceConfig* IE(s). In another example, the L1 measurement reporting configuration(s) configures way(s) the UE 102 uses to transmit L1 measurement results/reports. For example, the L1 measurement report configuration(s) is/are *CSI-ReportConfig* IE(s). For example, UE 102 transmits the L3 measurement report(s) to the CU 172 via the DU 174 in accordance with the L3 measurement configuration(s). UE 102 transmits the L1 measurement report(s) to the DU 174 in accordance with the L1 measurement configuration(s) or L1 measurement

reporting configuration(s). In one embodiment, the DU 174 does not transmit the L1 measurement report(s) to the CU 172.

[0056] In some embodiments, the L1 measurement configuration(s) are new RRC IE(s) for a lower layer triggered mobility (LTM). In some embodiments, the L1 measurement resource configuration(s) are new RRC IE(s) defined in 3GPP TS 38.331 for the LTM. In some embodiments, the L1 measurement reporting configuration(s) are new RRC IE(s) defined in 3GPP TS 38.331 for the LTM. In some embodiments, each of the L1 measurement reporting configuration(s) may include a trigger event configuration configuring a trigger event to trigger the UE 102 to transmit an L1 measurement report. If UE 102 detects the trigger event, the UE 102 transmits an L1 measurement report to the DU 174.

[0057] In some embodiments, (each of) the L1 measurement report(s) may include at least one L1 measurement result. In some embodiments, the at least L1 measurement result includes at least one L1-reference signal received power (L1-RSRP) value and/or at least one L1- Signal to Interference Noise Ratio (L1-SINR) value. For each of the L1 measurement report(s), the UE 102 transmits a PUCCH transmission including the L1 measurement report to the DU 174, in some embodiments. That is, UE 102 transmits the each of the L1 measurement report(s) on a PUCCH to the DU 174. In other embodiments, for each of the L1 measurement report(s), the UE 102 transmits a PUSCH transmission including the L1 measurement report to the DU 174. That is, UE 102 transmits each of the L1 measurement report(s) on a PUSCH to the DU 174. In yet other embodiments, the UE 102 transmits a portion of the L1 measurement report(s) on PUCCH(s) and the rest of the L1 measurement report(s) on physical UL shared channel(s) (PUSCH(s)) to the DU 174. That is, for each of the portion of the L1 measurement report(s), the UE 102 transmits a PUCCH transmission including the L1 measurement report to the DU 174, and for each of the rest of the L1 measurement report(s), the UE 102 transmits a PUSCH transmission including the L1 measurement report to the DU 174. In some embodiments, each of the L1 measurement report(s) is part of channel state information (CSI) (i.e., a CSI component) or CSI. In some embodiments, the UE 102 may include other CSI component(s) in (each of) the PUCCH transmission(s) and/or PUSCH transmission(s) described above. In one embodiment, the other CSI component(s) include such as a channel quality indicator (CQI), a Precoding Matrix Indicator (PMI), a CSI-RS Resource Indicator (CRI), a Synchronization Signal (SS)/Physical Broadcast Channel (PBCH) Resource Block Indicator (SSBRI), a Layer Indicator

(LI), and/or a Rank Indicator (RI). In some embodiments, UE 102 does not transmit the L1 measurement report(s) as an RRC message(s) to the DU 174.

[0058] In some embodiments, each of the L3 measurement report(s) may include at least one L3 measurement result. In some embodiments, the at least one L3 measurement result includes at least one RSRP (value) and/or at least one SINR (value). In one embodiment, the UE 102 transmits each of the L3 measurement report(s) on a PUSCH to the CU 172 via the DU 174. In some embodiments, each of the L3 measurement report(s) may be an RRC message (e.g., *MeasurementReport* message). In some embodiments, each of the L3 measurement configuration(s) includes a particular measurement identity (e.g., *measId*) and each of the L3 measurement report(s) includes a particular measurement identity in a particular L3 measurement configuration. When the CU 172 receives a L3 measurement report including a measurement identity and a L3 measurement result from the UE 102 via the DU 174, the CU 172 may determine that the L3 measurement report is associated with an L3 measurement configuration identified by the measurement identity.

[0059] In some alternative embodiments, for each of the at least one measurement report (e.g., L1 measurement report(s)), the UE 102 transmits 304 a MAC control element (CE) including the measurement report to the DU 174. To transmit the MAC CE(s), the UE 102 generates one or more MAC PDUs, each including one or more of the MAC CE(s) to the DU 174 in the event 304.

[0060] In some embodiments, the UE 102 performs measurements on one or more reference signals in accordance with the at least one measurement configuration. The one or more reference signals may include one or more Synchronization Signal (SS)/ Physical Broadcast Channel (PBCH) Resource Blocks (SSBs), and/or one or more CSI-RSs. UE 102 generates the at least one L1 measurement result and/or at least one L3 measurement result from the measurements. The DU 174 transmits the one or more reference signals on the cell 124A and other cell(s) (e.g., the cell 124B, the cell 124C and/or cell(s) not shown in FIG. 1A).

[0061] After (e.g., in response to) receiving one or some of the at least one measurement report from the UE 102, the first BS 104 (i.e., the CU 172 or DU 174) determines to prepare a first cell (e.g., the cell 124B), other than the serving cell, for LTM UE 102 switch. Note that the term “prepare a cell” is used in this disclosure to mean prepare a DU associated with the first cell, or prepare a CU associated with the first cell, or prepare the CU and DU associated

with the first cell. In some embodiments, the first BS 104 determines to prepare the first cell for the UE 102 because the at least one measurement report indicates that the first cell could be used by the first BS 104 to communicate with the UE 102. In some embodiments, the first BS 104 determines to prepare the first cell for the UE 102 because the at least one measurement report indicates that the first cell qualifies to be a candidate cell that could be used for communication with the UE 102. In some embodiments, if the L3 measurement report(s) indicates that signal strength and/or quality of the first cell is above a first predetermined threshold, i.e., it is better than strength and/or quality of the cell 124A, and/or is better than strength and/or quality of the cell 124A by a first predetermined threshold, the CU 172 determines to prepare the first cell for the UE 102 switch. In other embodiments, if the L1 measurement report(s) indicates that signal strength and/or quality of the first cell is above a first predetermined threshold (i.e., it is better than signal strength and/or quality of the cell 124A, and/or is better than signal strength and/or quality of the cell 124A by a first predetermined threshold), the DU 174 determines to prepare the first cell for the UE 102 switch. Thus, either the CU 172 or the DU 174 can prepare the first cell for the UE switch from the serving cell. Alternatively, the first BS 104 determines to prepare the first cell for the UE 102 regardless of whether a measure report is received from the UE 102 or not.

[0062] In the case that the CU 172 determines to prepare the first cell for LTM, the CU 172 transmits 308 a first CU-to-DU message to the DU 174 to prepare the first cell for the UE 102. In some embodiments, the CU 172 includes a cell identity (ID) of the first cell in the first CU-to-DU message to request the DU 174 to prepare the first cell for LTM for the UE 102. In some embodiments, the CU 172 includes a reference LTM DU configuration in the first CU-to-DU message. For example, the cell ID is cell global identity (CGI). In another example, the cell ID is a portion of the CGI. In yet another example, the cell ID is a physical cell ID (PCI). In response to the first CU-to-DU message, the DU 174 generates a first LTM DU configuration (referred to in this disclosure as LTM DU configuration 1) for the UE 102, which configures the first cell for LTM. The DU 174 then transmits 310 a first DU-to-CU message including the LTM DU configuration 1 to the CU 172 in response to the first CU-to-DU message. In some embodiments, the DU 174 may include the cell ID 1 together with the LTM DU configuration 1 in an IE of the first DU-to-CU message to indicate that the LTM DU configuration 1 is associated with the first cell (i.e., the cell ID 1). In the case that the DU 174 determines to prepare the first cell, the DU 174 initiates transmission of the first DU-to-CU message to the CU 172 instead of in response to a CU-to-DU message received from the

CU 172. In other words, either the DU 174 independently generates the LTM DU configuration 1 or the CU 172 instructs the DU 174 to generate the LTM DU configuration 1.

[0063] In some embodiments, the DU 174 includes, in the first DU-to-CU message, the cell ID of the first cell associated with the LTM DU configuration 1 to indicate that the LTM DU configuration 1 is configured for or associated with the first cell. The CU 172 identifies that the LTM DU configuration 1 is configured for or associated with the first cell. In some scenarios and embodiments, the CU 172 may include additional cell ID(s) (e.g., cell ID(s) 2, ..., N) in the first CU-to-DU message to prepare additional cell(s) (e.g., cell(s) 2, ..., N) for LTM for the UE 102, and the DU 174 includes additional LTM DU configuration(s) (e.g., LTM DU configuration(s) 2, ..., N), each configuring a particular cell of the additional cell(s), as described below. In such cases, the DU 174 includes, in the first DU-to-CU message, the additional cell ID(s) respectively associated with the additional LTM DU configuration(s) to indicate which LTM DU configuration is associated to which cell (ID). The cell(s) 1 and/or 2, ..., N are candidate cell(s).

[0064] In some embodiments, the CU 172 does not include a (reference) LTM DU configuration in the first CU-to-DU message. In such cases, the DU 174 generates a reference LTM DU configuration, generates the LTM DU configuration(s) 1 and/or 2, ..., N (i.e., non-reference LTM DU configuration(s)) based on the reference LTM DU configuration, and includes the reference LTM DU configuration in the first DU-to-CU message. In other embodiments, the CU 172 includes a reference LTM DU configuration in the first CU-to-DU message. In such cases, the DU 174 generates the LTM DU configuration(s) 1, and/or 2, ..., N, which are delta configuration(s) to augment the reference LTM DU configuration. In yet other embodiments, the CU 172 includes a reference LTM DU configuration (e.g., a first reference LTM DU configuration) in the first CU-to-DU message. In such cases, the DU 174 generates a reference LTM DU configuration (e.g., a second reference LTM DU configuration) replacing the first reference LTM DU configuration, generates the LTM DU configuration(s) 1 and/or 2, ..., N based on the second reference LTM DU configuration, and includes the second reference LTM DU configuration in the first DU-to-CU message.

[0065] In some embodiments, the reference LTM DU configuration includes physical layer configuration parameters, MAC configuration parameters, and/or RLC configuration parameters. In some embodiments, the reference LTM DU configuration is *CellGroupConfig* IE defined in 3GPP TS 38.331. In other embodiments, the reference LTM DU configuration

includes configuration parameters in the *CellGroupConfig* IE. In some embodiments, the reference LTM DU configuration includes a *CSI-MeasConfig* IE or configuration parameters for CSI measurement and/or reporting.

[0066] In some embodiments, the reference LTM DU configuration is different from the serving DU configuration. In some embodiments, a portion of the reference LTM DU configuration is the same as a portion of the serving DU configuration and the rest of the reference LTM DU configuration is different from the rest of the serving DU configuration. In other embodiments, the reference LTM DU configuration is the same as the serving DU configuration.

[0067] After receiving the first DU-to-CU message, the CU 172 generates a RRC reconfiguration message (e.g., an *RRCReconfiguration* message) including the LTM DU configuration 1 and transmits 316 a second CU-to-DU message including the RRC reconfiguration message to the DU 174. In some embodiments, the CU 172 includes the reference LTM DU configuration in the RRC reconfiguration message sent in step 316. In other embodiments, the CU 172 does not include a/the reference LTM DU configuration in the RRC reconfiguration message 316. In some embodiments, if the CU 172 transmits the reference LTM DU configuration to the UE 102 during event 302, the CU 172 does not include the reference LTM DU configuration in the RRC reconfiguration message 316. In other embodiments, if the CU 172 receives the reference LTM DU configuration from the DU 174, the CU 172 includes the LTM DU configuration in the RRC reconfiguration message 316. Otherwise, if the CU 172 does not receive a reference LTM DU configuration from the DU 174, the CU 172 does not include the reference LTM DU configuration in the RRC reconfiguration message 316.

[0068] In some embodiments, the CU 172 includes the LTM DU configuration 1 and/or the LTM CU configuration 1 in a first container (e.g., a field/IE) and includes the first container (e.g., LTM configuration (e.g., LTM-Config IE)) in the RRC reconfiguration message of the events 316 and 318. In such cases, the CU 172 generates the first container. The first container is to indicate the UE 102 not to immediately apply the LTM DU configuration 1 and/or the LTM CU configuration 1. In some scenarios or embodiments, the UE 102 receives an RRC reconfiguration message (e.g., the RRC reconfiguration message of the event 318) including a configuration (e.g., the LTM DU configuration 1). If the configuration is included in the first container, the UE 102 refrains from immediately

applying the configuration. Otherwise, if the configuration is not included in the first container, the UE 102 may immediately apply the configuration. In some embodiments, the first container includes a first addition or modification list (e.g., *ltn-ConfigToAddModList* field, *LTM-ConfigToAddModList* IE, *ltn-CandidateConfigToAddModList* field, or *LTM-CandidateConfigToAddModList* IE). The CU 172 includes the LTM DU configuration 1 and/or the LTM CU configuration 1 in a first element (referred to herein after as element 1) of the first addition or modification list. For example, element 1 may be an addition or modification IE (*ltn-ConfigToAddMod* field, *LTM-ConfigToAddMod* IE, *ltn-CandidateConfigToAddMod* field, or *LTM-CandidateConfigToAddMod* IE). When the UE 102 receives the first addition or modification list, the UE 102 may store the first addition or modification list, e.g., as a variable in its RAM. In other alternative embodiments, the DU 174 generates the first container and includes the first container in the first DU-to-CU message. In yet other alternative embodiments, the DU 174 generates element 1 and includes element 1 in the first DU-to-CU message.

[0069] In some embodiments, the CU 172 includes an LTM CU configuration 1 in the RRC reconfiguration message 316, the first container or the element 1, where the LTM CU configuration 1 is associated with the LTM DU configuration 1. To associate the LTM CU configuration 1 with the LTM DU configuration 1, the CU 172 may include the LTM CU configuration 1 and the LTM DU configuration in element 1. In some embodiments, the CU 172 includes LTM CU configuration(s) 2, ..., N in the RRC reconfiguration message 316 or the second container, where the LTM CU configuration(s) 2, ..., N associated with the LTM DU configuration(s) 2, ..., N, respectively. To associate the LTM CU configuration(s) 2, ..., N with the LTM DU configuration(s) 2, ..., N, the CU 172 may include the LTM CU configuration(s) 2, ..., N and the LTM DU configuration(s) in the element(s) 2, ..., N, respectively. In other embodiments, the CU 172 includes, in the element(s) 2, ..., N, the LTM CU configuration(s) 2, ..., N associated with the LTM DU configuration(s) 2, ..., N, respectively. Alternatively, the CU 172 does not include, in the RRC reconfiguration message 316, LTM CU configuration(s) for some or all of the LTM DU configuration 1 and/or LTM DU configuration(s) 2, ..., N.

[0070] After receiving the RRC reconfiguration message 316, the DU 174 transmits 318 the RRC reconfiguration message to UE 102. In response, the UE 102 transmits 320 a RRC reconfiguration complete message (e.g., an *RRCReconfigurationComplete* message) to the DU 174, which in turn transmits 322 a second DU-to-CU message including the RRC

reconfiguration complete message to the CU 172. In some embodiments, the CU 172 performs security protection (e.g., integrity protection and/or encryption) on the RRC reconfiguration message. For example, the CU 172 generates a message authentication code for integrity (MAC-I) for the RRC reconfiguration message, encrypts the RRC reconfiguration message and the MAC-I to obtain an encrypted RRC reconfiguration message and an encrypted MAC-I, and transmits a PDCP PDU including the encrypted RRC reconfiguration message and encrypted MAC-I to the UE 102 via the DU 174 in the events 316 and 318. When the UE 102 receives the PDCP PDU from the CU 172 via the DU 174 (i.e., events 316 and 318), the UE 102 decrypts the encrypted RRC reconfiguration and encrypted MAC-I to obtain the RRC reconfiguration message and MAC-I and verifies whether the MAC-I is valid. If the UE 102 verifies the MAC-I is invalid, the UE 102 discards or ignores the RRC reconfiguration message. In some embodiments, the UE 102 may perform a RRC connection reestablishment procedure in response to the invalid MAC-I. Otherwise, if the UE 102 verifies the MAC-I is valid, the UE 102 may process the RRC reconfiguration. The UE 102 refrains from applying (i.e., executing) the LTM DU configuration 1 until receiving a LTM command activating the LTM DU configuration 1 (e.g., events 330, 350, 398, 380, 430, or 450).

[0071] The events 308 (optional) and 310 are collectively referred to in FIG. 3 as an LTM preparation procedure 390 (also as a first procedure). The events 316, 318, 320, and 322 are collectively referred to in FIG. 3 as a LTM configuration delivery procedure 394.

[0072] In some embodiments, the first CU-to-DU message is a *UE Context Modification Request* message, and the first DU-to-CU message is a *UE Context Modification Response* message or *UE Context Modification Required* message. In the case of the *UE Context Modification Required* message, the CU 172 may transmit a *UE Context Modification Confirm* message to the DU 174 in response to *UE Context Modification Required* message. In some embodiments, the second CU-to-DU message is a *DL RRC Message Transfer* message. In other embodiments, the second CU-to-DU message is a *UE Context Modification Request* message, and the DU 174 may transmit a second DU-to-CU message (e.g., *UE Context Modification Response* message) to the CU 172 in response to the second CU-to-DU message.

[0073] In some embodiments, the CU 172 may include a reference LTM CU configuration in the RRC reconfiguration message 316 or the first container. In some embodiments, the CU

172 might generate the LTM CU configuration 1 (i.e., non-reference LTM CU configuration) as a delta configuration to augment the reference LTM CU configuration. Similarly, the CU 172 might generate some or all of the LTM CU configuration(s) 2, ..., N as delta configuration(s) to augment the reference LTM CU configuration. Alternatively, in the RRC reconfiguration message 316 or the first container, the CU 172 includes the reference LTM CU configuration and does not include a non-reference LTM CU configuration. In some embodiments, the CU 172 includes the reference LTM CU configuration and/or the reference LTM DU configuration in an additional container (e.g., reference LTM configuration) and include the additional container in the RRC reconfiguration message 316.

[0074] In some embodiments, the reference LTM CU configuration is different from the serving CU configuration. In some embodiments, a portion of the reference LTM CU configuration is the same as a portion of the serving CU configuration and the rest of the reference LTM CU configuration is different from the rest of the serving CU configuration. In yet other embodiments, the reference LTM CU configuration is the same as the serving LTM CU configuration.

[0075] In some embodiments, the CU 172 includes, in the RRC reconfiguration message, a first LTM ID (referred to herein after as ID 1) for identifying the LTM DU configuration 1 or the element 1. In some embodiments, the CU 172 includes the ID 1 in the first container or element 1. In some embodiments, the CU 172 assigns the ID 1.

[0076] In some embodiments, the CU 172 may transmit the ID 1 to the DU 174, and the DU 174 associates the ID 1 with the LTM DU configuration 1. In some embodiments, in the first CU-to-DU message, the CU 172 includes the ID 1 and indicates the ID 1 is associated with the LTM DU configuration 1. In other embodiments, after receiving the first DU-to-CU message, the CU 172 transmits 312 a third CU-to-DU message including the ID 1 to the DU 174 instead of including the ID 1 in the first CU-to-DU message. In some embodiments, in the third CU-to-DU message, the CU 172 may include the LTM DU configuration 1 and the ID 1 and indicate the association between the ID 1 and LTM DU configuration 1. Thus, the DU 174 may directly associate the ID 1 with the LTM DU configuration 1. In other embodiments, in the third CU-to-DU message, the CU 172 may include the cell ID 1 and the ID 1 (i.e., the first LTM ID) and indicate the association between the cell ID 1 and the ID 1. Thus, the DU 174 may associate the ID 1 with the LTM DU configuration 1, based on the association between the cell ID 1 and the ID 1 and the association between the cell ID 1 and

the LTM DU configuration 1. In yet other embodiments, in the third CU-to-DU message, the CU 172 may include the LTM DU configuration 1, the cell ID 1, and/or the ID 1 and indicate the association between the ID 1, LTM DU configuration 1, and/or the cell ID 1. In some embodiments, the DU 174 may transmit 314 a third DU-to-CU message to the CU 172 in response to the third CU-to-DU message. In some embodiments, the third CU-to-DU message and third DU-to-CU message are UE Context Modification Request message and UE Context Modification Response message. The events 312 (optional) and 314 (optional) are collectively referred to in FIG. 3 as a LTM ID assignment procedure 392 or a second procedure. In other embodiments, the CU 172 may include the ID 1, the cell ID 1, and/or the LTM DU configuration 1 in the second CU-to-DU message as described above. Thus, the third CU-to-DU message may be omitted.

[0077] In the case that the CU 172 includes the ID 1 in the first CU-to-DU message, the DU 174 may include the ID 1 in the LTM DU configuration 1, first container, or element 1. Alternatively, DU 174 does not include the ID 1 in the LTM DU configuration 1, first container and/or element 1.

[0078] In some embodiments, the CU 172 includes the reference LTM DU configuration in the first container. For example, the CU 172 includes the reference LTM DU configuration in a field of the first container, different from a field of the first container including the LTM DU configuration 1. In other embodiments, the CU 172 includes the reference LTM DU configuration in the RRC reconfiguration message 316 and outside the first container. For example, the CU 172 generates a third container (e.g., a field/IE) to include the first container and the reference LTM DU configuration and includes the third container in the RRC reconfiguration message 316. In yet other embodiments, DU 174 includes the reference LTM DU configuration in the first container. For example, DU 174 includes the reference LTM DU configuration in a field of the first container, different from a field of the first container including the LTM DU configuration 1. In yet other embodiments, the DU 174 generates a fourth container (e.g., a field/IE) to include the first container and the reference LTM DU configuration and includes the fourth container in the first DU-to-CU message 310. In such cases, CU 172 includes the fourth container in the RRC reconfiguration message 316. Alternatively, the CU 172 retrieves the reference LTM DU configuration and the LTM DU configuration 1 from the fourth container and includes the reference LTM DU configuration and the LTM DU configuration 1 as described above.

[0079] In some embodiments, neither the CU 172 nor the DU 174 assign an ID to identify the reference LTM DU configuration. In some embodiments, neither the CU 172 nor the DU 174 assign an ID to identify the reference LTM CU configuration.

[0080] In some embodiments, the LTM DU configuration 1 includes a plurality of configuration parameters for the UE 102 to communicate with the DU 174 on the first cell. In some embodiments, the plurality of configuration parameters includes physical layer configuration parameters (e.g., *PhysicalCellGroupConfig* IE), MAC layer configuration parameters (e.g., *MAC-CellGroupConfig* IE) and/or RLC configuration parameters (e.g., *RLC-BearerConfig* IE(s)). In some further embodiments, the plurality of configuration parameters includes a special cell configuration (e.g., *SpCellConfig* IE) and/or one or more SCell configurations (e.g., *SCellConfig* IE(s)). In some embodiments, the LTM DU configuration 1 is *CellGroupConfig* IE defined in 3GPP TS 38.331. In other embodiments, the LTM DU configuration 1 includes configuration parameters in the *CellGroupConfig* IE.

[0081] In some embodiments, the LTM CU configuration 1 includes PDCP configuration parameters, measurement configuration parameters, and/or radio bearer configuration parameters. In some embodiments, the LTM CU configuration 1 includes a *MeasConfig* IE and/or a *RadioBearerConfig* IE defined in 3GPP TS 38.331 or includes configuration parameters in the *MeasConfig* IE and/or *RadioBearerConfig* IE. In some embodiments, the LTM DU configuration 1 includes L1 measurement configuration 1 (e.g., a *CSI-MeasConfig* IE) and/or at least one transmission configuration indicator (TCI) state configuration. In other embodiments, the LTM CU configuration 1 includes the L1 measurement configuration and/or the TCI state configuration(s) 1. In some embodiments, the L1 measurement configuration includes at least one reference signal (RS) resource configuration 1 and/or at least one report configuration 1. In some embodiments, the RS resource configuration(s) 1 configures one or more RSs or one or more RS resources associated with the cell 1. The RS(s) includes SSB(s) and/or CSI-RS(s). The RS resource(s) includes SSB resource(s) and/or CSI-RS resource(s). In some embodiments, each of the RS resource configuration(s) 1 includes an RS resource configuration ID. In some embodiments, the RS resource configuration(s) 1 is/are (similar to) *CSI-ResourceConfig* IE(s). In some embodiments, the report configuration(s) 1 configures one or more UL resources (e.g., PUCCH resources or PUSCH resources) on cell 1 (i.e., the first cell) for the UE 102 to transmit measurement results. In some embodiments, each of the report configuration(s) 1 includes one or more RS resource configuration IDs identifying one or more RS resource configurations included in

the RS resource configuration(s) 1. In some embodiments, each of the TCI state configuration(s) 1 configures a TCI state that associates one or two DL RSs with a corresponding quasi-colocation (QCL) type. The DL RS(s) are associated with cell 1.

[0082] In some embodiments, the DU 174 includes the L1 measurement configuration 1 and/or the TCI state configuration(s) 1 in a serving DU configuration 1 (e.g., non-LTM DU configuration). In some embodiments, the DU 174 includes the serving DU configuration in the first DU-to-CU message. In other embodiments, the DU 174 transmits an additional DU-to-CU message including the serving DU configuration to the CU 172. In some embodiments, the additional DU-to-CU message is a *UE Context Modification Required* message. In some embodiments, the CU 172 includes the serving DU configuration 1 in the RRC reconfiguration message 316, 318. In other embodiments, the CU 172 transmits another RRC reconfiguration message including the serving DU configuration to the UE 102 via the DU 174.

[0083] In some embodiments, the DU 174 includes a random access configuration in the LTM DU configuration 1. In other embodiments, the DU 174 does not include a random access configuration in the LTM DU configuration 1. In some embodiments, if the cell 124A and first cell are not synchronized, the DU 174 determines to include the random access configuration in the LTM DU configuration 1. Otherwise, if cell 124A and first cell are synchronized, the DU 174 determines to not include the random access configuration in the LTM DU configuration 1. In other embodiments, if the DU 174 determines that the UE 102 has not synchronized in UL with the first cell, the DU 174 determines to include the random access configuration in the LTM DU configuration 1. Otherwise, if the DU 174 determines that the UE 102 has synchronized in UL with the first cell, the DU 174 determines to not include the random access configuration in the LTM DU configuration 1. If the LTM DU configuration 1 includes the random access configuration, the UE 102 performs the random access procedure in event 332 in accordance with the random access configuration, as described below. Otherwise, if the LTM DU configuration 1 does not include the random access configuration or indicates the UE 102 to skip a random access procedure in LTM, the UE 102 skips or refrains from performing the random access procedure of the event 332 in response to the LTM DU configuration 1 excluding the random access configuration.

[0084] In some embodiments, the DU 174 includes random access configuration parameters in the LTM DU configuration 1 and/or the reference LTM DU configuration

regardless of whether the cell 124A and first cell are synchronized or not. UE 102 performs the random access procedure in the event 332 in accordance with the random access configuration parameters, as described below.

[0085] In some embodiments, if the cell 124A and the first cell are synchronized, the DU 174 determines to include, in the LTM DU configuration 1, a first indication configuring the UE 102 not to perform a random access procedure on the first cell. Otherwise, if cell 124A and first cell are not synchronized, the DU 174 determines to not include the first indication in the LTM DU configuration 1. In other embodiments, if the DU 174 determines that the UE 102 has synchronized in UL with the first cell, the DU 174 determines to include the first indication in the LTM DU configuration 1. Otherwise, if the DU 174 determines that the UE 102 has not synchronized in UL with the first cell, the DU 174 determines to not include the first indication in the LTM DU configuration 1. If the LTM DU configuration 1 includes the first indication, the UE 102 skips, or refrains from performing the random access procedure of the event 332 in accordance with or in response to the first indication. Otherwise, if the LTM DU configuration 1 does not include the first indication, the UE 102 performs the random access procedure in accordance with the random access configuration in the event 332, in response to the LTM DU configuration 1 excluding the first indication, as described below.

[0086] In some embodiments, the DU 174 includes a reconfiguration with sync configuration (e.g., *ReconfigurationWithSync* IE) in the LTM DU configuration 1 or special cell configuration. In other embodiments, the DU 174 does not include a reconfiguration with sync configuration (e.g., *ReconfigurationWithSync* IE) in the LTM DU configuration 1 or special cell configuration. In some embodiments, if the cell 124A and first cell are not synchronized, the DU 174 determines to include the reconfiguration with sync configuration in the LTM DU configuration 1. Otherwise, if cell 124A and first cell are synchronized, the DU 174 determines to not include the reconfiguration with sync configuration in the LTM DU configuration 1. In other embodiments, if the DU 174 determines that the UE 102 has not synchronized in UL with the first cell, the DU 174 determines to include the reconfiguration with sync configuration in the LTM DU configuration 1. Otherwise, if the DU 174 determines that the UE 102 has synchronized in UL with the first cell, the DU 174 determines to not include the reconfiguration with sync configuration in the LTM DU configuration 1. In some embodiments, if the LTM DU configuration 1 includes the reconfiguration with sync configuration, the UE 102 performs the random access procedure in the event 332 as

described below, in response to or in accordance with the reconfiguration with sync configuration. Otherwise, if the LTM DU configuration 1 does not include the reconfiguration with sync configuration, the UE 102 skips, or refrains from performing the random access procedure of the event 332. In some embodiments, the DU 174 includes a cell ID (i.e., cell ID 1) of cell 1 (i.e., the first cell) in the LTM DU configuration 1. In one embodiment, the cell ID 1 may be a PCI. In another embodiment, the cell ID 1 is a CGI. In some embodiments, the cell ID 1 included in the LTM DU configuration 1 is a PCI, while the cell ID 1 included in the first CU-to-DU message is a CGI. In some further embodiments, the LTM DU configuration 1 includes a cell index 1 indexing the cell ID 1 or the first cell. Cell index 1 is not a cell ID. The cell index takes fewer bits than the cell ID. In some embodiments, the CU 172 sets the cell index 1 to a value and includes the cell index 1 in the first CU-to-DU message of the event 308.

[0087] In some embodiments, after (e.g., in response to) receiving one or some of the at least one measurement report of the event 304, the first BS 104 (i.e., the CU 172 or DU 174) determines to prepare additional cell(s) (i.e., cell(s) 2, ..., N) of the first BS 104 for LTM for the UE 102. In one embodiment, the first BS 104 determines to prepare the additional cell(s) for LTM for the UE 102 because the at least one measurement report indicates that the additional cell(s) could be used by the first BS 104 to communicate with the UE 102. The additional cell(s) may include the cell 124C and/or cell(s) other than the cells 124A, 124B and 124C. In some embodiments, if the L3 measurement report(s) indicates that signal strength and/or quality of a particular cell of the additional cell(s) is above a respective predetermined threshold and/or is better than the cell 124A, the CU 172 determines to prepare the particular cell for LTM for the UE 102. In other embodiments, if the L1 measurement report(s) indicates that signal strength and/or quality of a particular cell of the additional cell(s) is above a first predetermined threshold and/or is better than the cell 124A, the DU 174 determines to prepare the particular cell for LTM for the UE 102. In one embodiment, the respective predetermined threshold(s) for the additional cells may be different from the first predetermined threshold. In another embodiment, the respective predetermined threshold(s) for the additional cell(s) may be the same as the first predetermined threshold. In some embodiments, the respective predetermined thresholds for the additional cells may be the same or different. Alternatively, the first BS 104 determines to prepare the additional cell(s) for the UE 102 regardless of whether a measurement report is received from the UE 102 or not.

[0088] In the case that the CU 172 determines to prepare the additional cell(s), the CU 172 initiates and performs at least one additional LTM preparation procedure (LTM preparation procedure(s)) with the DU 174 to prepare the additional cell(s) for LTM, where each of the LTM preparation procedure(s) is similar to the procedure 390. In the case that the DU 174 determines to prepare the additional cell(s), the DU 174 initiates and performs at least one additional LTM preparation procedure (LTM preparation procedure(s)) with the CU 172 to prepare the additional cell(s) for LTM, where each of the LTM preparation procedure(s) is similar to the procedure 390.

[0089] In some embodiments, the CU 172 and DU 174 perform LTM preparation procedure(s) 2, ..., N to prepare the cell(s) 2, ..., N, respectively, similar to the procedure 390. The CU 172 may include the cell ID(s) 2, ..., N in CU-to-DU message(s) 2, ..., N in the LTM preparation procedure(s) 2, ..., N, respectively, similar to the first CU-to-DU message. In the LTM preparation procedure(s) 2, ..., N, the DU 174 generates LTM DU configuration(s) 2, ..., N configuring the cell(s) 2, ..., N and includes the LTM DU configuration(s) 2, ..., N in DU-to-CU message(s) 2, ..., N, respectively, as described for the LTM DU configuration 1. In the case that the DU 174 receives the CU-to-DU message(s) 2, ..., N, the DU-to-CU message(s) 2, ..., N responds to the CU-to-DU message(s) 2, ..., N, respectively. "N" is an integer larger than one. For example, "N" is 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16. In another example, the maximum value of "N" is 4, 8, 16, or 32. Examples and embodiments of the LTM DU configuration 1 may apply to the LTM DU configuration(s) 2, ..., N.

[0090] In other embodiments, the CU 172 and DU 174 perform a single LTM preparation procedure (i.e., the LTM preparation procedure 390) to prepare the cell(s) 1, 2, ..., N. In such cases, the DU 174 includes the LTM DU configuration(s) 1, 2, ..., N for the cell(s) 1, 2, ..., N, respectively in the first DU-to-CU message. In the first DU-to-CU message, the DU 174 may include the cell ID(s) 1, 2, ..., N, respectively, associated with the LTM DU configuration(s) 1, 2, ..., N to indicate that the LTM DU configuration(s) 1, 2, ..., N are configured for the cell ID(s) 1, 2, ..., N, respectively. In the case that the CU 172 determines to perform the LTM preparation procedure 390, the CU 172 includes the cell ID(s) 1, 2, ..., N in the first CU-to-DU message to request the DU 174 to prepare the cell(s) 1, 2, ..., N, respectively, for LTM.

[0091] After receiving the LTM DU configuration(s) 2, ..., N from the DU 174, the CU 172 may include the LTM DU configuration(s) 2, ..., N in the first container. In some embodiments, the CU 172 may include the LTM DU configuration(s) 2, ..., N in element(s) 2, ..., N, respectively, and includes the element(s) 2, ..., N in the first container. In some embodiments, the CU 172 includes, in the RRC reconfiguration message, LTM ID(s) (i.e., ID(s) 2, ..., N) for identifying the LTM DU configuration(s) 2, ..., N, respectively. In some embodiments, the CU 172 includes the ID(s) 2, ..., N in the first container. For example, the CU 172 may include the ID(s) 2, ..., N and LTM DU configuration(s) 2, ..., N in the element(s) 2, ..., N in the first addition or modification list.

[0092] In some embodiments, the CU 172 assigns the ID(s) 2, ..., N for the LTM DU configuration(s) 2, ..., N, respectively. In other embodiments, the CU 172 receives the ID(s) 2, ..., N from the DU 174 in the first DU-to-CU message of the procedure 390. In yet other embodiments, the CU 172 receives from the DU 174 the ID(s) 2, ..., N in the DU-to-CU message(s) 2, ..., N of the LTM preparation procedure(s) 2, ..., N, respectively.

[0093] In some embodiments, the CU 172 may perform an LTM ID assignment procedure with the DU 174 for each of the LTM DU configuration(s) 2, ..., N, similar to the procedure 392. In other embodiments, the CU 172 may include the ID(s) 2, ..., N and the LTM DU configuration(s) 2, ..., N in the third CU-to-DU message and indicate the association between the ID(s) 2, ..., N and the LTM DU configuration(s) 2, ..., N, respectively. Thus, the DU 174 may associate the LTM DU configuration(s) 2, ..., N with the ID(s) 2, ..., N, respectively. In yet other embodiments, the CU 172 may include the cell ID(s) 2, ..., N and the ID(s) 2, ..., N in the third CU-to-DU message and indicate the association between the cell ID(s) 2, ..., N and the ID(s) 2, ..., N, respectively. Thus, the DU 174 may associate the LTM DU configuration(s) 2, ..., N with the ID(s) 2, ..., N, respectively, based on the association between the cell ID(s) 2, ..., N and the ID(s) 2, ..., N and the association between the cell ID(s) 2, ..., N and the LTM DU configuration(s) 2, ..., N, respectively. In other embodiments, the CU 172 may include the ID(s) 2, ..., N, the cell ID(s) 2, ..., N and/or the LTM DU configuration(s) 2, ..., N in the second CU-to-DU message as described above. Thus, the third CU-to-DU message may be omitted. In yet other embodiments, the CU 172 may include the ID(s) 2, ..., N in the first CU-to-DU message and indicate the ID(s) 2, ..., N is/are respectively associated with the cell ID(s) 2, ..., N. In one embodiment, the DU 174 includes the ID(s) 2, ..., N in the LTM DU configuration(s) 2, ..., N. Thus, the CU 172 does

not include the ID(s) 2, ..., N in the RRC reconfiguration message, first container, and/or element(s) 2, ..., N.

[0094] In some alternative embodiments, the DU 174 assigns the ID(s) 2, ..., N. In some embodiments, the DU 174 includes the ID(s) 2, ..., N in the first DU-to-CU message of the procedure 390. In yet other embodiments, the DU 174 includes the ID(s) 2, ..., N in the DU-to-CU message(s) 2, ..., N of the LTM preparation procedure(s) 2, ..., N. The CU 172 may include the ID(s) 2, ..., N in the RRC reconfiguration message. In other embodiments, the DU 174 includes the ID(s) 2, ..., N in the LTM DU configuration(s) 2, ..., N. Thus, the CU 172 does not include an ID (e.g., LTM ID) identifying each of the LTM DU configuration(s) 2, ..., N in the RRC reconfiguration message, first container, and/or element 1 discussed above.

[0095] In some alternative embodiments, the CU 172 may generate a second container including the LTM DU configuration(s) 2, ..., N or element(s) 2, ..., N instead of using the first container. The CU 172 then transmits an additional RRC reconfiguration message including the second container to the UE 102 via the DU 174, substantially similar to the events 316 and 318. In response to this message, UE 102 transmits an additional RRC reconfiguration complete message to the CU 172 via the DU 174, similar to the events 320 and 322. In some embodiments, the second container may be a second addition or modification list (e.g., *ltm-ConfigToAddModList* field, *LTM-ConfigToAddModList* IE, *ltm-CandidateConfigToAddModList* field, or *LTM-CandidateConfigToAddModList* IE), and each of the element(s) 2, ..., N may be an addition or modification IE (e.g., *ltm-ConfigToAddMod* field, *LTM-ConfigToAddMod* IE, *ltm-CandidateConfigToAddMod* field, or *LTM-CandidateConfigToAddMod* IE). When the UE 102 receives the second addition or modification list, the UE 102 may store the second addition or modification list together with the first addition or modification list, e.g., as a variable in its RAM.

[0096] In some embodiments, the DU 174 includes cell ID(s) 2, ..., N in the LTM DU configuration(s) 2, ..., N to identify the cell(s) 2, ..., N, respectively. In one embodiment, each of the cell ID(s) 2, ..., N is a PCI. In some further embodiments, the LTM DU configuration(s) 2, ..., N includes cell index(es) 2, ..., N indexing the cell ID(s) 2, ..., N or the cell(s) 2, ..., N, respectively. In the case that the CU 172 prepares the cell(s) 2, ..., N for LTM in the procedure 390, the CU 172 may set the cell index(es) 2, ..., N to different value(s) and include the cell index(es) 2, ..., N in the first CU-to CU-to-DU message of the

event 308. In the case that the CU 172 prepares the cell(s) 2, ..., N in the additional LTM preparation procedure(s), the CU 172 may set the cell index(es) 2, ..., N to different values and include the cell index(es) 2, ..., N in CU-to-DU message(s) of the additional LTM preparation procedure(s). The CU 172 sets the cell index(es) 1, ..., N to different values. In some embodiments, the cell ID(s) 1, ..., N in the LTM DU configuration(s) 1, ..., N are different from the cell ID(s) 1, ..., N in the CU-to-DU message(s) described above.

[0097] In some embodiments, each of the LTM DU configuration(s) 1, ..., N includes physical configuration parameters, MAC configuration parameters, RLC configuration parameters and/or L1 measurement configuration(s). In some embodiments, each of the LTM DU configuration(s) 1, ..., N may be a *CellGroupConfig* IE as defined in 3GPP TS 38.331. In other embodiments, each of the LTM DU configuration(s) 1, ..., N include configuration parameters included in a *CellGroupConfig* IE as defined in 3GPP TS 38.331. In some further embodiments, the plurality of configuration parameters in each of the LTM DU configuration(s) include a particular special cell configuration (e.g., *SpCellConfig* IE) and/or one or more SCell configurations (e.g., *SCellConfig* IE(s)). In some embodiments, the LTM DU configuration(s) 1, ..., N are *CellGroupConfig* IE(s) defined in 3GPP specification 38.331. In other embodiments, the LTM DU configuration(s) 1, ..., N include configuration parameters in the *CellGroupConfig* IE.

[0098] In some embodiments, the CU 172 may include one or more additional LTM CU configurations in at least one of the element(s) 2, ..., N, the first container, or the second container. Each of the additional LTM CU configurations are associated with a particular LTM DU configuration of the LTM DU configuration(s) 2, ..., N. Examples and embodiments of the additional LTM CU configurations are similar to the LTM CU configuration 1.

[0099] In some embodiments, the CU 172 determines to release the LTM DU configuration M of the LTM DU configuration(s) 1, ..., N (or the element M of the element(s) 1, ..., M, with $1 \leq M \leq N$). In response to this determination, the CU 172 transmits an RRC reconfiguration message to the UE 102 via the DU 174 to instruct the UE 102 to release the LTM DU configuration M or element M. In one embodiment, the CU 172 generates a release list including the ID (i.e., LTM ID) M for releasing the LTM DU configuration M or element M and includes the release list in the RRC reconfiguration message. In response to the RRC reconfiguration message, UE 102 releases the LTM DU

configuration M or element M and transmits an RRC reconfiguration complete message to the CU 172 via the DU 174. In response to this determination, the CU 172 transmits a CU-to-DU message to the DU 174 to instruct the DU 174 to release the LTM DU configuration M. To instruct the DU 174 to release the LTM DU configuration M, the CU 172 may include the cell ID M or the ID (i.e., LTM ID) M in a release indication (e.g., a field or IE) in the CU-to-DU message. In response, the DU 174 releases the LTM DU configuration M and transmits a DU-to-CU message to the CU 172. In some embodiments, the CU-to-DU message and DU-to-CU message are a UE Context Modification Request message and a UE Context Modification Response message, respectively.

[0100] In other embodiments, DU 174 determines to release the LTM DU configuration K. In response to this determination, the DU 174 transmits a DU-to-CU message to the CU 172 to release the LTM DU configuration K. To indicate the LTM DU configuration K is released, the DU 174 may include the cell ID K or the ID (i.e., LTM ID) K in a release indication (e.g., a field or IE) in the DU-to-CU message, with $1 \leq K \leq N$. After (e.g., in response to) receiving the DU-to-CU message, the CU 172 generates a release list including the ID (i.e., LTM ID) K to release the LTM DU configuration K or element K and transmits an RRC reconfiguration message including the release list to the UE 102 via the DU 174. In response, the UE 102 releases the LTM DU configuration K or element K and transmits a RRC reconfiguration complete message to the UE 102 via the DU 174. The CU 172 may transmit a CU-to-DU message to the DU 174 in response to the DU-to-CU message. In some embodiments, the DU-to-CU message and CU-to-DU message are a UE Context Modification Required message and a UE Context Modification Confirm message, respectively.

[0101] After receiving the RRC reconfiguration in event 318 or transmitting the RRC reconfiguration complete message in event 320, the UE 102 transmits 324 at least one measurement report to the DU 174, similar to the event 304. In some embodiments, the DU 174 may transmit 326 a DU-to-CU message including the at least one measurement report to the CU 172, similar to the event 306. In other embodiments, the DU 174 does not transmit the at least one measurement report to the CU 172. In some embodiments, the at least one measurement report of the event 324 includes L1 measurement report(s) or L3 measurement report(s), as described above for the event 304. In some embodiments, the UE 102 transmits 324 the at least one measurement report on PUCCH(s) and/or PUSCH(s) to the DU 174, similar to the event 304. In other embodiments, the UE 102 transmits 324 at least one MAC

CE including the at least one measurement report to the DU 174, similar to the event 304. In some embodiments, UE 102 does not transmit the L1 measurement report(s) as an RRC message(s) to the DU 174.

[0102] In some embodiments, UE 102 transmits 324 the at least one measurement report to DU 174 in accordance with at least one measurement configuration. The at least one measurement configuration configures the UE 102 to perform measurements and report measurement results. The CU 172 transmits the at least one measurement configuration to the UE 102 via the DU 174. For example, the CU 172 may transmit one or more RRC messages (e.g., *RRCReconfiguration* message(s)) including the at least one measurement configuration to the UE 102 via the DU 174 in the event 302 and/or 316 and/or after the event 306 or 316. The one or more RRC messages may or may not include the RRC reconfiguration message of event 316. In accordance with the at least one measurement configuration, the UE 102 performs measurements on one or more reference signals. The one or more reference signals may include one or more SSBs and/or one or more CSI-RSs. The UE 102 obtains the at least one L1 measurement result and/or at least one L3 measurement result from the measurements and includes the at least one L1 measurement result and/or at least one L3 measurement result in the at least measurement report of the event 324. The DU 174 transmits the one or more reference signals on the cell 124A, the cell 1 and/or the cell(s) 2, ..., N. The one or more reference signals may be CSI-RS(s) or SSB(s).

[0103] In some embodiments, the at least one measurement configuration includes L3 measurement configuration(s) (e.g., *MeasConfig* IE(s)), as described for the event 304. In other embodiments, the at least one measurement configuration includes or is L1 measurement configuration(s), as described above. In yet other embodiments, the L1 measurement configuration(s) may be *CSI-MeasConfig* IE(s) defined in 3GPP TS 38.331. The L1 measurement configuration(s) may include RS resource configuration(s) and/or report configuration(s). UE 102 transmits 324 the L1 measurement report(s) on UL resources (e.g., PUCCH resources or PUSCH resources) to the DU 174 in accordance with the report configuration(s). DU 174 receives the L1 measurement report(s) on the UL resources in accordance with the report configuration(s). In some embodiments, the report configuration(s) are or are similar to *CSI-ReportConfig* IE(s). In other embodiments, each of the report configuration(s) is a new RRC IE. In some embodiments, (each of) the report configuration(s) configures periodically reporting and/or event-triggered reporting of the L1 measurement result(s).

[0104] In some embodiments, the L1 measurement report(s) is/are CSI report(s). In other embodiments, the L1 measurement report(s) is/are MAC CE(s). In some embodiments, each of the measurement report(s) includes one or more RS resource indicators and/or one or more quantized measurement values. The UE 102 performs measurements on the RS(s) or the RS resource(s) in accordance with the RS resource configuration(s) and/or the report configuration(s) and obtains the quantized measurement values from the measurements. In some embodiments, the RS resource indicator(s) indicates the RS(s) or a RS resource(s) where the UE 102 perform measurements or obtains the quantized measurement values. In some embodiments, the RS resource indicator(s) includes one or more SSB resource indicators (SSBRI(s)) and/or one or more CSI-RS resource indicators (CRI(s)). The quantized measurement values might include one or more L1-RSRP values and/or one or more L1-SINR values.

[0105] In yet other embodiments, the at least one measurement configuration includes new-type measurement configuration(s) (e.g., LTM measurement configuration(s)). The new-type measurement configuration may be newly defined in a 3GPP TS. In some embodiments, the new-type measurement configuration(s) includes reference signal resource configuration(s) configuring resources where the DU 174 transmits reference signal(s). For example, the reference signal resource configuration(s) include CSI-RS(s) and/or SSB(s). In one embodiment, the reference signal resource configuration(s) is/are *CSI-ResourceConfig* IE(s). In another embodiment, the new-type measurement configuration(s) include measurement report configuration(s), as described above. UE 102 transmits the measurement report(s) on PUCCH(s) or MAC CE(s) to the DU 174 in accordance with the measurement report configuration(s). DU 174 receives the measurement report(s) on PUCCH(s) or MAC CE(s) in accordance with the measurement report configuration(s). In such cases, the measurement report(s) may be L1 measurement report(s) or new-type measurement report(s) (e.g., LTM measurement report(s)). In some embodiments, the new-type measurement configuration includes configuration parameters newly defined in a 3GPP TS.

[0106] After (e.g., in response to) receiving the at least one measurement report in the event 324, the DU 174 generates a first LTM command to activate the LTM DU configuration 1 (i.e., the first LTM command commands the UE 102 to apply the LTM DU configuration 1 or to perform a serving cell change to the cell 1). The DU 174 then transmits 330 the first LTM command to UE 102. In some embodiments, the DU 174 transmits the first LTM command on cell 124A to the UE 102. In other embodiments, the DU 174 transmits the

first LTM command on the cell 124D to the UE 102. In some embodiments, the DU 174 may include the ID 1 in the first LTM command to indicate the LTM DU configuration 1 or element 1, and the UE 102 determines (e.g., identifies) the LTM DU configuration 1 or element 1 in accordance with the ID 1.

[0107] In other embodiments, the DU 174 may include the cell index 1 indexing the cell ID 1 in the first LTM command. UE 102 determines (e.g., identifies) the LTM DU configuration 1 or element 1, based on cell index 1. Before receiving the first LTM command, the UE 102 retrieves the cell index 1 from the LTM DU configuration 1 or element 1, and establishes an association 1 between the cell index 1 and the LTM DU configuration 1 or element 1. In other words, UE 102 decodes the LTM DU configuration 1 or element 1 to obtain the cell index 1, before receiving the first LTM command. Thus, the UE 102 identifies the LTM DU configuration 1 or element 1 in accordance with the cell index 1 and the association 1. Before receiving the first LTM command, the UE 102 retrieves the cell index(es) 2, ..., N from the LTM DU configuration(s) or element(s) 2, ..., N and establishes association(s) 2, ..., N between the cell index(es) 2, ..., N and the LTM DU configuration(s) or element(s) 2, ..., N, respectively. In other words, the UE 102 decodes the LTM DU configuration(s) or element(s) 2, ..., N to obtain the cell index(es) 2, ..., N, before receiving the first LTM command.

[0108] In yet other embodiments, the DU 174 may include the cell ID 1 in the first LTM command. UE 102 determines (e.g., identifies) the LTM DU configuration 1 or element 1, based on the cell ID 1. Before receiving the first LTM command, the UE 102 retrieves the cell ID 1 from the LTM DU configuration 1 or element 1, and establishes an association 1 between the cell ID 1 and the LTM DU configuration 1 or element 1. In other words, the UE 102 decodes the LTM DU configuration 1 or element 1 to obtain the cell ID 1, before receiving the first LTM command. Thus, the UE 102 identifies the LTM DU configuration 1 or element 1 in accordance with the cell ID 1 (received in the first LTM command) and the association 1. Before receiving the first LTM command, the UE 102 retrieves the cell ID(es) 2, ..., N from the LTM DU configuration(s) or element(s) 2, ..., N and establishes association(s) 2, ..., N between the cell ID(es) 2, ..., N and the LTM DU configuration(s) or element(s) 2, ..., N, respectively. In other words, the UE 102 decodes the LTM DU configuration(s) or element(s) 2, ..., N to obtain the cell ID(es) 2, ..., N, before receiving the first LTM command.

[0109] In yet other embodiments, the DU 174 may include a bit map in the first LTM command to activate the LTM DU configuration 1, instead of the ID 1 or cell index 1. The number of bits in the bit map is larger than or equal to “N”. In one embodiment, bit 1, ..., N corresponds to the cell index(es) 1, ..., N, the ID(s) 1, ..., N, the LTM DU configuration(s) 1, ..., N or the element(s) 1, ..., N, respectively, and the DU 174 sets a corresponding bit (e.g., bit 1) in the bit map to a first value to indicate the cell index 1, the ID 1, the LTM DU configuration 1, or the element 1. Thus, the UE 102 may determine the cell index 1, the ID 1, LTM DU configuration 1, or element 1 in accordance with the bit 1 set to the first value in the bit map. In another embodiment, bit 0, ..., N-1 corresponds to the cell index(es) 1, ..., N, the ID(s) 1, ..., N, the LTM DU configuration(s) 1, ..., N, or the element (s) 1, ..., N, respectively, and the DU 174 sets a corresponding bit (e.g., bit 0) in the bit map to a first value to indicate the cell index 1, the ID 1 the LTM DU configuration 1, or the element 1. Thus, the UE 102 may determine the cell index 1, the ID 1 LTM DU configuration 1, or element 1 in accordance with the bit 0 set to the first value in the bit map. In such embodiments, the DU 174 sets the remaining bits in the bit map to a second value to indicate that the rest of the LTM DU configuration(s) 1, ..., N is/are not activated. In some embodiments, the first value is one and the second value is zero. In other embodiments, the first value is zero and the second value is one. Generally, if the DU 174 determines to activate the LTM DU configuration L or change a serving cell to the cell L for the UE 102, the DU 174 may set the corresponding bit (e.g., bit L or bit $L-1$) in the bit map to the first value and set the remaining bits to the second value, where $1 \leq L \leq N$. In some embodiments, the DU 174 sets at most one bit in the bit map to the first value.

[0110] After determining or identifying the LTM DU configuration 1 or element 1, the UE 102 then applies the LTM DU configuration 1 and/or LTM CU configuration, after (e.g., in response to) receiving the first LTM command.

[0111] In some embodiments, the at least one measurement report (e.g., L1 measurement report(s) or new-type measurement report(s)) of the event 324 includes at least one measurement result for the first cell (i.e., cell 1), TRP(s) of the first cell or reference signal(s) transmitted on the first cell. The reference signal(s) may be CSI-RS(s) or SSB(s). DU 174 determines to activate the LTM DU configuration 1 or transmit the first LTM command, based on the at least one measurement result. In some embodiments, DU 174 determines to activate the LTM DU configuration 1 because, when, or if the at least one measurement result is above a second predetermined threshold. In some embodiments, the at least one

measurement result includes L1-RSRP value(s), L1-RSRQ value(s), and/or L1-SINR value(s). In other embodiments, the at least one measurement result includes RSRP value(s), RSRQ value(s), and/or SINR value(s) for the new-type measurement report(s). In some embodiments, the second predetermined threshold is different from the first predetermined threshold. In one embodiment, the second predetermined threshold is larger than the first predetermined threshold. In this case, the at least one measurement result indicates that the first cell is suitable for communication with the UE 102. In another embodiment, the second predetermined threshold is equal to the first predetermined threshold. In this case, the at least one measurement result indicates that the first cell has been continuously above the second predetermined threshold or the first predetermined threshold. This indicates that the first cell is suitable for communication with UE 102. Thus, DU 174 determines to activate the LTM DU configuration 1 in response to that signal strength or quality of the first cell being above the second predetermined threshold, for the UE 102.

[0112] In some embodiments, the at least one measurement report (e.g., L3 measurement report(s)) of events 324 and 326 includes at least one measurement result for the first cell. CU 172 determines to activate the LTM DU configuration 1 or transmit the first LTM command, because the at least one measurement result indicates that signal strength or quality of the first cell is above a second predetermined threshold. The second predetermined threshold is different from the first predetermined threshold. In one embodiment, the second predetermined threshold is larger than the first predetermined threshold. In such an embodiment, the at least one measurement report of the event 326 indicates that signal strength or quality of the first cell is suitable for communication with the UE 102. In another embodiment, the second predetermined threshold is equal to the first predetermined threshold. In such an embodiment, the at least one measurement report of the event 326 indicates that signal strength or quality of the first cell has been continuously above the second predetermined threshold or the first predetermined threshold. This also indicates that the first cell is suitable for communication with UE 102. Thus, the CU 172 determines to activate the LTM DU configuration 1 in response to that signal strength or quality of the first cell is above the second predetermined threshold. In response to this determination, the CU 172 transmits 328 a fourth CU-to-DU message to the DU 174 to activate the LTM DU configuration 1 or trigger a serving cell change to the cell 1 for the UE 102. In some embodiments, the CU 172 includes the ID 1 in the fourth CU-to-DU message. In other embodiments, the CU 172 includes the cell index 1 in the fourth CU-to-DU message.

[0113] In response to the fourth CU-to-DU message, the DU 174 transmits 330 the first LTM command to the UE 102 and optionally transmits a fourth DU-to-CU message to the CU 172. In some embodiments, the CU 172 includes the cell index 1 in the fourth CU-to-DU message. Thus, the DU 174 may determine to activate the LTM DU configuration 1 in accordance with the cell index 1. In other embodiments, the CU 172 may include the cell ID 1 in the fourth CU-to-DU message. Thus, DU 174 determines to activate the LTM DU configuration 1 in accordance with the cell ID 1. In yet other embodiments, the CU 172 may include the ID 1 in the fourth CU-to-DU message. Thus, DU 174 may determine to activate the LTM DU configuration 1 in accordance with the ID 1. In some embodiments, the fourth CU-to-DU message and fourth DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Response* message, respectively. In other embodiments, the fourth CU-to-DU message and/or fourth DU-to-CU message are new interface messages, e.g., F1 application protocol (F1AP) messages defined in 3GPP TS 38.473.

[0114] When or in response to determining to activate the LTM DU configuration 1 or transmit the first LTM command 330, the DU 174 might transmit 329 to the CU 172 a DU-to-CU message indicating LTM (being) executed. In some embodiments, the DU 174 includes the cell ID 1 or the ID 1 (i.e., LTM ID) in the DU-to-CU message 329 to indicate that the DU 174 is to activate the LTM DU configuration 1 or trigger a fast serving cell change (i.e., an LTM serving cell change). The DU may transmit the DU-to-CU message 329 to the CU 172 before or after transmitting the LTM command 330.

[0115] In some embodiments, the first LTM command is a MAC CE included in a MAC PDU that the UE 102 receives from the DU 174 in the event 330. The MAC CE may be a new MAC CE defined in 3GPP TS 38.321. In one embodiment, the DU 174 includes a subheader identifying the new MAC CE in the MAC PDU and the UE 102 identifies the new MAC CE in the MAC PDU in accordance with the subheader. The subheader may include a logical channel ID or extended logical channel ID defined in a 3GPP TS to identify the new MAC CE. For example, the logical channel ID or extended logical channel ID are newly defined in 3GPP TS 38.321. In other embodiments, the first LTM command is a DCI that the UE 102 receives on a PDCCH from the DU 174 in the event 330. The DU 174 generates a CRC for the DCI, scrambles the CRC with a first C-RNTI of the UE 102, and transmits the DCI and scrambled CRC on the PDCCH in event 330. In one embodiment, a format of the

DCI may be an existing DCI format defined in a 3GPP TS (e.g., TS 38.212). In another embodiment, the format of the DCI may be a new DCI format defined in a 3GPP TS.

[0116] In some embodiments, the DU 174 does not perform security protection (e.g., integrity protection and/or encryption) on the first LTM command. This speeds up processing the first LTM command in the UE 102 because the UE 102 does not perform security check (e.g., decryption and/or integrity check) on the first LTM command.

[0117] In some embodiments, after receiving the first LTM command, the UE 102 may transmit 331 an acknowledgement to the DU 174 on the cell 124A or cell 124D to indicate that the UE 102 receives the first LTM command. In some embodiments, the acknowledgement is a HARQ ACK. In other embodiments, the acknowledgement is a MAC CE. For example, the MAC CE is an existing MAC CE defined in 3GPP TS 38.321. In another example, the MAC CE is a new MAC CE defined in 3GPP TS 38.321. In yet other embodiments, the acknowledgement is a PUCCH transmission.

[0118] In some embodiments, the CU 172 transmits 316 the RRC reconfiguration message in response to the L3 measurement report 306 for the first cell (i.e., procedures 390 and 392 are not performed in this embodiment). To configure the UE 102 to transmit the L3 measurement report 306, the CU 172 may transmit a first RRC reconfiguration message including the L3 measurement configuration (e.g., a *MeasConfig* IE) to the UE 102 before the event 306. In some embodiments, the DU 174 transmits 330 the first LTM command in response to the L1 measurement report(s) 324 for the first cell. To configure the UE 102 to transmit the L1 or new-type measurement report(s) 324, the CU 172 may transmit a second RRC reconfiguration message including the L1 or new-type measurement configuration(s) to the UE 102. In some embodiments, the first and second RRC reconfiguration messages may be the same message (i.e., the same instance). In other embodiments, the first and second RRC reconfiguration messages are different messages. In some embodiments, the second RRC reconfiguration message is the RRC reconfiguration message of event 316. In other embodiments, the second RRC reconfiguration message is different from the RRC reconfiguration message of event 316.

[0119] After (e.g., in response to) receiving the first LTM command, the UE 102 accesses 332 the first cell. UE 102 identifies the LTM DU configuration 1 in accordance with the ID 1, the cell ID 1, or the cell index 1 received in the first LTM command and applies the LTM DU configuration 1 to communicate with the DU 174 on the first cell. In some embodiments, the

UE 102 disconnects from the cell 124A, after (e.g., in response to) receiving the first LTM command or after transmitting 331 the acknowledgement. In some embodiments, the UE 102 stops communicating on the cell 124A after (e.g., in response to) receiving 330 the first LTM command or transmitting 331 the acknowledgement. In some embodiments, the UE 102 accesses the first cell by performing a random access procedure on the first cell with the DU 174, in response to receiving the first LTM command. In other embodiments, the UE 102 skips a random access procedure and transmits the first transmission (e.g., a PUSCH transmission or a PUCCH transmission) on the first cell to the DU 174, after (e.g., in response to) receiving the first LTM command.

[0120] In some embodiments, the DU 174 configures the access of the UE 102 to the first cell, including whether the UE 102 performs a random access procedure, in the LTM DU configuration 1. When receiving the first LTM command (e.g., the first LTM command), the UE 102 determines whether to perform a random access procedure on the first cell in accordance with the LTM DU configuration 1. If the LTM DU configuration 1 configures the UE 102 to perform a random access procedure, the UE 102 performs a random access procedure on the first cell in event 332, in order to connect to the first cell. For example, the LTM DU configuration 1 includes a reconfiguration with sync configuration (e.g., *ReconfigurationWithSync* IE) to configure that the UE 102 performs a random access procedure when the UE 102 receives a LTM command for the first cell. In other embodiments, in the LTM DU configuration 1, the DU 174 configures the UE 102 to skip the random access procedure for a LTM serving cell change to the first cell. In such cases, after receiving the first LTM command, the UE 102 skips the random access procedure and transmits the first transmission (e.g., a PUSCH transmission or a PUCCH transmission) on the first cell to the DU 174 in event 332. In some embodiments, the DU 174 excludes a reconfiguration with sync configuration in the LTM DU configuration 1 to configure the UE 102 skipping a random access procedure for a LTM serving cell change to the first cell.

[0121] In other embodiments, the LTM DU configuration 1 includes the reconfiguration with sync configuration or the random access configuration. In such cases, the DU 174 configures whether the UE 102 performs a random access procedure on the first cell in a LTM command. Thus, UE 102 determines whether to perform the random access procedure on the first cell in event 332 in accordance with the first LTM command. In some embodiments, the DU 174 includes, in the first LTM command, an indication (e.g., a field) indicating skipping a random access procedure. In response to the indication or the first LTM

command including the indication, the UE 102 skips a random access procedure and directly transmits the first transmission (e.g., a PUSCH transmission or a PUCCH transmission) on the first cell to access the first cell. In other embodiments, the DU 174 excludes the indication in the first LTM command to configure the UE 102 to perform a random access procedure. In response to the first LTM command excluding the indication, the UE 102 performs a random access procedure on the first cell to access the first cell. In some other embodiments, the DU 174 includes a timing advance value in the first LTM command to indicate skipping a random access procedure. In response to receiving the timing advance value or the first LTM command including the timing advance value, the UE 102 skips a random access procedure and transmits the first transmission on the first cell to access the first cell, using the timing advance value. In yet other embodiments, the DU 174 excludes, in the first LTM command, a timing advance value to configure the UE 102 to perform a random access procedure. In response to the first LTM command excluding a timing advance command, the UE 102 performs a random access procedure on the first cell to access the first cell.

[0122] In some embodiments, the random access procedure is a four-step random access procedure. In other embodiments, the random access procedure is a two-step random access procedure. In some embodiments, the random access procedure is a contention-free random access procedure. In other embodiments, the random access procedure is a contention-based random access procedure. In cases where the random access procedure is a four-step random access procedure, UE 102 transmits a Message 3 including a UE identity to the DU 174 via the first cell in the random access procedure. The DU 174 transmits a contention resolution message (e.g., a Message 4) to the UE 102 in response to the Message 3. In cases where the random access procedure is a two-step random access procedure, UE 102 transmits a message A including the UE identity to the DU 174 via the first cell in the random access procedure. The DU 174 transmits a contention resolution message (e.g., message B) to the UE 102 in response to message A. In some embodiments, when the UE 102 receives the contention resolution message from the DU 174 on the first cell, the UE 102 determines that the UE 102 successfully completes the random access procedure (i.e., the UE 102 successfully accesses the first cell). In some embodiments, the LTM DU configuration 1 includes a second C-RNTI and the UE identity is the second C-RNTI of the UE 102. In such embodiments, the contention resolution message is a PDCCH transmission addressed to the second C-RNTI. In other embodiments, the LTM DU configuration 1 does not include a C-RNTI, the UE identity

is the first C-RNTI. In such embodiments, the contention resolution message is a PDCCH transmission addressed to the first C-RNTI.

[0123] In cases where the LTM DU configuration 1 includes a dedicated random access preamble, the random access procedure is a contention free random access procedure. In such cases, the UE 102 transmits the dedicated random access preamble to the DU 174 via the first cell. When the UE 102 receives a random access response including an ID of the dedicated random access preamble from the DU 174 on the first cell, the UE 102 determines that the UE 102 successfully completes the random access procedure (i.e., the UE 102 successfully accesses the first cell).

[0124] If the DU 174 configures the UE 102 to perform a random access procedure on the first cell as described above, the DU 174 will detect that the UE 102 has accessed the first cell when the DU 174 receives message 3, message A, or the dedicated preamble in the random access procedure. If the DU 174 configures the UE 102 to skip a random access procedure, the DU 174 will detect that the UE 102 has accessed the first cell when the DU 174 receives the first transmission.

[0125] In some embodiments, the UE 102 transmits the first transmission (e.g., the PUSCH transmission) on the first cell using an UL grant. In some embodiments, the first LTM command includes the UL grant. In other embodiments, when the UE 102 performs an LTM serving cell change to the first cell, in response to the first LTM command, the UE 102 receives a first DCI including the UL grant on a PDCCH on the first cell. In some embodiments, the UE 102 attempts to receive the first DCI or the UL grant by monitoring one or more PDCCHs on the first cell in accordance with the LTM DU configuration 1, when the UE 102 switches to the first cell in response to the first LTM command. While monitoring one or more PDCCHs on the first cell, the UE 102 receives the first DCI and a CRC of the first DCI on the PDCCH. In the case that the LTM DU configuration 1 includes the second C-RNTI, the UE 102 determines that the first DCI was sent for the UE 102, using the CRC and the second C-RNTI. In the case that the LTM DU configuration 1 does not include the second C-RNTI, the UE 102 determines that the first DCI was sent for the UE 102, using the CRC and the first C-RNTI.

[0126] In some embodiments, the CU 172 transmits at least one first TCI state configuration to the UE 102 via the DU 174. In some embodiments, each of the first TCI state configuration(s) configures a TCI state for the UE 102 to transmit and/or receive data

and/or control signal on the first cell. Each TCI state associates one or two DL RSs with a corresponding QCL type and the DL RS(s) might be associated with a particular cell of the cell(s) 1, ..., N. In some embodiments, the CU 172 receives 310 a DU-to-CU message including the first TCI state configuration(s) from the DU 174 and transmits 316, 318 an RRC message, including the first TCI state configuration(s), to the UE 102 via the DU 174. In further embodiments, the DU 174 includes the first TCI state configuration(s) in a serving DU configuration (e.g., *CellGroupConfig* IE) and includes the serving DU configuration in the DU-to-CU message. In some embodiments, the DU 174 includes the LTM DU configuration 1 in a first interface protocol IE/field in the message 312 and includes the serving DU configuration in a second interface protocol IE/field in the DU-to-CU message.

[0127] In some embodiments, the first interface protocol IE/field is defined as part of a format of the DU-to-CU message. CU 172 includes the serving DU configuration in the RRC message. In some embodiments, the CU 172 refrains from including the serving DU configuration in a container for LTM (e.g., the first container). In other embodiments, the CU 172 includes the first TCI state configuration(s) in an element for LTM, an addition or modification list for LTM, or a container, similar to the element 1, the first addition, or modification list, or the first container respectively. In some embodiments, the RRC message is the RRC reconfiguration message 316, 318 or another RRC reconfiguration message (not shown in FIG. 3). In some embodiments, the DU-to-CU message is the message 312, the message 314, a *UE Context Modification Response* message, or a *UE Context Modification Required* message. In some embodiments, the DU 174 also includes the first TCI state configuration(s) in the LTM DU configuration 1. In other embodiments, the DU 174 refrains from including the first TCI state configuration(s) in the LTM DU configuration 1.

[0128] In some embodiments, the first interface protocol IE/field is a first F1AP IE/field and the second interface protocol IE/field is a second F1AP IE/field. In some embodiments, one of the first F1AP IE/field and the second F1AP IE/field is a F1AP *CellGroupConfig* IE/field and the other is not the F1AP *CellGroupConfig* IE/field. In some embodiments, the DU 174 includes the first F1AP IE/field in a *DU to CU RRC Information* IE in the message 312 and includes the second F1AP IE/field in the *DU to CU RRC Information* IE in the DU-to-CU message. In other embodiments, neither the first F1AP IE/field nor the second F1AP IE is a F1AP *CellGroupConfig* IE/field. In other embodiments, the second F1AP IE/field is the *DU to CU RRC Information* IE and the first F1AP IE/field is a new IE specific for including a LTM DU configuration.

[0129] In some embodiments, after (e.g., in response to) receiving the first LTM command or while accessing 332 the first cell, the UE 102 monitors one or more PDCCHs on the first cell using some or all of the first TCI state configuration(s). In some embodiments, each of the first TCI state configuration(s) includes a TCI state ID identifying the corresponding TCI state configuration. For example, the first TCI state configuration(s) includes TCI state configuration(s) 1, ..., L, where L is a positive integer larger than zero. The TCI state configuration(s) 1, ..., L include TCI state ID(s) 1, ..., L identifying the TCI state configuration(s) 1, ..., L, respectively. DU 174 includes the TCI state ID 1 in the first LTM command to instruct the UE 102 to apply the TCI state configuration 1 to communicate on the first cell. After (e.g., in response to) receiving 330 the first LTM command, the UE 102 accesses and/or communicates on the first cell using the TCI state configuration 1 in accordance with the TCI state ID 1. For example, the UE 102 monitors one or more PDCCHs and/or transmits the first transmission, using the TCI state configuration 1. In some embodiments, the DU 174 detects that the UE 102 accesses the first cell and communicates with the UE 102 on the first cell, based on the TCI state configuration 1. For example, the DU 174 receives the first transmission from the UE 102 on the first cell, based on the TCI state configuration 1.

[0130] In some embodiments, the DU 174 includes the TCI state ID 2 in the first LTM command to indicate to the UE 102 to apply the TCI state configuration 2 to communicate on the first cell, in addition to the TCI state ID 1. After (e.g., in response to) receiving 330 the first LTM command, the UE 102 accesses and/or communicates 332 on the first cell using the TCI state configurations 1 and 2 in accordance with the TCI state ID 1 and the TCI state ID 2. For example, the UE 102 monitors one or more PDCCHs on the first cell using the TCI state configuration 1 and transmits the first transmission on the first cell using the TCI state configuration 2. In another example, the UE 102 monitors one or more PDCCHs on the first cell using the TCI state configuration 1 and the TCI state configuration 2 and transmits the first transmission on the first cell using one of the TCI state configurations 1 and 2. In some embodiments, the DU 174 detects that the UE 102 accesses the first cell and communicates with the UE 102 on the first cell, based on the TCI state configuration 1 and/or the TCI state configuration 2. For example, the DU 174 receives the first transmission from UE 102 on the first cell, based on one of the TCI state configurations 1 and 2.

[0131] In some alternative embodiments, the DU 174 might not include a TCI state ID in the first LTM command. In such cases, the UE 102 communicates on the first cell with the

first DU using the at least one first TCI state, after (e.g., in response to) receiving the first LTM command. In some embodiments, the DU 174 detects that the UE 102 accesses the first cell and communicates with the UE 102 on the first cell, based on the first TCI state configuration(s).

[0132] In some embodiments, before transmitting the first LTM command, the DU 174 might transmit one or more activation commands to the UE to activate some or all of the first TCI state configuration(s). In some embodiments, each of the activation command(s) is a MAC CE. In other embodiments, each of the activation command(s) is a DCI. In some embodiments, the DU 174 includes the TCI state ID 1 and/or TCI state ID 2 in the activation command(s) to activate the TCI state configuration 1 and/or the TCI state configuration 2, respectively. Accordingly, UE 102 determines or identifies that the TCI state configuration 1 and/or the TCI state configuration 2 is/are activated upon receiving 330 the activation command(s). In other embodiments, the DU 174 includes all the TCI state ID(s) for the first TCI state configuration(s) in the activation command(s). Accordingly, UE 102 determines or identifies that the first TCI state configuration(s) is/are activated upon receiving 330 the activation command(s). In some embodiments, the DU 174 refrains from including, in the first LTM command, a TCI state ID for a TCI state configuration that the DU 174 has not activated for the UE 102. In some embodiments, the DU 174 includes the cell ID 1 or the cell index 1 in the activation command(s). Based on the cell ID 1 or cell index 1, and the one or more TCI state IDs in the activation command(s), the UE 102 determines that the activation command(s) activates the one or more TCI state configurations in the first TCI state configuration(s), where each of the TCI state ID(s) identifies a particular TCI state configuration of the TCI state configuration(s).

[0133] In some embodiments, the UE 102 communicates with the DU 174 on the cell 124A (e.g., events 302, 304, 318, 320, 324, 330), using one or more TCI state configurations. In some embodiments, each of the TCI state configuration(s) configures a TCI state for the UE 102 to transmit and/or receive data and/or control signal on the cell 124A (i.e., the serving cell). In some embodiments, the UE 102 stops using the TCI configuration(s) upon receiving the first LTM command.

[0134] After successfully accessing the first cell (i.e., the switching cell), the UE 102 communicates 336 with the DU 174 on the first cell using the LTM DU configuration 1 and/or reference LTM DU configuration and communicates with the CU 172 via the DU 174.

In such cases, the DU 174 communicates 336 with the UE 102 on the first cell using the LTM DU configuration 1. In some scenarios or embodiments, the UE 102 communicates 336 PUSCH transmissions, PDSCH transmissions, PUCCH transmissions, PDCCH transmissions, and/or sounding reference signal (SRS) transmissions with the DU 174 on the first cell. In some embodiments, UE 102 uses some or all of the first TCI state configuration(s) to perform 336 the communication with the DU 174. Similarly, DU 174 uses some or all of the first TCI state configuration(s) to perform 336 the communication with the UE 102. In some embodiments, the DU 174 includes one or more additional TCI state configurations in the LTM DU configuration 1. In such cases, the DU 174 might transmit one or more activation commands to the UE 102 via the first cell in event 336 to activate the additional TCI state configuration(s). UE 102 determines that the additional TCI state configuration(s) is/are activated upon receiving the activation command(s). In some embodiments, each of the activation command(s) is a MAC CE. In other embodiments, each of the activation command(s) is a DCI. After receiving the activation command(s), the UE 102 uses the additional TCI state configuration(s) to communicate with the DU 174 on the first cell. Similarly, after transmitting 336 the activation command(s), the DU 174 uses the additional TCI state configuration(s) to communicate with the UE 102 on the first cell.

[0135] In the case that the UE 102 receives the reference LTM DU configuration as described above, the UE 102 communicates 336 with the DU 174 on the first cell in accordance with the LTM DU configuration 1 and at least a portion of the reference LTM DU configuration. In other words, UE 102 communicates 336 with the DU 174 in accordance with configuration parameters in the LTM DU configuration 1 and the reference LTM DU configuration. Similarly, the DU 174 communicates 336 with the UE 102 on the first cell in accordance with the LTM DU configuration 1 and at least a portion of the reference LTM DU configuration. In other words, the DU 174 communicates 336 with the UE 102 in accordance with configuration parameters in the LTM DU configuration 1 and the reference LTM DU configuration.

[0136] In the case that the UE 102 receives neither the LTM CU configuration 1 nor a/the reference LTM CU configuration, the UE 102 communicates 336 with the CU 172 via the DU 174 using the serving CU configuration. Correspondingly, if the CU 172 neither transmits the LTM CU configuration 1 nor a/the reference CU configuration to the UE 102, the CU 172 communicates 336 with the UE 102 via the DU 174 using the serving CU configuration. In the case that the UE 102 receives the LTM CU configuration 1 and the

reference LTM CU configuration from the CU 172, the UE 102 communicates 336 with the CU 172 via the DU 174 using the LTM CU configuration 1 and (at least a portion of) the reference LTM CU configuration not augmented by the LTM CU configuration 1. In this case, the CU 172 communicates 336 with the UE 102 via the DU 174 using the LTM CU configuration 1 and (at least a portion of) the reference LTM CU configuration not augmented by the LTM CU configuration 1.

[0137] In the case that the UE 102 receives the LTM CU configuration 1 and does not receive the reference LTM CU configuration from the CU 172, the UE 102 communicates 336 with the CU 172 via the DU 174 using the LTM CU configuration 1. In this case, the CU 172 communicates 336 with the UE 102 via the DU 174 using the LTM CU configuration 1. If the LTM CU configuration 1 is a full configuration, the UE 102 and CU 172 communicates 336 with each other via the DU 174 using the LTM CU configuration 1 instead of the serving CU configuration. In some embodiments, if the UE 102 does not receive a/the reference LTM CU configuration from the first BS 104, the UE 102 determines that the LTM CU configuration 1 is a full configuration. Correspondingly, if the CU 172 determines to configure or configures the LTM CU configuration 1 as a full configuration, the CU 172 does not transmit a/the reference LTM CU configuration to the UE 102. In other embodiments, the CU 172 includes a first indication (e.g., a field or IE) in the LTM CU configuration 1, the first container, the element 1, or the RRC reconfiguration message 316 to indicate that the LTM CU configuration 1 is a full configuration. If the LTM CU configuration 1 is a delta configuration to augment the serving CU configuration, the UE 102 and CU 172 communicate 336 with each other via the DU 174 using the LTM CU configuration 1 and at least a portion of the serving CU configuration, not augmented by the LTM CU configuration 1. In some embodiments, if the UE 102 does not receive a/the reference LTM CU configuration from the first BS 104, the UE 102 determines that the LTM CU configuration 1 is a delta configuration to augment the serving CU configuration. Correspondingly, if the CU 172 determines to configure or configures the LTM CU configuration 1 as a delta configuration to augment the serving CU configuration, the CU 172 does not transmit a/the reference LTM CU configuration to the UE 102. In some embodiments, the CU 172 indicates that the LTM CU configuration 1 is a delta configuration to augment the serving CU configuration, by excluding the first indication in the LTM CU configuration 1, the first container, the element 1, and/or the RRC reconfiguration message 316. Alternatively, the CU 172 includes a second indication (e.g., a field or IE) in the LTM CU configuration 1, the first

container, the element 1, or the RRC reconfiguration message 316 to indicate that the LTM CU configuration 1 is a delta configuration to augment the serving CU configuration. In some embodiments, the CU 172 indicates that the LTM CU configuration 1 is a full configuration, by excluding the second indication in the LTM CU configuration 1, the first container, the element 1, and/or the RRC reconfiguration message 316.

[0138] In case that the UE 102 receives the reference LTM CU configuration and does not receive the LTM CU configuration 1 from the CU 172, the UE 102 communicates 336 with the CU 172 via the DU 174 using the reference LTM CU configuration. In this case, the CU 172 communicates 336 with the UE 102 via the DU 174 using the reference LTM CU configuration. If the reference LTM CU configuration is a full configuration, the UE 102 and CU 172 communicates 336 with each other via the DU 174 using the reference LTM CU configuration instead of the serving CU configuration. In some embodiments, the UE 102 and CU 172 determine that the reference LTM CU configuration 1 is a full configuration as specified in a 3GPP TS. In other embodiments, the CU 172 includes a first indication (e.g., a field or IE) in the reference LTM CU configuration, the first container or the RRC reconfiguration message 316 to indicate that the reference LTM CU configuration is a full configuration. If the reference LTM CU configuration is a delta configuration to augment the serving CU configuration, the UE 102 and CU 172 communicates 336 with each other via the DU 174 using the reference LTM CU configuration and at least a portion of the serving CU configuration, not augmented by the reference LTM CU configuration. In some embodiments, the CU 172 indicates that the reference LTM CU configuration is a delta configuration to augment the serving CU configuration, by excluding the first indication in the reference LTM CU configuration, the first container, the element 1, and/or the RRC reconfiguration message 316. Alternatively, the CU 172 includes a second indication (e.g., a field or IE) in the reference LTM CU configuration, the first container, the element 1, or the RRC reconfiguration message 316 to indicate that the reference LTM CU configuration is a delta configuration to augment the serving CU configuration. In some embodiments, the CU 172 indicates that the reference LTM CU configuration is a full configuration, by excluding the second indication in the reference LTM CU configuration, the first container, the element 1, and/or the RRC reconfiguration message 316.

[0139] In the case that the UE 102 receives neither the reference LTM CU configuration, nor the LTM CU configuration 1 from the CU 172, the UE 102 communicates 336 with the CU 172 via the DU 174 using the serving LTM CU configuration. In this case, the CU 172

communicates 336 with the UE 102 via the DU 174 using the serving LTM CU configuration.

[0140] In some embodiments, the UE 102 transmits an RRC message (e.g., RRC reconfiguration complete message) to the CU 172, via the DU 174, and to the first cell to indicate that the UE 102 applies the LTM DU configuration 1. In the case that the UE 102 performs the random access procedure 332, the UE 102 may include the RRC message in the message 3 or message A. Alternatively, the UE 102 transmits the RRC message after completing the random access procedure. In case that the UE 102 skips the random access procedure 332, the UE 102 includes the RRC message in a PUSCH transmission of the at least one PUSCH transmission. In some embodiments, if the UE 102 maintains communication on the cell 124A with the first BS 104 (i.e., the UE 102 does not disconnect from the cell 124A), the UE 102 may transmit the RRC message to the first BS 104 via the cell 124A. When the DU 174 receives the RRC message, the DU 174 transmits the RRC message to the CU 172.

[0141] In other embodiments, the UE 102 refrains from transmitting the RRC message to the first BS 104 in response to applying the LTM DU configuration 1 or receiving the first LTM command. In such cases, the UE 102 may include or transmit data in the message 3, message A or PUSCH transmission as described above. The UE 102 may generate a MAC PDU and/or a RLC PDU including the data and transmits or includes the MAC PDU and/or RLC PDU in the PUSCH transmission. For example, the data may be a PDCP PDU, a SDAP PDU, an LTE Positioning Protocol (LPP) PDU, an RRC PDU and/or an NAS PDU. The RRC PDU includes an UL-DCCH-Message excluding a RRC reconfiguration complete message. The NAS PDU includes a Mobility Management (MM) message or a Session Management (SM) message. The MM message may be a 5G MM message or a 6G MM message, and the SM message may be a 5G SM message or a 6G SM message. When the DU 174 receives the data, the DU 174 transmits the data to the CU 172.

[0142] When the DU 174 determines that the UE 102 successfully connects to the first cell in the event 332 or 336, the DU 174 may transmit 334 a DU-to-CU message (e.g., Access Success message) to the CU 172 (e.g., a CP of the CU 172). In some embodiments, the DU 174 may include the cell ID 1 of the first cell in the DU-to-CU message of the event 334. The cell ID may be a PCI or a CGI. Thus, CU 172 determines that the UE 102 connects to the first cell upon receiving the DU-to-CU message of event 334. When the DU 174 determines that

the UE 102 successfully connects to the first cell, in the event 332 or 336, the DU 174 may transmit a DL Data Delivery Status message or frame to the CU 172 (e.g., a UP of the CU 172).

[0143] In some embodiments, when or after the CU 172 receives the DU-to-CU message 329, the CU 172 might stop or suspend transmitting DL data for the UE 102 to the DU 174 until receiving the DU-to-CU message 334. The CU 172 might do so because the DU 174 cannot buffer DL data for the UE 102 during the LTM execution in the events 330 and/or 332. After receiving the DU-to-CU message 334, the CU 172 continues or resumes transmitting DL data for the UE 102 to the DU 174. In other embodiments, when the CU 172 receives the DU-to-CU message 329, the CU 172 might continue transmitting DL data for the UE 102 to the DU 174. The CU 172 might do so because the DU 174 may buffer DL data for the UE 102 during the LTM execution in the events 330 and/or 332. When or after the DU 174 detects that UE 102 accesses cell 1, the DU 174 transmits the DL data to the UE 102 via cell 1.

[0144] In some embodiments, when determining that the UE 102 connects to the first cell, or when transmitting 330 the first LTM command, or when receiving 331 the acknowledgement, the DU 174 may stop communicating with the UE 102 on the cell 124A and/or release resources of the cell 124A configured for the UE 102.

[0145] In some embodiments, the DU 174 may generate some or all of the LTM DU configuration 1 and/or LTM DU configuration(s) 2, ..., N as full configuration(s) to replace the serving DU configuration. If the LTM DU configuration 1 is a full configuration, the UE 102 and DU 174 communicate 336 with each other in accordance with the LTM DU configuration 1 instead of the serving DU configuration. In some embodiments, the DU 174 includes an indication specifying that the LTM DU configuration 1 is a full configuration in the LTM DU configuration 1. In each of the LTM DU configuration(s) 2, ..., N, the DU 174 may include an indication to announce that the corresponding DU configuration is a full configuration. Each of the indication(s) in the LTM DU configuration(s) 1, ..., N may be a field or IE (i.e., the same field or IE). In other embodiments, the CU 172 may include, in the RRC reconfiguration message of the events 316, 318, a single indication specifying that the LTM DU configuration(s) 1 and/or 2, ..., N is/are full configuration(s). In the case of the second container, the CU 172 may include, in the additional RRC reconfiguration message, a single indication specifying that the LTM DU configuration(s) 2, ..., N is/are full

configuration(s). In yet other embodiments, the CU 172 may include, in the first container, a single indication specifying that the LTM DU configuration(s) 1 and/or 2, ..., N is/are full configuration(s). In yet other embodiments, for each of the LTM DU configuration(s) 2, ..., N, the CU 172 may include, in the first container, a particular indication specifying the corresponding LTM DU configuration is a full configuration. In the case of the second container, the CU 172 may include, in the second container, a single indication specifying that the LTM DU configuration(s) 2, ..., N is/are full configuration(s). In yet other embodiments, the CU 172 may include, in the element 1, includes an indication specifying that the LTM DU configuration 1 is a full configuration. In each of the element(s) 2, ..., N, the CU 172 may include an indication specifying that the corresponding LTM DU configuration is a full configuration. The UE 102 may determine that the LTM DU configuration 1 and/or LTM DU configuration(s) 2, ..., N is/are full configuration(s) based on the indication(s) above. In some embodiments, each of the indication(s) above is different from a *fullConfig* field defined in the current 3GPP TS. In some embodiments, each of the indication(s) above is a *fullConfig* field defined in the current 3GPP TS. In case that the LTM DU configuration 1 is a full configuration, the UE 102 in the event 336 does not apply the reference LTM DU configuration, if received from the first BS 104, e.g., in the RRC reconfiguration message 318. In such cases, the DU 174 might not include a/the reference LTM DU configuration in the first DU-to-CU message 310.

[0146] In other embodiments, the DU 174 may generate the LTM DU configuration 1 and/or LTM DU configuration(s) 2, ..., N as delta configuration(s) that augment (a portion of) the reference LTM DU configuration. In other words, the DU 174 generates the LTM DU configuration(s) 1, ...N based on the reference LTM DU configuration. For example, if the LTM DU configuration 1 is a delta configuration, the UE 102 and DU 174 augment (the portion of) the reference LTM DU configuration with the LTM DU configuration 1. Thus, the UE 102 and DU 174 communicate 336 with each other in accordance with the LTM DU configuration 1 and unaugment a portion of the reference LTM DU configuration. In some embodiments, the LTM DU configuration(s) 1, and/or 2..., N, first container, second container, or element(s) 1, ..., N exclude indication(s) specifying that the LTM DU configuration(s) 1, and/or 2..., N is/are full configuration(s) to indicate that the LTM DU configuration(s) 1 and/or 2, ..., N is/are delta configuration(s). The UE 102 may determine that each of the LTM DU configuration(s) 1 and/or 2, ..., N is a delta configuration based on

the fact that the indication is excluded in the LTM DU configuration(s) 1 and/or 2, ..., N, first container, second container, or element(s) 1 and/or 2, ..., N.

[0147] In some embodiments, if the UE 102 does not receive a reference LTM DU configuration for the LTM DU configuration 1 and/or the LTM DU configuration(s) 2, ..., N, the UE 102 determines that the LTM DU configuration 1, and/or the LTM DU configuration(s) 2, ..., N are full configuration(s). Correspondingly, if the DU 174 does not obtain a reference LTM DU configuration for the UE 102 (i.e., the DU 174 does not generate a reference LTM DU configuration for the UE 102 and/or receive a reference LTM DU configuration for the UE 102 from the CU 172), the DU 174 generates the LTM DU configuration 1, and/or the LTM DU configuration(s) 2, ..., N as full configuration(s).

[0148] In other embodiments, if the UE 102 does not receive a reference LTM DU configuration for the LTM DU configuration 1 and/or the LTM DU configuration(s) 2, ..., N, the UE 102 determines that the LTM DU configuration 1, and/or the LTM DU configuration(s) 2, ..., N are delta configuration(s) to augment the serving DU configuration. In such cases, UE 102 communicates 336 with the DU 174 in accordance with the LTM DU configuration 1 and at least a portion of the serving DU configuration not augmented by LTM DU configuration 1. Correspondingly, if the DU 174 does not obtain a reference LTM DU configuration for the UE 102 (i.e., the DU 174 does not generate a reference LTM DU configuration for the UE 102 and/or receive a reference LTM DU configuration for the UE 102 from the CU 172), the DU 174 generates the LTM DU configuration 1, and/or the LTM DU configuration(s) 2, ..., N as delta configuration(s) to augment the serving DU configuration. In such cases, the DU 174 communicates 336 with the UE 102 in accordance with the LTM DU configuration 1 and the at least a portion of the serving DU configuration.

[0149] In some embodiments, the UE 102 uses a UE MAC entity (e.g., MAC 204B) to communicate with a DU MAC entity (e.g., MAC 204B) of the DU 174 (e.g., the events 302, 304, 318, 320, 324, 330 and/or 331). In some embodiments, the UE 102 resets the UE MAC entity, after or in response to receiving the first LTM command and before performing 332 the random access procedure or communicating 336 with the DU 174 via the first cell. In some embodiments, the DU 174 resets the DU MAC entity after (e.g., in response to) transmitting the first LTM command, receiving the acknowledgement 331, or determining that the UE 102 connects to the first cell.

[0150] In some embodiments, when the UE 102 resets the UE MAC entity, the UE 102 performs at least one of the following actions for the UE MAC entity (i.e., UE MAC reset or full UE MAC reset):

- initialize B_j for configured logical channel(s) to zero;
- stop one or more timers;
- consider *timeAlignmentTimer*(s) as expired, if the UE 102 is configured to perform the random access procedure (e.g., the event 332) in the configuration (e.g., the configuration 1);
- set new data indicator(s) (NDI(s)) for UL HARQ process(es) to value 0;
- set NDI(s) for HARQ process ID(s) to value 0 for monitoring PDCCH in Sidelink resource allocation mode 1;
- flush Msg3 buffer;
- flush MSGA buffer;
- cancel, if any, triggered Scheduling Request procedure;
- cancel, if any, triggered Buffer Status Reporting procedure;
- cancel, if any, triggered Power Headroom Reporting procedure;
- cancel, if any, triggered consistent LBT failure;
- cancel, if any, triggered BFR;
- cancel, if any, triggered Sidelink Buffer Status Reporting procedure;
- cancel, if any, triggered Pre-emptive Buffer Status Reporting procedure;
- cancel, if any, triggered Timing Advance Reporting procedure;
- cancel, if any, triggered Recommended bit rate query procedure;
- cancel, if any, triggered configured uplink grant confirmation;
- cancel, if any, triggered configured sidelink grant confirmation;
- cancel, if any, triggered Desired Guard Symbol query;
- cancel, if any, triggered Positioning Measurement Gap Activation/Deactivation Request procedure;

- flush soft buffers for DL HARQ process(es);
- for each of the DL HARQ process(es), consider the next received transmission for a TB as the very first transmission;
- release, if any, Temporary C-RNTI; and
- reset one or more counters (e.g., BFI_COUNTERs and/or LBT_COUNTERs).

[0151] In some embodiments, when the DU 174 resets the DU MAC entity, the DU 174 performs at least one of the following actions for the DU MAC entity (i.e., DU MAC reset or full DU MAC reset):

- stop one or more timers;
- consider *timeAlignmentTimer*(s), that the DU 174 starts and/or maintains for the UE 102, as expired, if the UE 102 is configured to perform the random access procedure (e.g., the event 332) in the configuration (e.g., the configuration 1);
- set NDI(s) for DL HARQ process(es) to value 0;
- flush soft buffers for UL HARQ process(es);
- for each of the UL HARQ process(es), consider the next received transmission for a TB as the very first transmission; and
- reset one or more counters (e.g., BFI_COUNTERs and/or LBT_COUNTERs).

[0152] Depending on the embodiment, the UE 102 may determine to partially or fully reset the UE MAC entity. In some embodiments, when the UE 102 resets the UE MAC entity as described above, the UE 102 fully resets the UE MAC entity (i.e., a full UE MAC reset). In the full UE MAC reset, UE 102 performs some or all of the actions described above. In other embodiments, when the UE 102 resets the UE MAC entity as described above, the UE 102 partially resets the UE MAC entity (i.e., a partial UE MAC reset). In the partial UE MAC reset, UE 102 performs a subset or portion of the some or all of the actions in the full UE MAC reset.

[0153] In some embodiments, the partial UE MAC reset includes at least one of the following actions:

- consider *timeAlignmentTimer(s)* of the UE 102 as expired, if the UE 102 is configured to perform the random access procedure (e.g., the event 332) in the configuration (e.g., the configuration 1);
- flush Msg3 buffer;
- flush MSGA buffer;
- release, if any, Temporary C-RNTI; and
- reset one or more counters (e.g., BFI_COUNTERs and/or LBT_COUNTERs).

[0154] In some embodiments, the partial UE MAC reset further includes at least one of the following actions:

- cancel, if any, triggered Scheduling Request procedure;
- cancel, if any, triggered Buffer Status Reporting procedure;
- cancel, if any, triggered Power Headroom Reporting procedure;
- cancel, if any, triggered consistent LBT failure;
- cancel, if any, triggered BFR;
- cancel, if any, triggered Sidelink Buffer Status Reporting procedure;
- cancel, if any, triggered Pre-emptive Buffer Status Reporting procedure;
- cancel, if any, triggered Timing Advance Reporting procedure;
- cancel, if any, triggered Recommended bit rate query procedure;
- cancel, if any, triggered configured uplink grant confirmation;
- cancel, if any, triggered configured sidelink grant confirmation;
- cancel, if any, triggered Desired Guard Symbol query; and
- cancel, if any, triggered Positioning Measurement Gap Activation/Deactivation Request procedure.

[0155] In some embodiments, the partial UE MAC reset further includes at least one of the following actions:

- stop a first portion of the one or more timers and retain the rest of the one or more timers;

- set new data indicator(s) (NDI(s)) for UL HARQ process(es) to value 0;
- set NDI(s) for HARQ process ID(s) to value 0 for monitoring PDCCH in Sidelink resource allocation mode 1;
- flush soft buffers for DL HARQ process(es); and
- for each of the DL HARQ process(es), consider the next received transmission for a TB as the very first transmission.

[0156] Depending on embodiments, the DU 174 may determine to partially or fully reset the DU MAC entity. In some embodiments, when the DU 174 resets the DU MAC entity as described above, the DU 174 fully resets the DU MAC entity (i.e., a full DU MAC reset). In the full DU MAC reset, DU 174 performs some or all of the actions described above. In other embodiments, when the DU 174 resets the DU MAC entity as described above, the DU 174 partially resets the DU MAC entity (i.e., a partial DU MAC reset). In the partial DU MAC reset, the DU 174 performs a subset or portion of the some or all of the actions in the full DU MAC reset.

[0157] In some embodiments, the partial DU MAC reset includes at least one of the following actions in the partial MAC reset:

- consider *timeAlignmentTimer*(s), that the DU 174 starts and/or maintains for the UE 102, as expired, if the UE 102 is configured to perform the random access procedure (e.g., the event 332) in the configuration (e.g., the configuration 1); and
- reset one or more counters (e.g., BFI_COUNTERs and/or LBT_COUNTERs).

[0158] In some embodiments, when the partial DU MAC reset includes at least one of the following actions for the MAC entity (i.e., DU MAC reset):

- stop a first portion of the one or more timers and retain the rest of the one or more timers;
- set NDI(s) for DL HARQ process(es) to value 0;
- flush soft buffers for UL HARQ process(es);
- for each of the UL HARQ process(es), consider the next received transmission for a TB as the very first transmission; and
- reset one or more counters (e.g., BFI_COUNTERs and/or LBT_COUNTERs).

[0159] In other embodiments, the UE 102 refrains from resetting the UE MAC entity in response to receiving the first LTM command. Similarly, the DU 174 refrains from resetting the DU MAC entity after (e.g., in response to) transmitting the first LTM command, receiving the acknowledgement 331 or determining that the UE 102 connects to the first cell. In other words, the UE 102 communicates with the DU 174 on the first cell using the UE MAC entity (not reset). Similarly, the DU 174 communicates with the UE 102 using the DU MAC entity (not reset) on the first cell during or after the random access procedure 332 or after determining that the UE 102 connects to the first cell.

[0160] In some embodiments, the UE 102 uses at least one UE RLC entity (e.g., RLC 206B) to communicate RLC PDUs with at least one DU RLC entity (e.g., RLC 206B) of the DU 174 (e.g., the events 302, 304, 318, 320, 324, 330 and/or 331). In some embodiments, the UE 102 reestablishes some or all of the at least one UE RLC entity, after or in response to receiving the first LTM command and before performing 332 the random access procedure or communicating 336 with the DU 174 via the first cell. In some embodiments, the DU 174 reestablishes some or all of the at least one DU RLC entity after (e.g., in response to) transmitting the first LTM command, receiving the acknowledgement 331, or determining that the UE 102 connects to the first cell.

[0161] In some embodiments, the LTM DU configuration 1 may or may not include one or more RLC reestablishment indications (e.g., *reestablishRLC* field(s)) configuring the UE 102 to reestablish some or all of the at least one UE RLC entity. If the LTM DU configuration 1 includes the RLC reestablishment indication configuring the UE 102 to reestablish a first UE RLC entity, of the at least one UE RLC entity, which the UE 102 uses to communicate RLC PDU(s) with the DU 174, the UE 102 reestablishes the first UE RLC entity in response to the RLC reestablishment indication and the first LTM command. In some embodiments, UE 102 may reestablish the first UE RLC entity before performing 332 the random access procedure or communicating 336 with the DU 174 via the first cell. In other embodiments, UE 102 may reestablish the first UE RLC entity while or after performing 332 the random access procedure. Otherwise, if the LTM DU configuration 1 does not include the RLC reestablishment indication, the UE 102 refrains from reestablishing the first UE RLC entity in response to the first LTM command.

[0162] In some embodiments, when the UE 102 reestablishes the first UE RLC entity, the UE 102 performs at least one of the following actions for the first UE RLC entity:

- discard RLC SDU(s), RLC SDU segment(s), and RLC PDU(s), if any;
- stop and reset timer(s), if running; and
- reset state variables to initial values.

In some embodiments, the state variables and timer(s) are defined in 3GPP TS 38.322.

[0163] Otherwise, if the LTM DU configuration 1 does not include the RLC reestablishment indication for the first UE RLC entity, the UE 102 refrains from reestablishing the first UE RLC entity upon or when receiving the first LTM command. In other words, the UE 102 refrains from performing the actions for reestablishing the first UE RLC entity of the UE 102 upon or when receiving the first LTM command. In some embodiments, if the LTM DU configuration 1 or element 1 does not include the RLC reestablishment indication and includes an indication specifying that the configuration 1 is a full configuration, the UE 102 may reestablish the first UE RLC entity of the UE 102 upon or when receiving the first LTM command. Otherwise, if the LTM DU configuration 1 or element 1 does not include the RLC reestablishment indication and the indication specifying that the configuration 1 is a full configuration, the UE 102 refrains from reestablishing the first UE RLC entity upon or when receiving the first LTM command.

[0164] Similarly, the DU 174 reestablishes some or all of at least one DU RLC entity (e.g., NR RLC 206B) that the DU 174 uses to communicate with the at least one UE RLC entity of the UE 102 (e.g., the events 302, 304, 318, 320, 324, 330 and/or 331) in response to the RLC reestablishment indication. In some embodiments, the DU 174 reestablishes a first DU RLC entity of the at least one DU RLC entity after transmitting the first LTM command, receiving an acknowledgement for the first LTM command from the UE 102, or determining that the UE 102 connects to the first cell. In some embodiments, the acknowledgement is a HARQ ACK. In other embodiments, the acknowledgement is a MAC CE. In yet other embodiments, the acknowledgement is a PUCCH transmission. In some embodiments, when the first BS 104 reestablishes the first DU RLC entity, the DU 174 performs at least one of the following actions for the first DU RLC entity:

- discard RLC SDU(s), RLC SDU segment(s), and RLC PDU(s), if any;
- stop and reset timer(s), if running; and
- reset state variables to initial values.

In some embodiments, the state variables and timer(s) are defined in 3GPP TS 38.322.

[0165] In other embodiments, UE 102 refrains from reestablishing some or all of the at least one UE RLC entity in response to receiving the first LTM command. Similarly, DU 174 refrains from reestablishing some or more of the at least one DU RLC entity after (e.g., in response to) transmitting the first LTM command, receiving the acknowledgement 331, or determining that the UE 102 connects to the first cell. In other words, UE 102 communicates with the DU 174 on the first cell using some or all of the at least one UE RLC entity (not reestablished). For example, the some or all of the at least one UE RLC entity includes the first UE RLC entity and/or a second UE RLC entity. Similarly, the DU 174 communicates with the UE 102 using the some or all of the at least one DU RLC entity (not reestablished) on the first cell during or after the random access procedure 332 or after determining that the UE 102 connects to the first cell. For example, the some or all of the at least one DU RLC entity includes the first DU RLC entity and/or a second DU RLC entity.

[0166] In some embodiments, UE 102 uses at least one UE PDCP entity (e.g., PDCP 210) to communicate UL PDCP PDUs and/or DL PDCP PDUs with at least one CU PDCP entity (e.g., PDCP 210) of the CU 172 in event 302. In some embodiments, the UE 102 performs a PDCP recovery procedure for some or all of the at least one UE PDCP entity, after or in response to receiving the first LTM command. For example, UE 102 performs a PDCP recovery procedure for a first UE PDCP entity of the at least one UE PDCP entity, after or in response to receiving the first LTM command. In the PDCP recovery procedure, UE 102 may or may not reestablish the first UE PDCP entity. After or in response to performing the PDCP recovery procedure, the UE 102 may retransmit at least a portion of the UL PDCP PDUs to the CU 172 via the DU 174 and the first cell in the event 336. Similarly, the CU 172 performs a PDCP recovery procedure for some or all of the at least one CU PDCP entity after or in response to transmitting the first LTM command. For example, the CU 172 performs a PDCP recovery procedure for a first CU PDCP entity of the at least one CU PDCP entity, after or in response to transmitting the first LTM command. In some embodiments, the CU 172 performs the PDCP recovery procedure for the first CU PDCP entity in response to receiving the DU-to-CU message 329 or 334. In other embodiments, the CU 172 performs the PDCP recovery procedure for the first CU PDCP entity in response to receiving the DL Data Delivery Status message. In the PDCP recovery procedure, CU 172 may or may not reestablish the first CU PDCP entity. After or in response to performing the PDCP recovery

procedure, the CU 172 may retransmit at least a portion of the DL PDCP PDUs to the UE 102 via the DU 174 and the first cell in event 336.

[0167] In other embodiments, the UE 102 refrains from reestablishing some or all of the at least one UE PDCP entity in response to receiving the first LTM command. For example, some or all of the at least one UE PDCP entity includes the first UE PDCP entity and/or a second UE PDCP entity. Similarly, the CU 172 refrains from reestablishing some or more of the at least one CU PDCP entity, after (e.g., in response to) receiving the DU-to-CU message 329 or 340 or after (e.g., in response to) receiving the DL Data Delivery Status message. In other words, the UE 102 communicates with the CU 172 via the DU 174 and the first cell using some or all of the at least one UE PDCP entity (not reestablished). For example, some or all of the at least one UE PDCP entity includes the first UE PDCP entity and/or a second UE PDCP entity. Similarly, the CU 172 communicates with the UE 102 using some or all of the at least one CU PDCP entity (not reestablished) via the DU 174 and the first cell. For example, some or all of the at least one CU PDCP entity includes the first CU PDCP entity and/or a second CU PDCP entity.

[0168] In some embodiments, after determining that the UE 102 connects to the first cell, the CU 172 may transmit 338 a CU-to-DU message (e.g., a *UE Context Modification Request* message) to the DU 174 to indicate the DU 174 to stop communicating with the UE 102 and/or to release or suspend resources, of the cell 124A, configured for the UE 102. In response, the DU 174 may stop communicating on the cell 124A with the UE 102 and/or release or suspend resources, of the cell 124A, configured for the UE 102, and transmit 340 a DU-to-CU message (e.g., a *UE Context Modification Response* message) to the CU-172. The optional events 338 and 340 are collectively referred to in FIG. 3 as a “resource release procedure” 396.

[0169] After or while communicating with the DU 174 on the first cell, events 344, 346, 348, 350, 351, 352, 354 and/or 356 might occur, similar to the events 324, 326, 328, 330, 331, 332, 334 and/or 336, respectively. The UE 102 transmits 344 at least one measurement report to the DU 174. The at least one measurement report includes at least one measurement result for a second cell (i.e., cell 2). The at least one measurement result indicates that the second cell is suitable for communication with UE 102 and/or the first cell is not suitable for communication with the UE 102. After (e.g., in response to) receiving the at least one measurement report, the DU 174 determines to activate the LTM DU configuration 2 and

generates a second LTM command to activate the LTM DU configuration 2 (i.e., the second LTM command commands the UE 102 to apply the LTM DU configuration 2). The DU 174 then transmits 350 the second LTM command to the UE on the first cell.

[0170] When or in response to determining to activate the LTM DU configuration 2 or transmit the second LTM command, the DU 174 might transmit 349 to the CU 172 a DU-to-CU message indicating LTM command (being) executed. In some embodiments, the DU 174 includes the cell ID 2 or the ID 2 (i.e., LTM ID) in the DU-to-CU message 349 to indicate that the DU 174 is to activate the LTM DU configuration 2. The DU may transmit the DU-to-CU message 349 to the CU 172 before or after transmitting the LTM command 350.

[0171] The descriptions for events 324, 326, 328, 330, 331, 332, 334 and/or 336 may be applied to the events 344, 346, 348, 350, 351, 352, 354 and/or 356 with simple changes. For example, “cell 124A”, “first LTM command”, “first cell”, “ID 1”, “LTM DU configuration 1” and/or “LTM CU configuration 1” are replaced with “first cell”, “second LTM command” and “second cell”, “ID 2”, “LTM DU configuration 2”, and/or “LTM CU configuration 2”, respectively.

[0172] Events 344, 346, 348, 350, 351, 352, and 354 are collectively referred to, in FIG. 3, as an “LTM execution procedure” 398. The events 304, 306, 390, 392, 394, 324, 326, 328, 329, 330, 331, 332, 334, 336, 396, 398, or 356 are collectively referred to in FIG. 3 as a LTM DU configuration and/or activation procedure 380.

[0173] Referring next to FIG. 4, in a scenario 400, the first BS 104 includes a CU 172, a source DU (S-DU) 174A and a target DU (T-DU) 174B. The S-DU 174A operates the cell 124A and optionally additional cell(s), while the T-DU 174B operates the first cell (e.g., cell 124C). The scenario 400 is similar to the scenario 300. Thus, the descriptions for scenario 300 may generally apply to scenario 400. The differences between the scenarios 300 and 400 are described below.

[0174] Initially, UE 102 communicates 402 with the S-DU 174A on cell 124A using a serving DU configuration and communicates with the CU 172 via the S-DU 174A. The S-DU 174A is a serving DU similar to the DU 174 in FIG. 3. During communication 402, the UE 102 transmits 404, 406 at least one measurement report (e.g., L1 or L3 measurement report(s)) to the CU 172 via the S-DU 174A. Based on the at least one measurement report, the CU 172 determines to prepare cell(s) 1, ..., N (operated by the T-DU 174B) for LTM for the UE 102, where N is a positive integer larger than 0 or 1. The cell(s) 1, ..., N are identified

by cell ID(s) 1, ..., N, respectively. In response to the determination, the CU 172 performs 490 an LTM preparation procedure with the T-DU 174B to (request the T-DU 174B to) prepare cell(s) 1, ..., N for LTM for the UE 102. N may be a positive integer larger than zero or 1. In the LTM preparation procedure 490, the CU 172 transmits a CU-to-DU message, including the cell ID(s) 1, ..., N, to the T-DU 174B to request the T-DU 174B to prepare the cell(s) 1, ..., N for LTM for the UE 102, similar to the event 308. In response, the T-DU 174B transmits a DU-to-CU message including the LTM DU configuration(s) 1, ..., N to the CU 172, similar to the event 310. The LTM DU configuration(s) 1, ..., N configures the cell(s) 1, ..., N for LTM, respectively. In details, the LTM DU configuration(s) 1, ..., N include configuration parameters for communication on the cell(s) 1, ..., N, respectively. In some embodiments, the CU-to-DU message and DU-to-CU message in procedure 490 are UE Context Setup Request message and UE Context Setup Response message, respectively. The CU 172 then transmits the LTM DU configuration(s) 1, ..., N in an RRC reconfiguration message in an LTM configuration delivery procedure 494, similar to the LTM configuration delivery procedure 394. In some embodiments, the T-DU 174B may include cell index(es) 1, ..., N in the LTM DU configuration(s) 1, ..., N, respectively. In some embodiments, the CU 172 may set the cell index(es) 1, ..., N to different values and include the cell index(es) 1, ..., N in the CU-to-DU message of the procedure 490.

[0175] After performing the LTM preparation procedure 490, the CU 172 might perform an additional LTM preparation procedure(s) with the T-DU 174B to prepare cell(s) N+1, ..., N+M for LTM for the UE 102, similar to the procedure 490, where M is a positive integer larger than zero. The CU 172 might determine to do so based on one or more measurement reports received from the UE 102 via the S-DU 174A, similar to the events 404, 406. In the additional LTM preparation procedure, the CU 172 transmits a CU-to-DU message including cell ID(s) N+1, ..., N+M to the T-DU 174B to request the T-DU 174B to prepare the cell(s) N+1, ..., N+M for LTM for the UE 102. The cell ID(s) N+1, ..., N+M identifies the cell ID(s) N+1, ..., N+M, respectively. In response to the CU-to-DU message, the T-DU 174B transmits a DU-to-CU message including the LTM DU configuration(s) N+1, ..., N+M to the CU 172. The LTM DU configuration(s) N+1, ..., N+M configures the cell(s) N+1, ..., N+M for LTM, respectively. In details, the LTM DU configuration(s) N+1, ..., N+M include configuration parameters for communication on the cell(s) N+1, ..., N+M, respectively. The CU 172 then transmits the LTM DU configuration(s) N+1, ..., N+M in an RRC

reconfiguration message in an additional LTM configuration delivery procedure, similar to the LTM configuration delivery procedure 394 or 494.

[0176] In some embodiments, the LTM preparation procedure 490 is a UE Context Setup procedure, and the additional LTM preparation procedure is a UE Context Modification procedure.

[0177] In some embodiments, the CU 172 and S-DU 174A might perform procedure 380 with the UE 102, as described for FIG. 3. In procedure 380, the CU 172 and S-DU 174A perform the procedure(s) 390 and/or 392 to prepare cell(s) of the S-DU 174A for LTM for the UE 102. Note, the value N in the procedure 380 or described for FIG. 3 may be the same as or different from the value N described for FIG. 4. In procedure 390, the CU 172 might receive the first DU-to-CU message including the reference LTM DU configuration from the S-DU 174A in event 310. In other embodiments, the CU 172 and S-DU 174A do not perform procedure 380 with the UE 102. In such cases, the CU 172 may perform 488 a reference LTM DU configuration query procedure with the S-DU 174A to obtain a reference LTM DU configuration. In procedure 488, the CU 172 transmits 460 a CU-to-DU message to the S-DU 174A to request or query a reference LTM DU configuration. In some embodiments, the CU 172 may include an indication in the CU-to-DU message to request or query a reference LTM DU configuration. In response to the indication or CU-to-DU message 460, the S-DU 174A transmits 462 a DU-to-CU message including a reference LTM DU configuration to the CU 172. In some embodiments, the indication is a reference LTM DU configuration query indication. In other embodiments, the indication is an LTM indication, and the CU 172 might include a query indication (e.g., GNB-DU Configuration Query IE) in the CU-to-DU message. After receiving the reference LTM DU configuration (i.e., either in the procedure 390 or in the procedure 488), the CU 172 includes the reference LTM DU configuration (received from the S-DU 174A) in the CU-to-DU message in the LTM preparation procedure 490. The T-DU 174B generates the LTM DU configuration(s) 1, ..., N based on the reference LTM DU configuration received from the CU 172. In such cases, the T-DU 174B does not include a reference LTM DU configuration in the DU-to-CU message in procedure 490. In case of the additional LTM preparation procedure, the T-DU 174B does not include a reference LTM DU configuration in the DU-to-CU message in the additional LTM preparation procedure. The CU 172 might not include the reference LTM DU configuration in the CU-to-DU message in the additional LTM preparation procedure with the T-DU 174B. In the case of the additional LTM preparation procedure, the T-DU 174B generates the LTM

DU configuration(s) $N+1, \dots, N+M$ based on the reference LTM DU configuration received from the CU 172.

[0178] In some embodiments, the CU 172 does not provide a reference LTM DU configuration to the T-DU 174B in the LTM preparation procedure 490. In such cases, the T-DU 174B generates a reference LTM DU configuration and generates the LTM DU configuration(s) $1, \dots, N$ based on the reference LTM DU configuration. In such cases, the T-DU 174B includes the reference LTM DU configuration in the DU-to-CU message in procedure 490. The CU 172 transmits the reference LTM DU configuration in the RRC reconfiguration message in procedure 490. In the case of the additional LTM preparation procedure, the T-DU 174B generates the LTM DU configuration(s) $N+1, \dots, N+M$ based on the reference LTM DU configuration. In this case, the T-DU 174B might not include the reference LTM DU configuration in the DU-to-CU message in the additional LTM preparation procedure. In some embodiments, the reference LTM DU configuration generated by the T-DU 174B is different from the reference LTM DU configuration generated by the S-DU 174A. In other embodiments, the reference LTM DU configuration generated by the T-DU 174B is the same as the reference LTM DU configuration generated by the S-DU 174A.

[0179] In some embodiments, the CU 172 includes the LTM DU configuration(s) $1, \dots, N$ of the procedure 380 in the CU-to-DU message of the procedure 490, and the T-DU 174B generates the LTM DU configuration(s) $1, \dots, N$ and/or $N+1, \dots, N+M$, considering or based on configuration(s) in the LTM DU configuration(s) of the procedure 380.

[0180] In some embodiments, an LTM DU configuration X of procedure 380 includes at least one reference signal (RS) resource configuration X , where $1 \leq X \leq N$. Each of the RS resource configuration(s) X configures one or more RSs or one or more RS resources associated with a cell X of the S-DU 174A. The RS(s) includes SSB(s) and/or CSI-RS(s). The RS resource(s) includes SSB resource(s) and/or CSI-RS resource(s). In some embodiments, each of the RS resource configuration(s) X includes an RS resource configuration ID. In some embodiments, the RS resource configuration(s) X is/are (similar to) *CSI-ResourceConfig* IE(s). In some embodiments, the LTM DU configuration X includes a *CSI-MeasConfig* IE and the *CSI-MeasConfig* IE includes the *CSI-ResourceConfig* IE(s). The T-DU 174B generates at least one report configuration 1 for reporting, on cell 1 of the T-DU 174B, measurement results of the RS(s) or RS resource(s) and includes the report

configuration(s) 1 in the LTM DU configuration 1. In some embodiments, the report configuration(s) 1 is/are (similar to) *CSI-ReportConfig* IE(s). In some embodiments, the T-DU 174B generates at least one RS resource configuration 1, considering or based on the RS resource configuration(s) X and includes the RS resource configuration(s) 1 in the LTM DU configuration 1. In some embodiments, the T-DU 174B includes the RS resource configuration(s) X in the RS resource configuration(s) 1. In other embodiments, the T-DU 174B includes each of the RS resource configuration(s) X in the RS resource configuration(s) 1, except the RS resource configuration ID(s) in the RS resource configuration(s) X. The T-DU 174B assigns an RS resource configuration ID to a value for each of the RS resource configuration(s) 1 (including the RS resource configuration(s) X) and includes the RS resource configuration ID in the corresponding RS resource configuration.

[0181] In some embodiments, the report configuration(s) 1 configures one or more UL resources (e.g., PUCCH resources or PUSCH resources) on cell 1 for the UE 102 to transmit measurement results. In some embodiments, each of the report configuration(s) 1 includes one or more RS resource configuration IDs identifying one or more RS resource configurations included in the RS resource configuration(s) 1. After the UE 102 performs a LTM serving cell change/switch to the cell 1 from the cell 124A, the UE 102 communicates with the S-DU 174B (i.e., the T-DU 174B becomes a S-DU for the UE 102) and transmits measurement results on the UL resource(s) via the cell 1 to the S-DU 174B, in accordance with the report configuration(s) 1. Correspondingly, the S-DU 174B receives the measurement results on the UL resource(s) via cell 1 from the UE 102, in accordance with the report configuration(s) 1. In some embodiments, each of the measurement results includes one or more RS resource indicators and/or one or more quantized measurement values. The UE 102 performs measurements on the RS(s) or the RS resource(s) in accordance with the RS resource configuration(s) 1 and/or the report configuration(s) 1 and obtains the quantized measurement values from the measurements. In some embodiments, the RS resource indicator(s) indicates the RS(s) or a RS resource(s) where the UE 102 perform measurements or obtains the quantized measurement values. In some embodiments, the RS resource indicator(s) includes one or more SSB resource indicators (SSBRI(s)) and/or one or more CSI-RS resource indicators (CRI(s)). The quantized measurement values might include one or more L1-RSRP values and/or one or more L1-SINR values.

[0182] In some embodiments, the T-DU 174B also includes additional RS resource configuration(s) in the LTM DU configuration 1. Each of the additional RS resource

configuration(s) configures one or more additional RSs or one or more additional RS resources associated with cell 1. The additional RS(s) includes SSB(s) and/or CSI-RS(s). The additional RS resource(s) includes SSB resource(s) and/or CSI-RS resource(s). In some embodiments, each of the additional RS resource configuration(s) includes an RS resource configuration ID. In some embodiments, the additional RS resource configuration(s) is/are (similar to) *CSI-ResourceConfig* IE(s). In some embodiments, the T-DU 174B includes the *CSI-ResourceConfig* IE(s) in the *CSI-MeasConfig* IE. The T-DU 174B generates at least one additional report configuration for reporting, on cell 1 of the T-DU 174B, measurement results of the RS(s) or RS resource(s) and includes the additional report configuration(s) in the LTM DU configuration 1. In some embodiments, the additional report configuration(s) is/are (similar to) *CSI-ReportConfig* IE(s).

[0183] In some embodiments, the additional report configuration(s) configures one or more UL resources (e.g., PUCCH resources or PUSCH resources) on cell 1 for the UE 102 to transmit measurement results. In some embodiments, each of the additional report configuration(s) includes one or more RS resource configuration IDs identifying one or more RS resource configurations included in the additional RS resource configuration(s). After the UE 102 performs an LTM serving cell change/switch to the cell 1 from the cell 124A, the UE 102 communicates 436 with the S-DU 174B and transmits measurement results on the UL resource(s) via the cell 1 to the S-DU 174B, in accordance with the additional report configuration(s). Correspondingly, the S-DU 174B receives the measurement results on the UL resource(s) via cell 1, from the UE 102, in accordance with the additional report configuration(s). In some embodiments, each of the measurement results includes one or more RS resource indicators and/or one or more quantized measurement values. The UE 102 performs measurements on the additional RS(s) or the additional RS resource(s) in accordance with the additional RS resource configuration(s) and/or the additional report configuration(s) and obtains the quantized measurement values from the measurements. In some embodiments, the RS resource indicator(s) indicates the additional RS(s) or a RS resource(s) where the UE 102 perform measurements or obtains the quantized measurement values. In some embodiments, the RS resource indicator(s) includes one or more SSB resource indicators (SSBRI(s)) and/or one or more CSI-RS resource indicators (CRI(s)). The quantized measurement values might include one or more L1-RSRP values and/or one or more L1-SINR values.

[0184] Similarly, the T-DU 174B may generate RS resource configuration(s) 2, ..., N, and/or N+1, ..., N+M and/or report configuration(s) 2, ..., N, and/or N+1, ..., N+M, considering or based on the RS resource configuration(s) X, and include the RS resource configuration(s) 2, ..., N, and/or N+1, ..., N+M and/or the report configuration(s) 2, ..., N, and/or N+1, ..., N+M in the LTM DU configuration(s) 2, ..., N, and/or N+1, ..., N+M, respectively, as described above.

[0185] In other embodiments, the LTM DU configuration X of the procedure 380 includes at least one TCI state configuration X, where $1 \leq X \leq N$. Each of the TCI state configuration(s) X configures a TCI state that associates one or two DL RSs with a corresponding QCL type. In some embodiments, the DL RS(s) may be associated with the cell X operated by the S-DU 174A. In some embodiments, each of the TCI state configuration(s) X includes a TCI state ID. In some embodiments, each of the TCI state configuration(s) X is a *TCI-State* IE. In some embodiments, the TCI state configuration(s) X includes/is/are an *ul-TCI-ToAddModList-r17* field, one or more *TCI-UL-State-r17* IEs, a *dl-OrJointTCI-StateToAddModList-r17* field, one or more *TCI-State* IEs, *TCI-ActivatedConfig* IE, and/or a *tcI-StatesToAddModList* field. In some embodiments, the LTM DU configuration X includes a *PDSCH-Config* IE and the *PDSCH-Config* IE includes the TCI state configuration(s) X. In some embodiments, the T-DU 174B generates at least one TCI state configuration 1, considering or based on the TCI state configuration(s) X, and includes the TCI state configuration(s) 1 in the LTM DU configuration 1. In some embodiments, the TCI state configuration(s) 1 includes the TCI state configuration(s) X. In other embodiments, the T-DU 174B includes each of the TCI state configuration(s) X in the TCI state configuration(s) 1, except the TCI state ID(s) in the TCI state configuration(s) X. The T-DU 174B assigns a TCI state ID to a value for each of the TCI state configuration(s) 1 (including the TCI state configuration(s) X) and includes the TCI state ID in the corresponding TCI state configuration. While the UE 102 and the S-DU 174B communicate 436 with one another, the S-DU 174B might transmit a LTM command to the UE 102 to command the UE 102 to perform a fast serving cell change to the cell X. The S-DU 174B includes a TCI state ID in the LTM command to indicate to the UE 102 to apply a TCI state configuration identified by the TCI state ID to communicate on the cell X, where the TCI state configuration is one of the TCI state configuration(s) X or includes configurations of one of the TCI state configuration(s) X.

[0186] Similarly, the T-DU 174B may generate TCI state configuration(s) 2, ..., N, considering or based on the RS resource configuration(s) X, and include the TCI state configuration(s) 2, ..., N, and/or N+1, ..., N+M in the LTM DU configuration(s) 2, ..., N, and/or N+1, ..., N+M, respectively, as described above. Thus, the at least one TCI configuration may be generated by one of the CU 172, S-DU 174A, or T-DU 174B.

[0187] In some embodiments, in cases where the CU 172 performs the procedure 380 after performing the procedure 490, the CU 172 includes the LTM DU configuration(s) 1, ..., N of the procedure 490 in the CU-to-DU message of the procedure 380, and the S-DU 174A generates the LTM DU configuration(s) 1, ..., N of the procedure 380, considering or based on configurations in the LTM DU configuration(s) of the procedure 490, in a similar way as described above.

[0188] In some embodiments, the CU 172 assigns ID(s) 1, ..., N identifying the LTM DU configuration(s) 1, ..., N (received from the T-DU 174B), respectively, and performs the procedure 492 with the T-DU 174B to provide the ID(s) 1, ..., N and/or cell ID(s) 1, ..., N to the T-DU 174B, similar to the procedure 392. Thus, the T-DU 174B associates the ID(s) 1, ..., N with the LTM DU configuration(s) 1, ..., N and/or the cell ID(s) 1, ..., N, respectively. In other embodiments, the T-DU 174B assigns ID(s) 1, ..., N identifying the LTM DU configuration(s) 1, ..., N (generated by the T-DU 174B), respectively and includes the ID(s) 1, ..., N in the DU-to-CU message of the procedure 490, similar to the event 310. In some embodiments, the CU 172 assigns ID(s) N+1, ..., N+M identifying the LTM DU configuration(s) N+1, ..., N+M, respectively, and performs a procedure (similar to the procedure 492) with the T-DU 174B to provide the ID(s) N+1, ..., N+M and/or cell ID(s) N+1, ..., N+M to the T-DU 174B, similar to the procedure 392. Thus, the T-DU 174B associates the ID(s) N+1, ..., N+M with the LTM DU configuration(s) N+1, ..., N+M and/or the cell ID(s) N+1, ..., N+M, respectively. In other embodiments, the T-DU 174B assigns ID(s) N+1, ..., N+M identifying the LTM DU configuration(s) N+1, ..., N+M, respectively and includes the ID(s) 1, ..., N in the DU-to-CU message of the additional LTM preparation procedure, similar to the event 310.

[0189] In some embodiments, the CU 172 transmits 412 a CU-to-DU message including the ID(s) 1, ..., N to the S-DU 174A and in response, receives 414 a DU-to-CU message from the S-DU 174A. The CU-to-DU message 412 and DU-to-CU message 414 are collectively referred to in FIG. 4 as an LTM ID transfer procedure 493 or an LTM cell index

transfer procedure 493. In some embodiments, messages 412 and 414 may be UE Context Modification Request message and UE Context Modification Response message, respectively. In some embodiments, the CU 172 includes the LTM DU configuration(s) 1, ..., N and/or cell ID(s) 1, ..., N in the CU-to-DU message 412. In one embodiment, the CU 172 includes the ID(s) 1, ..., N in the CU-to-DU message 412. In another embodiment, the CU 172 includes the cell index(es) 1, ..., N in the CU-to-DU message 412. In some alternative embodiments, the CU 172 may perform multiple LTM ID transfer procedures to transmit the ID(s) 1, ..., N, cell ID(s) 1, ..., N, and/or LTM DU configuration(s) 1, ..., N to the S-DU 174A. In each of the procedures, the CU 172 may include a particular portion of the ID(s) 1, ..., N, cell ID(s) 1, ..., N, and/or LTM DU configuration(s) 1, ..., N in a CU-to-DU message similar to the message 412. Thus, the S-DU 174A associates the ID(s) 1, ..., N with the LTM DU configuration(s) 1, ..., N and/or the cell ID(s) 1, ..., N, respectively. In other alternative embodiments, the CU 172 may perform multiple LTM cell index transfer procedures to transmit the cell index(es) 1, ..., N, cell ID(s) 1, ..., N, and/or LTM DU configuration(s) 1, ..., N to the S-DU 174A. In each of the procedures, the CU 172 includes a particular portion of the cell index(es) 1, ..., N, cell ID(s) 1, ..., N, and/or LTM DU configuration(s) 1, ..., N in a CU-to-DU message similar to the message 412. Thus, the S-DU 174A associates the cell index(es) 1, ..., N with the LTM DU configuration(s) 1, ..., N and/or the cell ID(s) 1, ..., N, respectively.

[0190] In some embodiments, the S-DU 174A generates a first serving DU configuration, based on the LTM DU configuration(s) 1, 2, ..., and/or N, and includes the first serving DU configuration in the DU-to-CU message 414. In some embodiments, the first serving DU configuration includes configurations updating (e.g., augmenting, modifying, or replacing) the serving DU configuration 402. In other embodiments, the first serving DU configuration includes configurations that are not included in the serving DU configuration 402. The CU 172 transmits an RRC reconfiguration message including the first serving DU configuration to the UE 102. UE 102 applies the first serving DU configuration to communicate with the serving DU upon receiving the RRC reconfiguration message. For example, the RRC reconfiguration message is or is similar to the RRC reconfiguration message in procedure 494. Depending on embodiments, the UE 102 communicates with the S-DU 174A using configurations included in the serving DU configuration 402 and not updated by the first serving DU configuration. The following are example embodiments of generating the first serving DU configuration based on the LTM DU configuration 1, ..., N.

[0191] In some embodiments, an LTM DU configuration Y of procedure 490 includes at least one RS resource configuration Y, where $1 \leq Y \leq N$. Each of the RS resource configuration(s) Y configures one or more RSs or one or more RS resources associated with the cell Y of the T-DU 174B. The RS(s) includes SSB(s) and/or CSI-RS(s). The RS resource(s) includes SSB resource(s) and/or CSI-RS resource(s). In some embodiments, each of the RS resource configuration(s) Y includes an RS resource configuration ID. In some embodiments, the RS resource configuration(s) Y is/are (similar to) *CSI-ResourceConfig* IE(s). In some embodiments, the LTM DU configuration Y includes a *CSI-MeasConfig* IE and the *CSI-MeasConfig* IE includes the *CSI-ResourceConfig* IE(s). The S-DU 174A generates at least one serving report configuration for reporting, on the cell 124A, measurement results of the RS(s) or RS resource(s) and includes the serving report configuration(s) in the first serving DU configuration. In some embodiments, the serving report configuration(s) is/are (similar to) *CSI-ReportConfig* IE(s). In some embodiments, the S-DU 174A generates at least one serving RS resource configuration, considering or based on the RS resource configuration(s) Y, and includes the serving RS resource configuration(s) in the first serving DU configuration. In some embodiments, the S-DU 174A includes the RS resource configuration(s) Y in the serving RS resource configuration(s). In other embodiments, the S-DU 174A includes each of the RS resource configuration(s) Y in the serving RS resource configuration(s), except the RS resource configuration ID(s) in the RS resource configuration(s) Y. The S-DU 174A assigns a RS resource configuration ID to a value for each of the serving RS resource configuration(s) (including the RS resource configuration(s) Y) and includes the RS resource configuration ID in the corresponding serving RS resource configuration.

[0192] In some embodiments, the serving report configuration(s) configures one or more UL resources (e.g., PUCCH resources or PUSCH resources) on cell 124A for the UE 102 to transmit measurement results. In some embodiments, each of the serving report configuration(s) includes one or more RS resource configuration IDs identifying one or more RS resource configurations included in the serving RS resource configuration(s). While the UE 102 communicates with the S-DU 174A, the UE 102 transmits measurement results on the UL resource(s) via the cell 124A to the S-DU 174A, in accordance with the serving report configuration(s) (e.g., event 424). Correspondingly, the S-DU 174A receives the measurement results on the UL resource (s) via the cell 124A from the UE 102, in accordance with the serving report configuration(s). In some embodiments, each of the measurement

results includes one or more RS resource indicators and/or one or more quantized measurement values. UE 102 performs measurements on the RS(s) or the RS resource(s) in accordance with the serving RS resource configuration(s) and/or the serving report configuration(s) and obtains the quantized measurement values from the measurements. In some embodiments, the RS resource indicator(s) indicates the RS(s) or a RS resource(s) where the UE 102 performs measurements or obtains the quantized measurement values. In some embodiments, the RS resource indicator(s) includes one or more SSB resource indicators (SSBRI(s)) and/or one or more CSI-RS resource indicators (CRI(s)). The quantized measurement values might include one or more L1-RSRP values and/or one or more L1-SINR values.

[0193] In other embodiments, the LTM DU configuration Y of the procedure 490 includes at least one TCI state configuration Y, where $1 \leq Y \leq N$. The at least one TCI state configuration may be generated by one of the CU 172, S-DU 174A, or T-DU 174B. Each of the TCI state configuration(s) Y configures a TCI state that associates one or two DL RSs with a corresponding QCL type. In some embodiments, the DL RS(s) may be associated with the cell Y operated by the T-DU 174B. In some embodiments, each of the TCI state configuration(s) Y includes a TCI state ID. In some embodiments, each of the TCI state configuration(s) Y is a *TCI-State* IE. In some embodiments, the TCI state configuration(s) Y includes/is/are an *ul-TCI-ToAddModList-r17* field, one or more *TCI-UL-State-r17* IEs, a *dl-OrJointTCI-StateToAddModList-r17* field, one or more *TCI-State* IEs, *TCI-ActivatedConfig* IE and/or a *tcI-StatesToAddModList* field. In some embodiments, the LTM DU configuration Y includes a *PDSCH-Config* IE and the *PDSCH-Config* IE includes the TCI state configuration(s) Y. In some embodiments, the S-DU 174A generates at least one serving TCI state configuration, considering or based on the TCI state configuration(s) Y and includes the serving TCI state configuration(s) in the first serving DU configuration. In some embodiments, the serving TCI state configuration(s) 1 includes the TCI state configuration(s) Y. In other embodiments, the S-DU 174A includes each of the TCI state configuration(s) Y in the serving TCI state configuration(s), except the TCI state ID(s) in the TCI state configuration(s) Y. The S-DU 174A assigns a TCI state ID to a value for each of the serving TCI state configuration(s) (including the TCI state configuration(s) Y) and includes the TCI state ID in the corresponding serving TCI state configuration. While the S-DU 174A communicates 436 with the UE 102, the S-DU 174A might transmit an LTM command to the UE 102 to request the UE 102 to perform a fast serving cell change to the cell Y. The S-DU

174A includes a TCI state ID in the LTM command to request the UE 102 to apply a TCI state configuration identified by the TCI state ID, to communicate on the cell Y. The TCI state configuration is one of the TCI state configuration(s) Y or includes configurations of one of the TCI state configuration(s) Y.

[0194] In some embodiments, the CU 172 transmits a CU-to-DU message including the ID(s) N+1, ..., N+M to the S-DU 174A and receives a DU-to-CU message from the S-DU 174A in response, similar to the CU-to-DU message 412 and the DU-to-CU message 414, respectively. In some embodiments, the CU 172 includes the LTM DU configuration(s) N+1, ..., N+M and/or cell ID(s) N+1, ..., N+M in the CU-to-DU message. In some alternative embodiments, the CU 172 may perform multiple LTM ID transfer procedures to transmit the ID(s) N+1, ..., N+M, cell ID(s) N+1, ..., N+M and/or LTM DU configuration(s) N+1, ..., N+M to the S-DU 174A. In each of the procedures, the CU 172 includes a particular portion of the ID(s) N+1, ..., N+M, cell ID(s) N+1, ..., N+M and/or LTM DU configuration(s) 1, ..., N in a CU-to-DU message similar to the message 412. Thus, the S-DU 174A associates the ID(s) N+1, ..., N+M with the LTM DU configuration(s) N+1, ..., N+M and/or the cell ID(s) N+1, ..., N+M, respectively. In some embodiments, the S-DU 174A generates a second serving DU configuration, based on the LTM DU configuration(s) N+1, N+2, ..., and/or N+M, and includes the second serving DU configuration in the DU-to-CU message. In some embodiments, the second serving DU configuration includes configurations updating (e.g., augmenting, modifying, or replacing) the first serving DU configuration and/or updating configurations included in the serving DU configuration 402 and not updated by the first serving DU configuration. In other embodiments, the second serving DU configuration includes configurations that are not included in the first serving DU configuration. The CU 172 transmits an RRC reconfiguration message including the second serving DU configuration to the UE 102 via the S-DU 174A. UE 102 applies the second serving DU configuration to communicate with the serving DU upon receiving the RRC reconfiguration message. For example, the RRC reconfiguration message is or is similar to the RRC reconfiguration message in procedure 494. Depending on embodiments, UE 102 communicates with the S-DU 174A using configurations included in the serving DU configuration 402 and/or the first serving DU configuration and not updated by the second serving DU configuration. In some embodiments, the S-DU 174A generates one or more new L1 measurement configurations, based on L1 measurement configuration(s) in the LTM DU configuration(s) N+1, N+2, ..., and/or N+M, and includes the new L1 measurement

configuration(s) in the second serving DU configuration. In some embodiments, the S-DU 174A generates one or more new TCI state configuration, based on TCI state configuration(s) in the LTM DU configuration(s) N+1, N+2, ..., and/or N+M, and includes the new TCI state configuration(s) in the second serving DU configuration.

[0195] In some embodiments, in the case that the CU 172 and S-DU 174A perform the procedure 380 with the UE 102, value(s) of the ID(s) 1, ..., N of the procedure 380 are different from value(s) of the ID(s) 1, ..., N, and the ID(s) N+1, ..., N+M described for the scenario 400. In some embodiments, in the case that the CU 172 and S-DU 174A perform the procedure 380 with the UE 102, value(s) of the cell ID(s) 1, ..., N of the procedure 380 are different from value(s) of the cell ID(s) 1, ..., N, and the cell ID(s) N+1, ..., N+M described for the scenario 400. In some embodiments, in the case that the CU 172 and S-DU 174A perform the procedure 380 with the UE 102, value(s) of the cell index(es) 1, ..., N of the procedure 380 are different from value(s) of the cell index(es) 1, ..., N, and the cell index(es) N+1, ..., N+M described for the scenario 400.

[0196] Later in time, UE 102 might transmit 424 at least one measurement report to the S-DU 174A, similar to the event 324. The at least one measurement report (e.g., L1 measurement report(s)) includes an event ID, first measurement result(s) for the cell 1 of the T-DU 174B, and/or includes second measurement result(s) for the cell 124A. In some embodiments, the first measurement result(s) may be or include RSRP, RSRQ, and/or SINR that the UE 102 obtains from measuring reference signal(s) transmitted on the cell 1. Likewise, the second measurement result(s) may be or include RSRP, RSRQ, and/or SINR that the UE 102 obtains from measuring reference signal(s) transmitted on the cell 124A. In some embodiments, the event ID, RSRP, RSRQ, and/or SINR are L1-event ID, L1-RSRP, L1-RSRQ, and/or L1-SINR, respectively. Based on the first measurement result(s) and/or second measurement result(s), the S-DU 174A might transmit 430 a first LTM command (i.e., LTM command 1) including the ID 1 to the UE 102, to request the UE 102 to perform a serving cell change/switch to the cell 1 of the T-DU 174B. In some embodiments, the first LTM command includes the ID 1. In other embodiments, the first LTM command includes the cell index 1. The first LTM command may also include the at least one TCI state configuration. When the UE 102 receives the first LTM command, the UE 102 performs a serving cell change to cell 1, from a serving cell, in accordance with the LTM DU configuration 1. After (e.g., in response to) receiving the first LTM command, the UE 102 might or might not perform 432 a random access procedure with the T-DU 174B, similar to

the event 332. After (e.g., in response to) receiving the first LTM command or completing the random access procedure 432, the UE 102 may communicate 436 with the T-DU 174B on the first cell using the LTM DU configuration 1 and/or reference LTM DU configuration and communicates with the CU 172 via the T-DU 174B, similar to the event 336. If a serving cell change occurs in procedure 380, the serving cell may be cell 1 (e.g., cell 124C) or cell 2 of the S-DU 174A. Otherwise, if no serving cell change occurs in procedure 380 or the procedure 380 is not performed, the serving cell is the cell 124A. If the first LTM command includes the ID 1, the UE 102 identifies the LTM DU configuration 1 and/or cell ID 1 (i.e., the cell 1), based on the ID 1, as described relative to FIG. 3. If the first LTM command includes the cell index 1, the UE 102 identifies the LTM DU configuration 1, cell ID 1 (i.e., the cell 1), and/or LTM ID 1, based the cell index 1, as described for FIG. 3. The UE 102 applies the LTM DU configuration 1 (and the at least one TCI state configuration) to communicate with the T-DU 174B, after (e.g., in response to) receiving the first LTM command or successfully accessing cell 1.

[0197] When or in response to determining to activate the LTM DU configuration 1 or transmit the first LTM command 430, the S-DU 174A might transmit 429 to the CU 172 a DU-to-CU message indicating LTM (being) executed. In some embodiments, the S-DU 174A includes the cell ID 1 or the ID 1 (i.e., LTM ID) in the DU-to-CU message 429 to indicate that the S-DU 174A is to activate the LTM DU configuration 1 or trigger a LTM serving cell change. The S-DU 174A may transmit the DU-to-CU message 429 to the CU 172 before or after transmitting the LTM command 430. In some embodiments, when or after the CU 172 receives the DU-to-CU message 429, the CU 172 might stop or suspend transmitting DL data for the UE 102 to the S-DU 174A until receiving the DU-to-CU message 434. After receiving the DU-to-CU message 434, the CU 172 starts, continues or resumes transmitting DL data for the UE 102 to the T-DU 174B. When or after the T-DU 174B detects that UE 102 accesses cell 1, the T-DU 174B transmits the DL data to the UE 102 via cell 1.

[0198] The resource release procedure 496 may be similar to the procedure 396. Alternatively, in the resource release procedure 496, the CU 172 may transmit a CU-to-DU message (e.g., a *UE Context Release Command* message) to the S-DU 174A to release a UE context of the UE 102. In response, the S-DU 174A releases a UE context of the UE 102 and transmits 440 a DU-to-CU message (e.g., a *UE Context Release Complete* message) to the CU-172.

[0199] The events 380, 404, 406, 490, 492, 494, 494, 424, 426, 428, 429, 430, 431, 432, 434, 436, 496, 498, or 456 are collectively referred to in FIG. 4 as an “LTM configuration and/or activation procedure” 480.

[0200] Referring next to FIG. 5A, in a scenario 500A, the second BS 106 operates as an MN, and the first BS 104 operates as an SN. The SN 104 includes a CU 172 and a DU 174. The scenario 500A is similar to the scenario 300, except that the scenario 500A is a DC scenario and the scenario 300 is a single connectivity (SC) scenario. The MN 106 may include a CU and a DU similar to the first BS 104 of FIG. 3.

[0201] Initially, UE 102 is in DC communication with MN 106 and with SN 104. In event 502, the UE 102 communicates with the DU 174 on cell 124A using a serving DU configuration and communicates with the CU 172 via the DU 174 using a serving CU configuration, similar to event 302. In some alternative embodiments, UE 102 does not communicate with the CU 172 via the DU 174 in the event 302. In some embodiments, the UE 102 in DC may communicate 502 UL PDUs and/or DL PDUs with the MN 106 and/or SN 104 via radio bearers which may include SRBs and/or DRB(s). The MN 106 and/or the SN 104 may configure the radio bearers to the UE 102. The UE 102 in DC communicates 502 UL PDUs and/or DL PDUs with the SN 104 on an SCG (i.e., SCG radio resources) that the SN 104 configures for communication with the UE 102. The UE 102 in DC communicates UL PDUs and/or DL PDUs with the MN 106 on an MCG (i.e., MCG radio resources) in accordance with a MN configuration (i.e., MCG configuration). In some embodiments, the serving DU configuration is an SN configuration (i.e., SCG configuration). In the MN configuration, the MN 106 configures the MCG which includes at least one serving cell (e.g., the cell 126 and/or other cell(s)) operated by the MN 106. In the serving DU configuration, the SN 106A configures the SCG which includes at least one serving cell (e.g., the cell 124A and/or other cell(s)) operated by the SN 104. In some embodiments, the MN configuration includes multiple configuration parameters, and the UE 102 receives the configuration parameters in one or more RRC messages from the MN 106. As described for FIG. 3, the serving DU configuration includes multiple configuration parameters. In some embodiments, the UE 102 receives these configuration parameters in one or more RRC messages from the SN 104, e.g., via the MN 106 and/or on an SRB (e.g., SRB3) that the MN 106 or SN 104 configures to exchange RRC messages between the UE 102 and the SN 104.

[0202] While the UE 102 communicates in DC with the MN 106 and SN 104, the MN 106 may perform 580 a LTM DU configuration and/or activation procedure with the UE 102, similar to the procedures 380 and/or 480. In some embodiments, while communicating in DC with the MN 106 and SN 104, the UE 102 may transmit at least one measurement report to the CU 172 via the DU 174 and cell 124A in the events 504 and 506, similar to the events 304 and 306, respectively. In other embodiments, while communicating in DC with the MN 106 and SN 104, the UE 102 may transmit 505 at least one measurement report to the MN 106 via the cell 126. MN 106 in turn transmits 507 the at least one measurement report to the CU 172. In some embodiments, the MN 106 generates at least one SN message including the at least one measurement report and transmits the at least one SN message to the CU 172 in the event 507. In one embodiment, the at least one SN message include *RRC Transfer* message(s) and/or *SN Modification Request* message(s).

[0203] After (e.g., in response to) receiving the at least one measurement report or while the SN 104 communicates with the UE 102, the SN 104 determines to prepare the first cell for the UE 102, as described relative to FIG. 3. The events 590, 592, 594, 524, 526, 528, 529, 530, 531, 532, 534, 536, 596, 598, or 556 are similar to the events 390, 392, 394, 324, 326, 328, 329, 330, 331, 332, 334, 336, 396, 398, or 356, respectively. After receiving the first LTM command 530 (which may include an LTM DU configuration and/or a TCI state configuration), transmitting 531 the acknowledgement, and/or determining 532 that the UE 102 successfully connects to the first cell the UE 102 operating in DC with the MN 106 and SN 104 communicates 536 with the DU 174 on the first cell in accordance with the LTM DU configuration 1 and communicates 536 with the CU 172 via the DU 174, similar to the event 336. Later in time, the DU 174 and/or CU 172 may perform the LTM execution procedure 598 with the UE 102 to request the UE 102 to perform a cell change from the first cell to the second cell, similar to the procedure 398 or 498. As a result of the procedure 598, the UE 102 operating in DC with the MN 106 and SN 104 communicates 556 with the DU 174 on the second cell in accordance with the LTM DU configuration 2 and communicates 556 with the CU 172 via the DU 174, similar to the event 356.

[0204] The events 504, 506, 505, 507, 590, 592, 594, 524, 526, 528, 529, 530, 531, 532, 534, 536, 596, 598, or 556 are collectively referred to in FIG. 5A as an “LTM DU configuration and/or activation procedure” 581.

[0205] Referring next to FIG. 5B, a scenario 500B is generally similar to the scenario 500A, except that the SN 104 transmits 517, 519 the RRC reconfiguration message to the UE 102 via the MN 106 and receives 521, 523 the RRC reconfiguration complete message from the UE 102 via the MN 106. The RRC reconfiguration message transmitted at 517, 519 is similar to the RRC reconfiguration message transmitted at 316, 318. The RRC reconfiguration complete message received at 521, 523 is similar to the RRC reconfiguration message received at 320, 322. In some embodiments, the SN 104 generates a first SN message (e.g., *SN Modification Required* message, *SN Modification Required* message, or *RRC Transfer* message) including the RRC reconfiguration message and transmits the first SN message to the MN 106 in the event 517. The MN 106 generates a MN RRC message including the RRC reconfiguration message and transmits 519 the MN RRC message to the UE 102. In response, UE 102 generates a MN RRC response message including the RRC reconfiguration complete message and transmits 521 the MN RRC response message to MN 106. In some embodiments, the MN 106 generates a second SN message (e.g., *SN Reconfiguration Complete* message or *RRC Transfer* message) including the RRC reconfiguration complete message and transmits the second SN message to the SN 104 in event 523. In some embodiments, the MN RRC message and MN RRC response message may be a RRC reconfiguration message and a RRC reconfiguration complete message, respectively.

[0206] The events 504, 506, 505, 507, 590, 592, 594, 517, 519, 521, 523, 524, 526, 528, 529, 530, 531, 532, 534, 536, 596, 598, or 556 are collectively referred to in FIG. 5B as an “LTM DU configuration and/or activation procedure” 582.

[0207] Referring next to FIG. 6A, in a scenario 600A, the second BS 106 operates as an MN, and the first BS 104 operates as an SN, similar to the scenarios 300-500B. The SN 104 includes a CU 172, an S-DU 174A, and a T-DU 174B, similar to the first BS 104 in the scenario 400. While the UE 102 communicates in DC with the MN 106 and SN 104, the MN 106 may perform 680 an LTM DU configuration and/or activation procedure with the UE 102, similar to the procedures 380 and/or 480. While the UE 102 communicates in DC with the M-DU 174A and S-DU 174B, the CU 172 may perform 681 an LTM DU configuration and/or activation procedure with the UE 102 via the M-DU 174A or S-DU 174B, similar to the procedure 581 or 582.

[0208] Referring next to FIG. 6B, a scenario 600B is similar to the scenarios 300-500B and 600A, except that the SN 104 transmits 617, 619 the RRC reconfiguration message to the UE 102 via the MN 106 and receives 621, 623 the RRC reconfiguration complete message from the UE 102 via the MN 106.

[0209] Referring next to FIG. 7A, in a scenario 700A, the first BS 104 operates as an MN and an SN, similar to the scenarios 300-600B. The first BS 104 includes a CU 172, a master DU (M-DU) 174A, and a secondary DU (S-DU) 174B. The CU 172 operates with the M-DU 174A as a MN, similar to the first BS 104 in FIG. 3 or the MN 106 in FIGs. 5A-6B, and the CU 172 operates with the S-DU 174B as a SN, similar to the SN 104 in FIGs. 5A-6B.

[0210] In the scenario 700A, the UE 102 initially communicates 702 in DC with the M-DU 174A and S-DU 174B and communicates 702 with the CU 172 via the M-DU 174A and S-DU 174B. In event 702, the UE 102 communicates with the S-DU 174B on cell 124A using a serving DU configuration and communicates with the CU 172 via the S-DU 174B using a serving CU configuration, similar to event 302. Events 704 and 706 are similar to events 304 and 306. In some embodiments, UE 102 may transmit 705 at least one measurement report to the M-DU 174A, similar to event 304. The M-DU 174A in turn transmits 707 at least one DU-to-CU message including the at least one measurement report to the CU 172, similar to the event 306. While the UE 102 communicates in DC with the M-DU 174A and S-DU 174B, the CU 172 may perform 780 an LTM DU configuration and/or activation procedure with the UE 102 via the M-DU 174A, similar to the procedure 380.

[0211] The events 704, 706, 705, 707, 790, 792, 794, 724, 726, 728, 729, 730, 731, 732, 734, 736, 796, 798, or 756 are collectively referred to in FIG. 7A as an “LTM configuration and/or activation procedure” 781.

[0212] Referring next to FIG. 7B, a scenario 700B is similar to the scenarios 300-600B and 700A, except that the CU 172 transmits 717, 719 the RRC reconfiguration message to the UE 102 via the M-DU 174A and receives 721, 723 the RRC reconfiguration complete message from the UE 102 via the M-DU 174A.

[0213] The events 704, 706, 705, 707, 790, 792, 794, 717, 719, 721, 723, 724, 726, 728, 729, 730, 731, 732, 734, 736, 796, 798, or 756 are collectively referred to in FIG. 7B as an “LTM DU configuration and/or activation procedure” 782.

[0214] Referring next to FIG. 8A, in a scenario 800A, the first BS 104 operates as an MN and an SN, similar to the scenarios 300-700B. The first BS 104 includes a CU 172, a master

DU (M-DU) 174A, a secondary DU (S-DU) 174B, and a target secondary DU (T-DU) 174C. The CU 172 operates with the M-DU 174A as a MN and operates with the S-DU 174B as a SN. While the UE 102 communicates in DC with the M-DU 174A and S-DU 174B, the CU 172 may perform 880 a LTM DU configuration and/or activation procedure with the UE 102 via the M-DU 174A, similar to the procedure 380. While the UE 102 communicates in DC with the M-DU 174A and S-DU 174B, the CU 172 may perform 881 an LTM DU configuration and/or activation procedure with the UE 102 via the S-DU 174A, similar to the procedure 581 or 582.

[0215] Referring next to FIG. 8B, a scenario 800B is similar to the scenarios 300-700B and 800A, except that that the CU 172 transmits 817, 819 the RRC reconfiguration message to the UE 102 via the M-DU 174A and receives 821, 823 the RRC reconfiguration complete message from the UE 102 via the M-DU 174A.

[0216] Next, several example methods that may be implemented in a RAN node including a DU and/or a CU, to support LTM based on TCI state configurations are discussed next with reference to FIGs. 9A-16B. Examples and embodiments described for FIGs. 3-8B may apply or be combined with the embodiments illustrated in FIGs. 9A-16B.

[0217] FIG. 9A illustrates an example method 900A, which may be implemented by a CU (e.g., the CU 172 of the first BS 104 or second B 106), for enabling LTM for a UE (e.g., the UE 102). The method 900A begins at block 902, where the CU performs a first procedure for LTM for a UE with a first DU (e.g., events 308, 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The CU receives 904 a first LTM DU configuration for configuring a first cell for LTM, from the first DU in the first procedure (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The CU transmits 906 a first message including the first LTM DU configuration to the UE via a RAN node (e.g., events 316, 318, 394, 380, 480, 494, 580, 594, 581, 517, 519, 582, 680, 694, 681, 617, 619, 780, 794, 781, 717, 719, 880, 894, 881, 817, or 819). The CU performs 908 a second procedure for LTM change for the UE with the first DU (e.g., events 312, 314, 392, 380, 492, 480, 580, 592, 581, 582, 680, 692, 681, 780, 792, 880, 892, or 881). The CU receives 910 at least one first TCI state configuration from the first DU during the second procedure (e.g., events 314, 392, 380, 492, 480, 580, 592, 581, 582, 680, 692, 681, 780, 792, 880, 892, or 881). In some embodiments, each of the first TCI state configuration(s) configures a TCI state for the UE to transmit and/or receive data and/or

control signal on the first cell. The CU transmits 912 the first TCI state configuration(s) to a second DU (e.g., events 412, 493, 693, and 893). The CU transmits 914 a second message including the first TCI state configuration(s) to the UE via the RAN node (e.g., events 316, 318, 394, 380, 480, 494, 580, 594, 581, 517, 519, 582, 680, 694, 681, 617, 619, 780, 794, 781, 717, 719, 880, 894, 881, 817, or 819). In some embodiments, the CU includes the first TCI state configuration(s) in a LTM configuration IE and includes the LTM configuration IE in the second message. The LTM configuration IE includes the first LTM DU configuration.

[0218] The CU receives 916 an indication message from the first DU, indicating that the UE successfully accesses the first cell after transmitting the first message and the second message to the UE (e.g., events 334, 354, 398, 380, 434, 454, 498, 480, 580, 534, 598, 581, 582, 680, 634, 698, 681, 780, 734, 798, 880, 881, 834, or 898). The CU communicates 918 with the UE, via the first DU and the first cell using the first TCI state configuration (e.g., events 336, 356, 380, 436, 456, 480, 536, 556, 580, 581, 582, 636, 656, 680, 681, 736, 756, 780, 836, 856, 880, or 881).

[0219] In some embodiments, one of the first DU and the second DU is a serving DU and the other is a target DU (i.e., a candidate DU). In other embodiments, the first DU and the second DU are target DUs (i.e., candidate DUs). In some embodiments, the RAN node is a serving DU (e.g., the first DU, the second DU or a third DU), and the CU communicates with the UE via the serving DU and a serving cell operated by the serving DU. In other embodiments, the RAN node is a BS that communicates with the UE. For example, the BS is an MN and the CU is a CU of a SN. In another example, the BS is an SN and the CU is a CU of a MN.

[0220] In the first procedure, the CU receives a first DU-to-CU message including the first LTM DU configuration from the first DU. In the second procedure, the CU receives a second DU-to-CU message including the first TCI state configuration(s) from the first DU. In some embodiments, the first DU generates a serving DU configuration (e.g., RRC *CellGroupConfig* IE) including the first TCI state configuration(s) and includes the serving DU configuration in the second DU-to-CU message. In other embodiments, the first DU includes the first TCI state configuration(s) in the first LTM DU configuration. In yet other embodiments, the first DU includes the first TCI state configuration(s) in the serving DU configuration and the first LTM DU configuration. In the following descriptions, “the first

TCI state configuration(s)” may be replaced by “the serving DU configuration” or “the first LTM DU configuration”.

[0221] In some embodiments, the first DU-to-CU message and the second DU-to-CU message are the same message (i.e., the same instance). In other embodiments, the first DU-to-CU message and the second DU-to-CU message are separate messages. The first DU-to-CU message or the second DU-to-CU message may be a *UE Context Setup Response* message, a *UE Context Modification Response* message, or a *UE Context Modification Required* message as described below. In some embodiments, to identify the first LTM DU configuration and the first TCI state configuration(s), the first DU-to-CU message includes the first LTM DU configuration in a first interface protocol IE/field and the second DU-to-CU message includes the first TCI state configuration(s) in a second interface protocol IE/field. In some embodiments, the first interface protocol IE/field is a first F1AP IE/field and the second interface protocol IE/field is a second F1AP IE/field. In some embodiments, one of the first F1AP IE/field and the second F1AP IE/field is an *F1AP CellGroupConfig IE/field* and the other is not the *F1AP CellGroupConfig IE/field*. In other embodiments, neither the first F1AP IE/field nor the second F1AP IE is a *F1AP CellGroupConfig IE/field*. In other embodiments, the second F1AP IE/field is a *DU to CU RRC Information IE* and the first F1AP IE/field is a new IE specific for including a LTM DU configuration.

[0222] In some embodiments, the CU transmits a third CU-to-DU message including the first TCI state configuration(s) to the second DU. In cases where the first TCI state configuration(s) is included in the first LTM DU configuration, the CU includes the first LTM DU configuration in the third CU-to-DU message. In such cases, the second DU retrieves the first TCI state configuration(s) from the first LTM DU configuration. In some embodiments, the second DU transmits a third DU-to-CU message to the CU, in response to the third CU-to-DU message. In some embodiments, the CU includes the first TCI state configuration(s) or the first LTM DU configuration in an interface protocol IE/field and includes the interface protocol IE/field in the third CU-to-DU message. In some embodiments, the interface protocol field/IE is a *CU to DU RRC Information IE*. In other embodiments, the interface protocol field/IE is a *F1AP CellGroupConfig IE*. In such cases, the CU includes the *F1AP CellGroupConfig IE* in the *CU to DU RRC Information IE* and includes the *CU to DU RRC Information IE* in the third CU-to-DU message. In some embodiments, the CU includes an indication in the third CU-to-DU message to indicate that the first TCI state configuration(s) or the first LTM DU configuration is for LTM. In other

embodiments, the interface protocol field/IE is a new interface protocol field/IE for LTM. In some embodiments, the new interface protocol field/IE is defined in a 3GPP TS. In some embodiments, the CU includes the new interface protocol field/IE in a *CU to DU RRC Information* IE in the third CU-to-DU message. In other embodiments, the CU includes the new interface protocol field/IE outside the *CU to DU RRC Information* IE. In some embodiments, the third CU-to-DU message and the third DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Response* message, respectively. In other embodiments, the third CU-to-DU message and the third DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Required* message, respectively. In yet other embodiments, the third CU-to-DU message and the third DU-to-CU message are a *UE Context Setup Request* message and a *UE Context Setup Response* message, respectively. In some embodiments, the first message and the second message are RRC reconfiguration messages. In some embodiments, the first message and the second message may be combined as a single message, i.e., the first message and the second message are the same message. In other embodiments, the first message and the second message are separate messages.

[0223] In some embodiments, the first LTM DU configuration includes the first TCI state configuration(s), and the CU receives the first TCI state configuration(s) in the first LTM DU configuration. In such embodiments, the CU retrieves the first TCI state configuration(s) from the first LTM DU configuration and includes the first TCI state configuration(s) in the second message. In other embodiments, the first LTM DU configuration includes the first TCI state configuration(s), and the CU receives the first TCI state configuration(s) in the second DU-to-CU message. In other words, the first DU includes the first TCI state configuration(s) in the second interface protocol IE/field in the second DU-to-CU message in addition to including the first TCI state configuration(s) in the first LTM DU configuration.

[0224] In some embodiments, the first procedure is a UE Context Setup procedure or a UE Context Modification procedure. The UE Context Modification procedure may be initiated by the CU or the first DU. In the case of the UE Context Setup procedure, the CU transmits a *UE Context Setup Request* message and receives a *UE Context Setup Response* message including the first LTM DU configuration from the first DU, in response. In the case of the UE Context Modification procedure initiated by the CU, the CU transmits a *UE Context Modification Request* message and receives a *UE Context Modification Response* message including the first LTM DU configuration from the first DU, in response. In the case of the

UE Context Modification procedure initiated by the first DU, the CU receives a *UE Context Modification Required* message including the first LTM DU configuration from the first DU and transmits a *UE Context Modification Confirm* message to the first DU, in response.

[0225] In some embodiments, the second procedure is a UE Context Setup procedure or a UE Context Modification procedure. The UE Context Modification procedure may be initiated by the CU or the first DU. In the case of the UE Context Setup procedure initiated by the CU, the CU transmits a *UE Context Setup Request* message and receives a *UE Context Setup Response* message including the first TCI state configuration(s) from the first DU, in response. In the case of the UE Context Modification procedure initiated by the CU, the CU transmits a *UE Context Modification Request* message and receives a *UE Context Modification Response* message including the first TCI state configuration(s) from the first DU. In the case of the UE Context Modification procedure initiated by the first DU, the CU receives a *UE Context Modification Required* message including the first TCI state configuration(s) from the first DU and transmits a *UE Context Modification Confirm* message to the first DU.

[0226] In some embodiments, the first and second procedures may be combined as a single procedure, i.e., the first procedure and the second procedure are the same procedure and the first DU-to-CU message and the second DU-to-CU message are the same DU-to-CU message (e.g., a *UE Context Setup Response* message, a *UE Context Modification Response* message, or a *UE Context Modification Required* message as described below). In such cases, the CU receives the first LTM DU configuration and the first TCI state configuration(s) from the first DU in the procedure. In the case of the UE Context Setup procedure initiated by the CU, the CU transmits a *UE Context Setup Request* message and receives a *UE Context Setup Response* message including the first LTM DU configuration and the first TCI state configuration(s) from the first DU, in response. In the case of the UE Context Modification procedure initiated by the CU, the CU transmits a *UE Context Modification Request* message and receives a *UE Context Modification Response* message including the first LTM DU configuration and the first TCI state configuration(s) from the first DU. In the case of the UE Context Modification procedure initiated by the first DU, the CU receives a *UE Context Modification Required* message including the first LTM DU configuration and the first TCI state configuration(s) from the first DU and, in response, transmits a *UE Context Modification Confirm* message to the first DU. In some embodiments, the first interface protocol IE/field and the second interface protocol IE/field are included in a parent IE/field

(e.g., *DU to CU RRC Information IE/field*) in the DU-to-CU message. In other embodiments, one of the first interface protocol IE/field and the second interface protocol IE/field are included in the parent IE/field and the other is not included in the parent IE/field. In yet other embodiments, neither the first interface protocol IE/field nor the second interface protocol IE/field are included in the same parent IE.

[0227] In some embodiments, if the first DU is a target DU (i.e., the first DU is not a serving DU), the CU transmits a CU-to-DU message including the first TCI state configuration(s) to the serving DU (e.g., the second DU or the third DU) (e.g., events 412, 493, 693, 893). In some embodiments, the CU receives a DU-to-CU message from the serving DU, in response. Otherwise, if the first DU is the serving DU, the CU does not transmit the first TCI state configuration(s) to the serving DU. In some embodiments, the CU-to-DU message and the DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Response* message, respectively.

[0228] In some embodiments, each of the first TCI state configuration(s) includes a TCI state ID identifying the corresponding TCI state configuration. In some embodiments, the serving DU transmits a first LTM command to the UE, where the first LTM command requests the UE to connect the first cell (e.g., events 330, 380, 430, 480, 530, 580, 581, 582, 680, 681, 630, 780, 730, 880, 881, or 830). After (e.g., in response to) receiving the first LTM command, the UE disconnects from a serving cell operated by the serving DU and connects to the first cell and communicates on the first cell with the first DU (e.g., events 336, 380, 436, 480, 536, 580, 581, 582, 636, 680, 681, 736, 780, 836, 880, or 881). In some embodiments, the first TCI state configuration(s) includes TCI state configuration(s) 1, ..., L, where L is a positive integer and larger than zero. The TCI state configuration(s) 1, ..., L may include TCI state ID(s) 1, ..., L identifying the TCI state configuration(s) 1, ..., L, respectively. The serving DU includes the TCI state ID 1 in the first LTM command to request the UE to apply the TCI state configuration 1 to communicate on the first cell. The UE accesses and/or communicates on the first cell using the TCI state configuration 1 in accordance with the TCI state ID 1 after (e.g., in response to) receiving the first LTM command. In some embodiments, the first DU detects that the UE accesses the first cell and communicates with the UE on the first cell, based on the TCI state configuration 1.

[0229] In some embodiments, the serving DU includes the TCI state ID 2 in the first LTM command to indicate to the UE to apply the TCI state configuration 2 to communicate on the

first cell, in addition to the TCI state ID 1. After (e.g., in response to) receiving the first LTM command, the UE accesses and/or communicates on the first cell using the TCI state configurations 1 and 2 in accordance with the TCI state ID 1 and the TCI state ID 2. In some embodiments, the first DU detects that the UE accesses the first cell and communicates with the UE on the first cell, based on the TCI state configuration 1 and the TCI state configuration 2. For example, after (e.g., in response to) receiving the first LTM command, the UE may skip a random access procedure and directly transmits the first transmission (e.g., a PUSCH transmission or a PUCCH transmission) on the first cell using the first TCI state configuration(s). The first DU receives the first transmission from the UE on the first cell using the first TCI state configuration(s).

[0230] In some alternative embodiments, the serving DU might not include a TCI state ID in the first LTM command, and the UE communicates on the first cell with the first DU using the at least one first TCI state, after (e.g., in response to) receiving the first LTM command. In some embodiments, the first DU detects that the UE accesses the first cell and communicates with the UE on the first cell, based on the first TCI state configuration(s). For example, the UE may skip a random access procedure and directly transmits the first transmission (e.g., a PUSCH transmission or a PUCCH transmission) on the first cell to the DU 174, in response to receiving the first LTM command. The first DU receives the first transmission from the UE using the first TCI state configuration(s).

[0231] In some embodiments, the serving DU includes a first ID identifying the first cell or the first LTM configuration in the first LTM command, where the first ID may be a first cell ID, a first cell index, or a first LTM ID. In some embodiments, the serving DU receives the ID and/or the first LTM DU configuration from the CU. In some embodiments, the serving DU includes a timing advance value in the first LTM command. In some embodiments, the serving DU transmits a DCI (e.g., a PDCCH order) on the serving cell to the UE to order the UE to transmit a preamble (e.g., a random access preamble) on the first cell before transmitting the first LTM command. After (e.g., in response to) the DCI, the UE transmits the preamble on the first cell. The first DU determines the timing advance value by measuring the time the first DU takes to receive the preamble (i.e., propagation delay). After (e.g., in response to) receiving the first LTM command, the UE disconnects from the serving cell and accesses the first cell using the timing advance value. After (e.g., in response to) receiving the first LTM command, the UE applies the timing advance value in one or more uplink transmissions on the first cell to the first DU.

[0232] In some embodiments, before transmitting the first LTM command, the serving DU might transmit one or more activation commands to activate the TCI state configuration(s) 1, ..., K, where K is a positive integer and $1 \leq K \leq L$. For example, K is 1 or 2. In another example, K is equal to L. The UE determines that the TCI state configuration(s) 1, ..., K is/are activated upon receiving the activation command(s). In some embodiments, each of the activation command(s) is a MAC CE. In other embodiments, each of the activation command(s) is a DCI. In some embodiments, the serving DU includes or indicates the TCI state ID(s) 1, ..., K in the activation command(s). In some embodiments, when the serving DU determines to send an LTM command (e.g., the first LTM command) for the UE to command the UE to perform a fast serving change to a target cell (e.g., the first cell), the serving DU only includes, in the LTM command (e.g., the first LTM command), one or more TCI state IDs (e.g., one, some or all of the TCI state ID(s) 1, ..., K) for one or more TCI state configurations (e.g., the TCI state configuration(s) 1, ..., K) that the serving DU has activated for the UE. In some embodiments, the serving DU refrains from including, in a LTM command for the UE, a TCI state ID for a TCI state configuration that the serving DU has not activated for the UE. In some embodiments, the DU 174 includes the first cell ID or the first cell index in the activation command(s). Based on the first cell ID or the first cell index, and the one or more TCI state IDs in the activation command(s), the UE determines that the activation command(s) activates the one or more TCI state configurations in the first TCI state configuration(s), where each of the TCI state ID(s) identifies a particular TCI state configuration of the TCI state configuration(s).

[0233] In some embodiments, the first LTM DU configuration includes the first TCI state configuration(s), and the CU receives 908 the first TCI state configuration(s) in the (second) DU-to-CU message. In some embodiments, the first DU includes the first TCI state configuration(s) in the (second) interface protocol IE/field in the (second) DU-to-CU message in addition to including the first TCI state configuration(s) in the first LTM DU configuration. After detecting that the UE accessed the first cell, the first DU performs communication of PUSCH transmissions, PDSCH transmissions, PUCCH transmissions, PDCCH transmissions, and/or SRS transmissions with the UE. In some embodiments, the first DU performs communication with the UE, using the first TCI state configuration(s). In some embodiments, the first DU includes additional TCI state configurations in the first LTM DU configuration. In some embodiments, the first DU uses some or all of the additional TCI state configurations to perform communication of PUSCH transmissions, PDSCH

transmissions, PUCCH transmissions, PDCCH transmissions, and/or SRS transmissions with the UE.

[0234] In some embodiments, the CU performs a third procedure for LTM for the UE with the first DU and receives at least one first RS resource configuration from the first DU in the third procedure. In the third procedure, the CU receives a third DU-to-CU message including the first RS resource configuration(s) from the first DU. In some embodiments, the third procedure may be a UE Context Setup procedure, or a UE Context Modification procedure as described above, and the third DU-to-CU message is a *UE Context Setup Response* message, a *UE Context Modification Response* message, or a *UE Context Modification Required* message. In some embodiments, each of the first RS resource configuration(s) configures one or more RSs and/or one or more RS resources. The RS may be a SSB or a CSI-RS. In some embodiments, each of the first RS resource configuration(s) is a NZP-CSI-RS-Resource IE, a NZP-CSI-RS-ResourceSet IEs, and/or a CSI-SSB-ResourceSet IE.

[0235] In some embodiments, the CU transmits a fourth CU-to-DU message including the at least one first RS resource configuration to the second DU. Based on the at least one first RS resource configuration, the second DU generates at least one first report configuration for reporting measurement results of the RS(s) or RS resource(s). In some embodiments, the first report configuration(s) configures UL resources (e.g., PUCCH resources or PUSCH resources) for transmission of measurement results. In some embodiments, each of the measurement results includes an RS resource indicator and/or a quantized measurement value. The RS resource indicator is an SSB resource indicator or a CSI-RS resource indicator. The quantized measurement value might be an L1-RSRP or an L1-SINR. The second DU transmits a fourth DU-to-CU message including the first report configuration(s) to the CU. The CU then transmits a third message including the first report configuration(s) to the UE 102 via the serving DU or the RAN node. In some embodiments, each of the first report configuration(s) includes a resource configuration ID identifying a particular RS resource configuration in the at least one first RS resource configuration. In some embodiments, each of the first report configuration(s) is a *CSI-ReportConfig* IE. In some embodiments, the first reporting configuration(s) is/are similar to the L1 measurement report configuration(s) described above. In some embodiments, the CU includes the first RS resource configuration(s) in the third message.

[0236] In some other embodiments, the second DU includes the first report configuration(s) in a DU configuration (e.g., a RRC *CellGroupConfig* IE) and includes the DU configuration in the fourth DU-to-CU message. In some embodiments, the fourth CU-to-DU message is a *UE Context Modification Request* message, and the fourth DU-to-CU message is a *UE Context Modification Response* message or a *UE Context Modification Required* message. In some embodiments, the second DU includes the first RS resource configuration(s) in the DU configuration. In other embodiments, the serving DU does not include the first RS resource configurations in the serving DU configuration. In some embodiments, the second DU includes the DU configuration in a *DU to CU RRC Information* IE in the fourth DU-to-CU message. For example, the second DU includes the serving DU configuration in an interface protocol IE/field (e.g., F1AP *CellGroupConfig* IE/field) and includes the interface protocol UE/field in the fourth DU-to-CU message. After receiving the fourth DU-to-CU message, the CU transmits a third message including the DU configuration to the UE 102 via the serving DU or the RAN node. In some embodiments, if the second DU is a serving DU, the DU configuration is a serving DU configuration, and the CU includes the serving DU configuration in the third message. The CU refrains from including the serving DU configuration in an LTM configuration. In other embodiments, if the second DU is not a serving DU (e.g., the second DU is a target DU), the DU configuration is a (second) LTM DU configuration, and the CU includes the LTM DU configuration in an LTM configuration in the third message. In the following description, “the first report configuration(s)” may be replaced by “the serving DU configuration” or “the (second) LTM DU configuration”.

[0237] In some embodiments, the third message is a RRC reconfiguration message similar to the RRC reconfiguration message in the event 316, 318, 394, 380, 480, 494, 580, 594, 581, 517, 519, 582, 680, 694, 681, 617, 619, 780, 794, 781, 717, 719, 880, 894, 881, 817, or 819. In other embodiments, the third message is a RRC reconfiguration message in the event 316, 318, 394, 380, 480, 494, 580, 594, 581, 517, 519, 582, 680, 694, 681, 617, 619, 780, 794, 781, 717, 719, 880, 894, 881, 817, or 819.

[0238] In some alternative embodiments, the CU receives the first RS resource configuration(s) from the first DU in the first procedure or the first DU-to-CU message. In some embodiments, the first DU includes the first RS resource configuration(s) in the first LTM DU configuration. In some embodiments, the CU might receive 908 the first RS resource configuration(s) in the first LTM DU configuration. In some embodiments, the first DU includes the first LTM DU configuration in the first interface protocol IE/field and

includes the first RS resource configuration(s) in the second interface protocol IE/field in the first DU-to-CU message.

[0239] In other alternative embodiments, the CU receives the first RS resource configuration(s) from the first DU in the second procedure or the second DU-to-CU message. In some embodiments, the first DU includes the first TCI state configuration(s) and the first RS resource configuration(s) in the second interface protocol IE/field in the first DU-to-CU message. In other embodiments, the first DU includes the first TCI state configuration(s) and the first RS resource configuration(s) in the second interface protocol IE/field and a third interface protocol IE/field (e.g., F1AP IE/field) in the first DU-to-CU message, respectively. In some alternative embodiments, the CU includes the first RS resource configuration(s) and/or the first report configuration(s) in the first message. In other alternative embodiments, the CU includes the first RS resource configuration(s) and/or the first report configuration(s) in the second message.

[0240] In some embodiments, if the first DU is a target DU (i.e., the first DU is not a serving DU), the CU transmits the first TCI state configuration(s) to the serving DU (e.g., the second DU). Otherwise, if the first DU is the serving DU, the CU does not transmit the first TCI state configuration(s) to the first DU. In some embodiments, if the first DU is a target DU (i.e., the first DU is not a serving DU), the CU transmits the at least one first RS resource configuration to the serving DU (e.g., the second DU). Otherwise, if the first DU is the serving DU, the CU does not transmit the at least one first RS resource configuration to the first DU. In some embodiments, the serving DU and the first DU are the S-DU 174A and the T-DU 174B in FIGs. 4, 6A, and 6B, respectively. In some embodiments, the serving DU and the first DU are the S-DU 174B and the T-DU 174C in FIGs. 8A and 8B, respectively.

[0241] In some embodiments, the CU receives a first additional LTM DU configuration and at least one first additional TCI state configuration from the first DU in the first DU-to-CU message and the second DU-to-CU message, respectively. In other embodiments, the CU performs one or more additional procedures with the first DU similar to the first and/or second procedure(s). In the additional procedure(s), the CU receives one or more additional DU-to-CU messages including the first additional LTM DU configuration and at least one first additional TCI state configuration from the first DU, similar to the first and/or second DU-to-CU message(s). The first additional LTM DU configuration configures a first additional cell for LTM for the UE. In some embodiments, the CU includes the first

additional LTM DU configuration and the at least one first additional TCI state configuration in the first message and the second message, respectively. Alternatively, the CU includes the first additional LTM DU configuration and the at least one first additional TCI state configuration in the first message. Yet alternatively, the CU transmits one or more additional messages including the first additional LTM DU configuration and the at least one first additional TCI state configuration, to the UE, via the RAN node. In some embodiments, the additional message(s) is/are RRC reconfiguration message(s). In some embodiments, the CU transmits the at least one first additional TCI state configuration to the second DU and/or the serving DU. In one embodiment, the CU includes the at least one first additional TCI state configuration in the third CU-to-DU message. In another embodiment, the CU transmits a fourth CU-to-DU message including the at least one first additional TCI state configuration to the second DU and/or the serving DU, similar to the third CU-to-DU message. While the first DU (i.e., a serving DU) communicates 918 with the UE on the first cell, the first DU might transmit an additional LTM command to the UE, where the additional LTM command requests the UE to connect to a first additional cell (e.g., events 350, 398, 380, 450, 498, 480, 598, 580, 581, 582, 680, 681, 698, 780, 798, 880, 881, or 898). After (e.g., in response to) receiving the additional LTM command, the UE disconnects from the first cell and connects to the first additional cell and communicates on the first additional cell with the first DU (e.g., events 356, 380, 456, 480, 556, 580, 581, 582, 656, 680, 681, 756, 780, 856, 880, or 881). In some embodiments, the at least one first additional TCI state configuration includes TCI state configuration(s) $L+1, \dots, L+M$, where L and M are positive integers. The TCI state configuration(s) $L+1, \dots, L+M$ include TCI state ID(s) $L+1, \dots, L+M$ identifying the TCI state configuration(s) $L+1, \dots, L+M$, respectively. The first DU includes the TCI state ID $L+1$ in the additional LTM command to indicate to the UE to apply the TCI state configuration $L+1$ to communicate on the first additional cell. The UE communicates on the first additional cell using the TCI state configuration $L+1$ in accordance with the TCI state ID $L+1$ in response to the additional LTM command. In some embodiments, the first DU includes the TCI state ID $L+2$ in the additional LTM command to request the UE to apply the TCI state configuration $L+2$ to communicate on the first additional cell, in addition to the TCI state ID $L+1$. In such cases, the UE communicates on the first additional cell with the first DU, using the TCI state configurations $L+1$ and $L+2$ in accordance with the TCI state ID $L+1$ and TCI state ID $L+2$ after (e.g., in response to) receiving the additional LTM command. In some embodiments, the first DU might not include a TCI state ID (e.g., the TCI state ID 1) in

the additional LTM command, and the UE communicates on the first additional cell with the first DU using the at least one first additional TCI state, after (e.g., in response to) receiving the additional LTM command. In some embodiments, the first DU includes an additional ID identifying the first additional cell or the first additional LTM configuration in the additional LTM command, where the additional ID may be an additional cell ID, an additional cell index, or an additional LTM ID. In some embodiments, the first DU receives the additional ID from the CU.

[0242] In some embodiments, before transmitting the additional LTM command, the first DU might transmit one or more activation commands to activate the TCI state configuration(s) $L+1, \dots, L+N$, where N is a positive integer and $1 \leq N \leq M$. For example, N is 1 or 2. The UE activates the TCI state configuration(s) $L+1, \dots, L+N$ after (e.g., in response to) receiving the activation command(s). In some embodiments, each of the activation command(s) is a MAC CE. In other embodiments, each of the activation command(s) is a DCI. In some embodiments, the first DU includes or indicates the TCI state ID(s) $L+1, \dots, L+N$ in the activation command(s). In some embodiments, when the first DU determines to send an LTM command for the UE to request the UE to perform a fast serving change/switch to a target cell (e.g., the first additional cell), the first DU only includes, in the LTM command (e.g., the additional LTM command), one or more TCI state configurations (e.g., one, some, or all of the TCI state configuration(s) $L+1, \dots, L+N$) that the first DU has activated for the UE. In other words, the first DU refrains from including or indicating, in a LTM command for the UE, a TCI state ID for a TCI state configuration that the first DU has not activated for the UE.

[0243] In some embodiments, the CU receives a second additional LTM DU configuration and at least one second additional TCI state configuration from the second DU or the third DU. The third LTM DU configuration configures a second additional cell for LTM for the UE. The CU transmits the second additional LTM DU configuration and the at least one second additional TCI state configuration to the UE, similar to blocks 902-910 and 914. The CU might transmit the at least one second additional TCI state configuration to the first DU and/or other DU(s), similar to block 912. The CU then might receive an indication message from the second DU or the third DU, indicating that the UE successfully accesses the second additional cell, similar to block 916. The CU communicates with the UE via the second DU or the third DU and the second additional cell, similar to block 918.

[0244] In some embodiments, each of the TCI state configuration(s) above associates one or two DL RSs with a corresponding QCL type. The DL RS(s) is/are transmitted on a cell. (each) TCI state configuration includes a QCL information IE (e.g., for QCL type 1). In some embodiments, the (each) TCI state configuration further includes an additional QCL information IE (e.g., for QCL type 2) and/or an additional physical cell identity (PCI) index. In some embodiments, the (each) TCI state configuration further configures a UL power control configuration and/or a pathloss RS. For example, the (each) TCI state configuration includes a UL power control ID and a pathloss RS ID identifying the UL power control configuration and/or the pathloss RS, respectively. The QCL information includes configurations such as a serving cell index, a bandwidth part (BWP) ID, an RS ID, and/or a QCL type. The RS ID indicates an RS where the QCL information is associated. In some embodiments, the RS ID is a CSI-RS ID (e.g., NZP-CSI-RS-ResourceId) and RS may be a CSI-RS (e.g., NZP-CSI-RS-Resource) indicated by the CSI-RS ID. In other embodiments, the RS ID is an SSB index and the RS is an SSB indicated by the SSB index. The serving cell index indicates a cell where the RS is configured. The BWP ID indicates a BWP where the RS is located. The BWP belongs to the cell. The cell is the first cell in the first TCI state configuration(s). The cell is the first additional cell in the at least one first additional TCI state configuration. The cell is the second additional cell in the at least one second additional TCI state configuration. The QCL type is type A, type B, type C, or type D. In some embodiments, the (each) TCI state configuration includes a TCI state ID to identify the (each) TCI state configuration as described above. The additional QCL information includes similar configurations as described above and has different values for these configurations from the QCL information. For example, the QCL information and the additional QCL information have the same RS ID (value) and different QCL types in a TCI state configuration. In some embodiments, the at least one (first, first additional, or second additional) TCI state configuration includes an *ul-TCI-ToAddModList-r17* field, one or more *TCI-UL-State-r17* IEs, a *dl-OrJointTCI-StateToAddModList-r17* field, one or more *TCI-State* IEs, *TCI-ActivatedConfig* IE, and/or a *tcI-StatesToAddModList* field.

[0245] FIG. 9B is a flow diagram of an example method 900B similar to the method 900A, except that method 900B includes blocks 913 and 915 instead of block 914. The CU receives 913 at least one second TCI state configuration from the second DU. In some embodiments, the CU receives a DU-to-CU message including the second TCI state configuration(s) from the second DU (e.g., events 414, 493, 693, or 893). The DU-to-CU message is similar to the

third DU-to-CU message described in FIG. 9A. In some embodiments, the second DU is the serving DU as described in the embodiment for FIG. 9A. In other embodiments, the second DU is not the serving DU as described for FIG. 9A. The CU transmits 915 a second message including the second TCI state configuration(s) to the UE via the RAN node (e.g., events 316, 318, 394, 380, 480, 494, 580, 594, 581, 517, 519, 582, 680, 694, 681, 617, 619, 780, 794, 781, 717, 719, 880, 894, 881, 817, or 819). In some embodiments, the CU includes the second TCI state configuration(s) in a non-LTM field (e.g., a *masterCellGroup* field or a *secondaryCellGroup* field) in the second message.

[0246] In some embodiments, the second DU generates the second TCI state configuration(s) based on the first TCI state configuration(s). In some embodiments, the second DU retrieves each TCI state configuration (e.g., QCL information, additional QCL information, PCI index, UL power control ID, and/or pathloss RS ID) from the first TCI state configuration(s) and, includes each TCI state configuration in the second TCI state configuration(s). In each TCI state configuration in the second TCI state configuration(s), the second DU assigns a value to a TCI state ID and includes the TCI state ID in the corresponding TCI state configuration. In some embodiments, the second DU does not use value(s) of the TCI state ID(s) in the first TCI state configuration(s).

[0247] As described in FIG. 9A, the second DU receives 912 the first LTM DU configuration including the first TCI state configuration(s) from the CU. In some embodiments, the second DU decodes the first LTM DU configuration to obtain the first TCI state configuration(s) and retrieves each TCI state configuration from the first TCI state configuration(s). In some embodiments, the second DU generates the second TCI state configuration(s) including each TCI state configuration in the first TCI state configuration(s). In some embodiments, the second DU generates the second TCI state configuration(s) identical to the first TCI state configuration(s). In other embodiments, the second DU generates the second TCI state configuration(s) based on the first TCI state configuration(s), as described above.

[0248] In some embodiments, the second DU might generate a DU configuration including the second TCI state configuration(s) and transmits the DU configuration to the CU. In some embodiments, the second DU includes the DU configuration in the DU-to-CU message. In some embodiments, the DU configuration is an RRC IE (e.g., a *RRC CellGroupConfig* IE defined in 3GPP TS 38.331). In some embodiments, if the second DU is a serving DU, the

DU configuration is a serving DU configuration and the CU includes the serving DU configuration in the second message. The CU refrains from including the serving DU configuration in an LTM configuration. In other embodiments, if the second DU is not a serving DU (e.g., the second DU is a target DU), the DU configuration is an (second) LTM DU configuration, and the CU includes the LTM DU configuration in an LTM configuration in the second message.

[0249] FIG. 10 illustrates an example method 1000, which may be implemented by a CU (e.g., the CU 172 of the first BS 104 or second BS 106), for transmitting a TCI state configuration to a DU to enable LTM for a UE (e.g., the UE 102).

[0250] The method 1000 begins with the CU receiving 1002 at least one first TCI state configuration for a UE from a first DU (e.g., events 314, 392, 380, 492, 480, 580, 592, 581, 582, 680, 692, 681, 780, 792, 880, 892, or 881). The CU determines 1004 whether the first DU is communicating with the UE. If the CU determines 1004 that the first DU is not communicating with the UE (i.e., the first DU is not a serving DU of the UE), the CU transmits 1006 the first TCI state configuration(s) to a serving DU of the UE (e.g., events 412, 493, 693, or 893). Otherwise, if the CU determines 1004 that the first DU is communicating with the UE (i.e., the first DU is a serving DU of the UE), the CU refrains 1008 from transmitting the first TCI state configuration(s) to the serving DU. Descriptions for FIGs. 9A and 9B may apply to FIG. 10.

[0251] FIG. 11 illustrates an example method 1100, which may be implemented by a first DU (e.g., the DU 174, 174A, 174B, or 174C of the first BS 104 or second BS 106 in FIGs. 3-8B), for enabling LTM for a UE (e.g., the UE 102).

[0252] The method 1100 begins with the first DU performing 1102 a first procedure for LTM for the UE with a CU (e.g., events 308, 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The first DU transmits 1104 a first LTM DU configuration configuring a first cell for LTM, to the CU, in the first procedure (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The first DU transmits 1106 the first LTM DU configuration to the UE. In some embodiments, the first DU receives a first message including the first LTM DU configuration from the CU and transmits the first message to the UE (e.g., events 316, 318, 394, 380, 580, 594, 581, 582, 780, 794, or 781). The first DU performs 1108 a second procedure for LTM for the UE with the CU (e.g., events 312, 314, 392, 380, 492, 480, 580, 592, 581, 582, 680, 692, 681, 780,

792, 880, 892, or 881). The first DU transmits 1110 at least one first TCI state configuration to the CU in the second procedure (e.g., events 314, 392, 380, 492, 480, 580, 592, 581, 582, 680, 692, 681, 780, 792, 880, 892, or 881). In some embodiments, each of the first TCI state configuration(s) configures a TCI state for the UE to transmit and/or receive data and/or control signal on the first cell. The first DU transmits 1112 the first TCI state configuration(s) to the UE. In some embodiments, the first DU receives a second message including the first TCI state configuration(s) from the CU and transmits the second message to the UE (e.g., events 316, 318, 394, 380, 580, 594, 581, 582, 780, 794, or 781). The first DU detects 1114 that the UE accessed the first cell (e.g., events 332, 352, 398, 380, 432, 452, 498, 480, 580, 532, 598, 581, 582, 680, 632, 698, 681, 780, 732, 798, 880, 881, 832, or 898). In some embodiments, the first DU detects that the UE accesses the first cell, based on one, some, or all of the first TCI state configuration(s). The first DU transmits 1116 an indication message to the CU, indicating that the UE successfully accesses the first cell (e.g., events 334, 354, 398, 380, 434, 454, 498, 480, 580, 534, 598, 581, 582, 680, 634, 698, 681, 780, 734, 798, 880, 881, 834, or 898). The first DU communicates 1118 with the UE via the first cell using the first TCI state configuration(s) (e.g., events 336, 356, 380, 436, 456, 480, 536, 556, 580, 581, 582, 636, 656, 680, 681, 736, 756, 780, 836, 856, 880, or 881).

[0253] Examples and embodiments described for FIGs. 9A and 9B may apply to FIG. 11.

[0254] FIG. 12A illustrates an example method 1200A, which may be implemented by a DU (e.g., the DU 174, 174A, 174B, or 174C of the first BS 104 or second BS 106 in FIGs. 3-8B), for enabling LTM for a UE (e.g., the UE 102).

[0255] The method 1200A begins with the DU communicating 1202 with the UE and a CU (e.g., events 302, 402, 502, 602, 702, 802, 380, 480, 580, 680, 780, 880, 581, 582, 681, 780, 880, or 881). The DU receives 1204 a first CU-to-DU message from a CU to request preparing a first cell for LTM for the UE (e.g., events 308, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The DU generates 1206 a first LTM DU configuration configuring the first cell. The DU generates 1208 at least one first TCI state configuration for configuring at least one TCI state. The DU transmits 1210 a first DU-to-CU message including the first LTM DU configuration and the at least one first TCI state configuration to the CU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881).

[0256] The DU transmits 1212 a first LTM command to the UE, commanding the UE to switch to the first cell using an LTM procedure. The DU detects 1214 that the UE accesses the first cell (e.g., events 332, 336, 352, 356, 380, 432, 436, 452, 456, 498, 480, 532, 536, 552, 598, 556, 580, 581, 582, 632, 636, 698, 656, 680, 681, 732, 736, 798, 756, 780, 832, 836, 898, 868, 880, or 881). In some embodiments, the DU detects that the UE accesses the first cell, using one or some of the first TCI state configuration(s). The DU transmits 1216 an indication message to the CU, indicating that the UE successfully accesses the first cell (e.g., events 334, 354, 380, 398, 434, 454, 498, 480, 534, 598, 580, 581, 582, 734, 798, 780, 834, 898, 880, or 881). The DU communicates 1218 with the UE via the first cell, using the first TCI state configuration(s) (e.g., events 336, 356, 380, 436, 456, 480, 536, 556, 580, 581, 582, 636, 656, 680, 681, 736, 756, 780, 836, 856, 880, or 881).

[0257] In some embodiments, the DU includes the first LTM DU configuration in a first interface protocol IE or field (IE/field) in the first DU-to-CU message. In some embodiments, the DU includes the first TCI state configuration(s) in a second interface protocol IE/field in the first DU-to-CU message. In some embodiments, one of the first interface protocol IE/field and the second interface protocol IE/field is a *F1AP CellGroupConfig* IE/field and the other is different from the *F1AP CellGroupConfig* IE/field. In other embodiments, one of the first interface protocol IE/field and the second interface protocol IE/field is a *DU to CU RRC Information* IE/field and the other is different from the *DU to CU RRC Information* IE/field. The DU includes the first LTM DU configuration and the first TCI state configuration(s) in the different interface protocol IEs/fields, so that the CU may retrieve or identify the first LTM DU configuration and the first TCI state configuration(s) from the first interface protocol IE/field and the second interface protocol IE/field, respectively. Thus, the CU may properly transmit the first LTM DU configuration and the first TCI state configuration(s) to the UE as described in FIG. 9A.

[0258] In other embodiments, the DU includes the first LTM DU configuration and the first TCI state configuration(s) in an interface protocol IE/field of the first DU-to-CU message. In some embodiments, the DU includes the first LTM DU configuration and the first TCI state configuration(s) in a first child IE/field and a second child IE/field, respectively, and includes the first child IE/field and the second child IE/field in the interface protocol IE/field of the first DU-to-CU message. The DU includes the first LTM DU configuration and the first TCI state configuration(s) in the different child IEs/fields, so that the CU may retrieve or identify the first LTM DU configuration and first TCI state

configuration(s) from the first child IE/field and the second child IE/field, respectively. Thus, the CU may properly transmit the first LTM DU configuration and the at least one first reference signal resource configuration to the UE, as described in FIG. 9A.

[0259] In some embodiments, the first CU-to-DU message and the first DU-to-CU message are a *UE Context Setup Request* message and a *UE Context Setup Response* message. In other embodiments, the first CU-to-DU message and the first DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Response* message. In yet other embodiments, the first CU-to-DU message and the first DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Required* message. In such cases, the DU transmits a *UE Context Modification Response* message to the CU in response to the *UE Context Modification Request* message, and the DU receives a *UE Context Modification Confirm* message from the CU in response to the *UE Context Modification Required* message.

[0260] In some embodiments, the DU receives a second CU-to-DU message from the CU to request preparing a second cell for LTM for the UE (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). In such cases, the DU generates a second LTM DU configuration configuring the second cell, and generates at least one second TCI state configuration for at least one second TCI state. The DU transmits a second DU-to-CU message, including the second LTM DU configuration and the second TCI state configuration(s), to the CU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881).

[0261] FIG. 12B is a flow diagram of an example method 1200B similar to the method 1200A, except that the method 1200B includes blocks 1209 and 1211 instead of block 1210. The DU transmits 1209 a first DU-to-CU message including the first LTM DU configuration to the CU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The DU transmits 1210 an additional DU-to-CU message including the at least one TCI state configuration to the CU. Unlike FIG. 12A, the DU includes the at least one first TCI state configuration in the additional DU-to-CU message instead of the first DU-to-CU message.

[0262] In some embodiments, the DU includes the first LTM DU configuration in a first interface protocol IE or field (IE/field) in the first DU-to-CU message. In some embodiments, the DU includes the first TCI state configuration(s) in a second interface protocol IE/field in

the additional DU-to-CU message. In some embodiments, one of the first interface protocol IE/field and the second interface protocol IE/field is a F1AP *CellGroupConfig* IE/field and the other is different from the F1AP *CellGroupConfig* IE/field. In other embodiments, one of the first interface protocol IE/field and the second interface protocol IE/field is a *DU to CU RRC Information* IE/field and the other is different from the *DU to CU RRC Information* IE/field. The DU includes the first LTM DU configuration and the first TCI state configuration(s) in the different interface protocol IEs/fields, so that the CU may retrieve or identify the first LTM DU configuration and the first TCI state configuration(s) from the first interface protocol IE/field and the second interface protocol IE/field, respectively. Thus, the CU may properly transmit the first LTM DU configuration and the at least one first reference signal resource configuration to the UE, as described for FIGs. 9A-9B.

[0263] Examples and embodiments described for a DU (e.g., the serving DU, the first DU, or the second DU) in FIGs. 9A, 9B, and 11 may apply to the DU in FIGs. 12A and 12B.

[0264] FIG. 13A illustrates an example method 1300A, which may be implemented by a DU (e.g., the DU 174, 174A, 174B, or 174C in FIGs. 3 to 8B), for enabling LTM for a UE (e.g., the UE 102).

[0265] The method 1300A begins with the DU receiving 1302 at least one first TCI state configuration from the CU, where each of the at least one first TCI state configuration configures a TCI state (e.g., events 308, 390, 380, 312, 392, 490, 492, 480, 580, 590, 592, 581, 582, 680, 690, 692, 681, 780, 790, 792, 880, 890, 892, or 881). In some embodiments, the DU receives a CU-to-DU message including the first TCI state configuration(s) from the CU. In some embodiments, each of the first TCI state configuration(s) configures a TCI state for communication on a cell of another DU (e.g., a T-DU). The DU generates 1304 at least one second TCI state configuration based on the at least one first TCI state configuration. The DU transmits 1306 the at least one second TCI state configuration to the CU (e.g., events 310, 390, 380, 314, 392, 490, 492, 480, 580, 590, 592, 581, 582, 680, 690, 692, 681, 780, 790, 792, 880, 890, 892, or 881). In some embodiments, the DU transmits a DU-to-CU message including the second TCI state configuration(s) to the CU. The DU transmits 1308 a first LTM command directing the UE to connect to a first cell to the UE, where the first LTM command includes a first TCI state ID identifying a first one of the at least one second TCI state configuration (e.g., events 330, 350, 398, 380, 430, 450, 498, 480, 580, 530, 598, 581, 582, 680, 681, 630, 698, 780, 730, 798, 880, 881, 830, or 898). In some embodiments, the

DU may include a second TCI ID identifying a second one of the second TCI state configuration(s) in the first LTM command.

[0266] In some embodiments, the CU-to-DU message and the DU-to-CU message are a *UE Context Setup Request* message and a *UE Context Setup Response* message, respectively. In other embodiments, the CU-to-DU message and the DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Response* message, respectively. In some alternative embodiments, the DU-to-CU message is a *UE Context Modification Required* message. In some embodiments, the DU includes an LTM ID identifying an LTM configuration in the first LTM command. In one embodiment, the LTM ID is a cell ID of the first cell. In another embodiment, the LTM ID is a cell index indexing the first cell. In yet another embodiment, the LTM ID is an ID identifying a LTM configuration for communication via the first cell.

[0267] In some embodiments, the CU includes the first TCI state configuration(s) in a new IE/field and includes the new IE/field in the CU-to-DU message. In some embodiments, the CU includes the new IE/field in a *CU to DU RRC Information* IE and includes the *CU to DU RRC Information* IE in the CU-to-DU message. In other embodiments, the CU does not include the new IE/field in a *CU to DU RRC Information* IE. In some embodiments, the CU includes the first TCI state configuration(s) in a new IE/field and includes the new IE/field in the CU-to-DU message. In other embodiments, the DU receives 1302 the CU-to-DU message including a DU configuration (e.g., a *RRC CellGroupConfig* IE) including the first TCI state configuration(s) from the CU. In some embodiments, the CU includes the DU configuration in a *CU to DU RRC Information* IE and includes the *CU to DU RRC Information* IE in the CU-to-DU message.

[0268] In some embodiments, the DU includes the second TCI state configuration(s) in an interface protocol IE/field in the DU-to-CU message. In some embodiments, the interface protocol IE/field is a new IE/field different from a *F1AP CellGroupConfig* IE/field defined in 3GPP TS 38.473. In other embodiments, the DU includes the second TCI state configuration(s) in a serving DU configuration and transmits 1306 the serving DU configuration to the CU. In some embodiments, the serving DU configuration is a cell group configuration (e.g., a *RRC CellGroupConfig* IE) including configuration parameters for communication between the UE and DU. In some embodiments, the DU transmits 1306 a DU-to-CU message including the serving DU configuration to the CU.

[0269] FIG. 13B is a flow diagram of an example method 1300B similar to the method 1300A, except that the method 1300B includes block 1307 instead of blocks 1304, 1306, and 1308. The DU transmits 1307 a first LTM command directing the UE to connect to a first cell to the UE, where the first LTM command includes a first TCI state ID identifying a first one of the first TCI state configuration(s). In some embodiments, the DU may include a second TCI state ID identifying a second one of the first TCI state configuration(s) in the first LTM command.

[0270] Examples and embodiments described for a DU (e.g., the serving DU, the first DU, or the second DU) in FIGs. 9A, 9B, and 11-12B may apply to the DU in FIGs. 13A and 13B.

[0271] FIG. 14A illustrates an example method 1400A, which may be implemented by a DU (e.g., the DU 174, 174A, 174B, or 174C in FIGs. 3-8B), for enabling LTM for a UE (e.g., the UE 102).

[0272] The method 1400A begins with the DU receiving 1402 a first CU-to-DU message from a CU to request preparing a first cell for LTM for a UE, where the first CU-to-DU message includes at least one first TCI state configuration and each of the first TCI state configuration(s) configures a TCI state (e.g., events 308, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). In some embodiments, each of the TCI state(s) associates one or two DL RSs with a corresponding QCL type and a cell other than the first cell. The DU generates 1404 at least one second TCI state configuration based on the first TCI state configuration(s). The DU generates 1406 a first LTM DU configuration for the UE to switch to the first cell using an LTM procedure. The first LTM DU configuration may include the second TCI state configuration(s). The DU transmits 1408 a first DU-to-CU message, including the first LTM DU configuration and the second TCI state configuration, to the CU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881).

[0273] In some embodiments, the DU retrieves each TCI state configuration (e.g., QCL information, additional QCL information, PCI index, UL power control ID, and/or pathloss RS ID) from the first TCI state configuration(s) and, includes each TCI state configuration in the second TCI state configuration(s). In each TCI state configuration in the second TCI state configuration(s), the DU assigns a value to a TCI state ID and includes the TCI state ID in the corresponding TCI state configuration. In some embodiments, the DU does not use value(s) of the TCI state ID(s) in the first TCI state configuration(s).

[0274] In some embodiments, the DU receives a second CU-to-DU message from the CU to request preparing a second cell for LTM for the UE, where the second CU-to-DU message includes the first TCI state configuration(s) (e.g., events 308, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The DU generates at least one third TCI state configuration based on the first TCI state configuration(s). The DU generates a second LTM DU configuration for the UE, configuring the second cell. The second LTM DU configuration may include the third TCI state configuration(s). The DU transmits a second DU-to-CU message including the second LTM DU configuration and the third TCI state configuration(s) to the CU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881).

[0275] FIG. 14B is a flow diagram of an example method 1400B similar to the method 1400A, except that the method 1400B includes block 1405 instead of blocks 1404 and 1406. The DU generates 1405 a first LTM DU configuration for the UE, configuring the first cell, and including the first TCI state configuration(s).

[0276] In some embodiments, the DU receives a second CU-to-DU message from the CU to request preparing a second cell for LTM for the UE, where the second CU-to-DU message includes the first TCI state configuration(s) (e.g., events 308, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The DU generates a second LTM DU configuration for the UE, configuring the second cell. The DU transmits a second DU-to-CU message, including the second LTM DU configuration and the first TCI state configuration(s), to the CU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881).

[0277] Examples and embodiments described for a DU (e.g., the serving DU, the first DU or the second DU) in FIGs. 9A, 9B, and 11-13B may apply to the DU in FIGs. 14A and 14B. Examples and embodiments described for FIGs. 14A and 14B may apply to the previous figures.

[0278] FIG. 15 illustrates an example method 1500, which may be implemented by a DU (e.g., a S-DU in FIGs. 4, 6A-6B, and 8A-8B), for enabling LTM for a UE (e.g., the UE 102).

[0279] The method 1500 begins with the DU communicating 1502 with the UE, using a first serving DU configuration (e.g., events 402, 602, or 802). The DU receives 1504 a first CU-to-DU message including a first LTM DU configuration configuring a first cell for LTM for the UE, from a CU (e.g., events 412, 493, 693, or 893). The DU generates 1506 a second

serving DU configuration based on the first LTM DU configuration and, optionally, based on a TCI state configuration(s). The DU transmits 1508 a first DU-to-CU message including the second serving DU configuration and the TCI state configuration(s), to the CU (e.g., events 414, 493, 693, or 893). The DU communicates 1510 with the UE in accordance with the second serving DU configuration (e.g., events 424, 436, 444, 498, 624, 698, 636, 824, 898, or 836). The DU transmits 1512 a first LTM command requesting the UE to connect to the first cell (e.g., events 430, 450, 498, 630, 698, 830, or 898).

[0280] In some embodiments, the DU is a serving DU. In some embodiments, the CU receives the first LTM DU configuration from a target DU (e.g., 490, 690, or 890).

[0281] In some embodiments, the second serving DU configuration augments the first serving DU configuration. For example, the second serving DU configuration includes (new) configurations that do not exist in the first serving DU configuration. In other embodiments, the second serving DU configuration includes (new) configurations updating (existing) configurations included in the first serving DU configuration. Examples of the first serving DU configuration and the second serving DU configuration are similar to the serving DU configuration described above.

[0282] In some embodiments, the first LTM DU configuration includes at least one first RS resource configuration and at least one first report configuration for reporting measurements of some RSs configured in the first RS source configuration(s). In some embodiments, the DU generates at least one second RS resource configuration based on the first RS resource configuration(s) and includes the second RS resource configuration(s) in the second serving DU configuration. In some embodiments, the DU generates at least one second report configuration for reporting measurement results of some RSs configured in the second RS resource configuration(s) and includes the second report configuration(s) in the second serving DU configuration. In other embodiments, the DU generates at least one second report configuration for reporting measurement results of some RSs configured in the first RS resource configuration(s) and includes the first RS resource configuration(s) and the second report configuration(s) in the second serving DU configuration. In some embodiments, the first serving DU configuration includes at least one third RS resource configuration and/or at least one third report configuration for reporting measurement results of some RSs configured in the third RS resource configuration(s). In some embodiments, RSs configured in the third RS resource configuration(s) are different from RSs configured in the

first RS resource configuration(s) and the second RS resource configuration(s). In some embodiments, some of the third report configuration(s) are the same as the second report configuration(s). In other embodiments, the third report configuration(s) are different from the second report configuration(s).

[0283] In some embodiments, the first LTM DU configuration includes at least one first TCI state configuration. In some embodiments, the DU generates at least one second TCI state configuration based on the first TCI state configuration(s) and includes the second TCI state configuration(s) in the second serving DU configuration. In other embodiments, the DU includes the first TCI state configuration(s) in the second serving DU configuration. In some embodiments, the first serving DU configuration includes at least one third TCI state configuration.

[0284] In some embodiments, the CU generates an RRC message including the second serving DU configuration and transmits the RRC message to the UE via the DU, an additional DU, or a BS. In some embodiments, the CU receives an RRC response message from the UE via the DU, the additional DU, or the BS. For example, the RRC message and the RRC response message are similar to the RRC reconfiguration message and RRC reconfiguration complete message, respectively, as described in FIGs. 3-8B.

[0285] In some embodiments, the DU receives a second CU-to-DU message including a second LTM DU configuration for the UE, from the CU (e.g., events 490, 480, 680, 690, 681, 880, 890, or 881). The DU generates a third serving DU configuration based on the second LTM DU configuration. In some embodiments, the DU generates the third serving DU configuration, based on the second LTM DU configuration and the first serving DU configuration. The DU transmits a second DU-to-CU message including the third serving DU configuration to the CU (e.g., events 490, 480, 680, 690, 681, 880, 890, or 881). The DU communicates with the UE in accordance with the third serving DU configuration (e.g., events 424, 436, 444, 498, 480, 624, 698, 680, 681, 636, 880, 881, 824, 898, or 836). In some embodiments, the third serving DU configuration augments the second serving DU configuration. For example, the third serving DU configuration includes (new) configurations that do not exist in the second serving DU configuration. In other embodiments, the third serving DU configuration includes (new) configurations updating (existing) configurations included in the second serving DU configuration. Examples of the third serving DU configuration are similar to the serving DU configuration described above.

[0286] In some embodiments, the second LTM DU configuration includes at least one fourth RS resource configuration and at least one fourth report configuration for reporting measurements of some RSs configured in the fourth RS resource configuration(s). In some embodiments, the DU generates at least one fifth RS resource configuration based on the fourth RS resource configuration(s) and includes the fifth RS resource configuration(s) in the third serving DU configuration. In some embodiments, the DU generates at least one fifth report configuration for reporting measurement results of some RSs configured in the fifth RS resource configuration(s) and includes the fifth report configuration(s) in the third serving DU configuration. In other embodiments, the DU generates at least one fifth report configuration for reporting measurement results of some RSs configured in the fourth RS resource configuration(s) and includes the fourth RS resource configuration(s) and the fifth report configuration(s) in the third serving DU configuration. In some embodiments, RSs configured in the third RS resource configuration(s) are different from RSs configured in the fourth RS resource configuration(s) and the fifth RS resource configuration(s). In some embodiments, some of the third report configuration(s) are the same as the fifth report configuration(s). In other embodiments, the third report configuration(s) are different from the fifth report configuration(s).

[0287] In some embodiments, the second LTM DU configuration includes at least one fourth TCI state configuration. In some embodiments, the DU generates at least one fifth TCI state configuration based on the fourth TCI state configuration(s) and includes the fifth TCI state configuration(s) in the third serving DU configuration. In other embodiments, the DU includes the fourth TCI state configuration(s) in the third serving DU configuration.

[0288] In some embodiments, the (first or second) CU-to-DU message and the (first or second) DU-to-CU message are a *UE Context Setup Request* message and a *UE Context Setup Response* message, respectively. In other embodiments, the (first or second) CU-to-DU message and the (first or second) DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Response* message, respectively. In some alternative embodiments, the (first or second) DU-to-CU message is a *UE Context Modification Required* message.

[0289] FIG. 16 illustrates an example method 1600, which may be implemented by a DU (e.g., the DU 174, 174A, 174B, or 174C in FIGs. 3-8B), for enabling LTM for a UE (e.g., the UE 102).

[0290] The method 1600 begins with the DU receiving 1602 a first CU-to-DU message including a first LTM DU configuration for the UE, from a CU, where the first LTM DU configuration configures a first cell for LTM (e.g., events 308, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The DU generates 1604 a second DU configuration based on the first LTM DU configuration, where the second DU configuration configures a second cell for LTM. The DU transmits 1606 a first DU-to-CU message including the second LTM DU configuration to the CU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The DU detects 1608 that the UE accessed the second cell. The DU transmits 1610 an indication message to the CU, indicating that the UE successfully accessed the second cell (e.g., events 332, 336, 352, 356, 380, 432, 436, 452, 456, 498, 480, 532, 536, 552, 598, 556, 580, 581, 582, 632, 636, 698, 656, 680, 681, 732, 736, 798, 756, 780, 832, 836, 898, 868, 880, or 881). The DU communicates 1612 with the UE via the second cell using the second LTM configuration (e.g., events 336, 356, 380, 436, 456, 480, 536, 556, 580, 581, 582, 636, 656, 680, 681, 736, 756, 780, 836, 856, 880, or 881).

[0291] In some embodiments, the DU is a serving DU which may be a source DU or a secondary DU as described in FIGs. 4, 6A-6B, and 8A-8B. In other embodiments, the DU is a target DU as described in FIGs. 4, 6A-6B, and 8A-8B.

[0292] In some embodiments, the DU generates a portion of the second LTM DU configuration based on the first LTM DU configuration, and generates the rest of the second LTM DU configuration independent of the first LTM DU configuration. In some embodiments, the first LTM DU configuration includes at least one first RS resource configuration.

[0293] In some embodiments, the first LTM DU configuration includes at least one first RS resource configuration and at least one first report configuration for reporting measurement results of some RSs configured in the first RS resource configuration(s). In some embodiments, the DU generates at least one second RS resource configuration based on the first RS resource configuration(s) and includes the second RS resource configuration(s) in the second LTM DU configuration. In some embodiments, the DU generates at least one second report configuration for reporting measurement results of some RSs configured in the second RS resource configuration(s) and includes the second report configuration(s) in the second LTM DU configuration. In other embodiments, the DU generates at least one second

report configuration for reporting measurement results of some RSs configured in the first RS resource configuration(s) and includes the first RS resource configuration(s) and the second report configuration(s) in the second LTM DU configuration. In some embodiments, the DU generates at least one third RS resource configuration and/or at least one third report configuration for reporting measurement results of some RSs configured in the third RS resource configuration(s). In some embodiments, RSs configured in the third RS resource configuration(s) are different from RSs configured in the first RS resource configuration(s) and the second RS resource configuration(s). In some embodiments, some of the third report configuration(s) are the same as the second report configuration(s). In other embodiments, the third report configuration(s) are different from the second report configuration(s).

[0294] In some embodiments, the first LTM DU configuration includes at least one first TCI state configuration. In some embodiments, the DU generates at least one second TCI state configuration based on the first TCI state configuration(s) and includes the second TCI state configuration(s) in the second LTM DU configuration. In other embodiments, the DU includes the first TCI state configuration(s) in the second LTM DU configuration.

[0295] In some embodiments, the CU generates an RRC message including the second LTM DU configuration, and transmits the RRC message to the UE via the DU, an additional DU, or a BS. In some embodiments, the CU receives an RRC response message from the UE via the DU, the additional DU, or the BS, in response. For example, the RRC message and the RRC response message are similar to the RRC reconfiguration message and RRC reconfiguration complete message, respectively, as described in FIGs. 3 to 8B.

[0296] In some embodiments, the DU receives a second CU-to-DU message including a third LTM DU configuration for the UE from the CU, where the third LTM DU configuration configures a third cell for LTM (e.g., events 490, 480, 680, 690, 681, 880, 890, or 881). The DU generates a fourth LTM DU configuration to update the second LTM DU configuration, based on the third LTM DU configuration. The fourth LTM DU configuration still configures the second cell for LTM. In some embodiments, the DU generates the fourth DU configuration, based on the third LTM DU configuration, the second LTM DU configuration and the first LTM DU configuration. The DU transmits a second DU-to-CU message including the fourth LTM DU configuration to the CU (e.g., events 490, 480, 680, 690, 681, 880, 890, or 881). In some embodiments, the fourth LTM DU configuration augments the second LTM DU configuration. For example, the fourth DU configuration includes (new)

configurations that do not exist in the second LTM DU configuration. In other embodiments, the fourth DU configuration includes (new) configurations updating (existing) configurations included in the second LTM DU configuration.

[0297] In some embodiments, the third LTM DU configuration includes at least one fourth TCI state configuration. In some embodiments, the DU generates at least one fifth TCI state configuration based on the fourth TCI state configuration(s) and includes the fifth TCI state configuration(s) in the fourth LTM DU configuration. In other embodiments, the DU includes the fourth TCI state configuration(s) in the fourth LTM DU configuration.

[0298] In some embodiments, the (first or second) CU-to-DU message and the (first or second) DU-to-CU message are a *UE Context Setup Request* message and a *UE Context Setup Response* message, respectively. In other embodiments, the (first or second) CU-to-DU message and the (first or second) DU-to-CU message are a *UE Context Modification Request* message and a *UE Context Modification Response* message, respectively. In some alternative embodiments, the (first or second) DU-to-CU message is a *UE Context Modification Required* message.

[0299] FIG. 17 illustrates an example method 1700, which may be implemented by a CU (e.g., the CU 172 of the first BS 104 or second BS 106), for enabling LTM for a UE (e.g., the UE 102).

[0300] The method 1700 begins with the CU communicating 1702 with the UE via a serving DU (e.g., events 402, 602, or 802). The CU transmits 1704 a first CU-to-DU message including a first LTM DU configuration for the UE to the serving DU (e.g., events 490, 690, or 890). The CU receives 1706 a first DU-to-CU message including a serving DU configuration from the serving DU (e.g., events 490, 690, or 890). The CU transmits 1708 the serving DU configuration to the UE via the serving DU or a RAN node (e.g., events 494, 694, 617, 619, 894, 817, or 819). In some embodiments, the RAN node is another DU (e.g., a M-DU or a S-DU in FIGs. 6A, 6B, 8A or 8B) or a BS (e.g., a MN or a SN).

[0301] In some embodiments, the serving DU and the CU are the DU and the CU of FIG. 15, respectively. Examples and embodiments described for FIG. 15 apply to FIG. 17.

[0302] FIG. 18 illustrates an example method 1800, which may be implemented by a CU (e.g., the CU 172 of the first BS 104 or second BS 106), for enabling LTM for a UE (e.g., the UE 102).

[0303] The method 1800 begins with the CU communicating 1802 with the UE via a first DU (e.g., events 302, 402, 502, 602, 702, 802, 380, 480, 580, 680, 780, 880, 581, 582, 681, or 881). The CU transmits 1804 a first CU-to-DU message including a first LTM DU configuration for the UE, to a second DU (e.g., events 308, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The CU receives 1806 a first DU-to-CU message including a second LTM DU configuration from the second DU (e.g., events 310, 390, 380, 490, 480, 580, 590, 581, 582, 680, 690, 681, 780, 790, 880, 890, or 881). The CU transmits 1808 the second LTM DU configuration to the UE via the first DU or a RAN node (e.g., events 316, 318, 394, 380, 494, 480, 580, 594, 581, 582, 680, 694, 617, 619, 780, 794, 880, 881, 894, 817, or 819). In some embodiments, the RAN node is another DU (e.g., the M-DU or S-DU in FIGs. 6A, 6B, 8A, and 8B) or a BS (e.g., a MN or a SN).

[0304] In some embodiments, the first DU is a serving DU (e.g., the DU 174 in FIG. 3, the S-DU in FIG. 4, the M-DU or S-DU in FIGs. 5A-8B), and the second DU is a target DU (e.g., the T-DU in FIGs. 4, 6A, 6B, 8A, and 8B). In other embodiments, the second DU and the first DU are the same DU (i.e., a serving DU such as the DU 174 in FIG. 3, the S-DU in FIG. 4, or the M-DU or S-DU in FIGs. 5A-8B). In some embodiments, the CU and the second DU are the CU and the DU in FIG. 16, respectively. Examples and embodiments described for FIG. 16 apply to FIG. 18. In some embodiments, the serving DU is the serving DU described in FIG. 15. Examples and embodiments described for FIG. 15 apply to FIG. 17.

[0305] Description for one of the above figures may apply to another of the above figures. Examples, embodiments, and methods described above may be combined, if there is no conflict. An event or block described above may be optional or omitted. For example, an event or block with dashed lines in the figures may be optional. In some embodiments, “message” is used and may be replaced by “information element (IE)”, and vice versa. In some embodiments, “IE” is used and may be replaced by “field”, and vice versa. In some embodiments, “configuration” may be replaced by “configurations” or “configuration parameters”, and vice versa. In some embodiments, the “LTM command” may be replaced by “serving cell change command”, “Layer 1/Layer 2 switching command”, “lower layer switching command” or “lower layer serving cell change command”. In some embodiments, “some” means “one or more”. In some embodiments, “at least one” means “one or more”. In some embodiments, the “DU configuration” may be replaced by “cell group configuration”. In some embodiments, the “cell index” may be replaced with “serving cell index”, “LTM cell index”, “special cell (SpCell) index”, “PCell index”, or “PSCell index”. In some

embodiments, the “serving” may be replaced by “source”. In some embodiments, the “measurement report” may be replaced by “measurement result(s)”.

[0306] A user device in which the techniques of this disclosure may be implemented (*e.g.*, the UE 102) may be any suitable device capable of wireless communications such as a smartphone, a tablet computer, a laptop computer, a mobile gaming console, a point-of-sale (POS) terminal, a health monitoring device, a drone, a camera, a media-streaming dongle or another personal media device, a wearable device such as a smartwatch, a wireless hotspot, a femtocell, or a broadband router. Further, the user device in some cases may be embedded in an electronic system such as the head unit of a vehicle or an advanced driver assistance system (ADAS). Still further, the user device may operate as an internet-of-things (IoT) device or a mobile-internet device (MID). Depending on the type, the user device may include one or more general-purpose processors, a computer-readable memory, a user interface, one or more network interfaces, one or more sensors, etc.

[0307] Numerical adjectives “first”, “second”, and “third” do not imply any order (are not ordinals) but are markers to distinguish separate instances of similar elements. References to the singular (*e.g.*, “a” or “an”, “the”) should include the plural unless clearly indicated otherwise.

[0308] As used herein, a phrase referring to “at least one of” or “one or more of” a list of items refers to any combination of those items, including single members. For example, “at least one of: a, b, or c” is intended to cover the possibilities of: a only, b only, c only, a combination of a and b, a combination of a and c, a combination of b and c, and a combination of a and b and c.

[0309] Although the features and elements of the present embodiments are described in the embodiments in particular combinations, each feature or element can be used alone without the other features and elements of the embodiments or in various combinations with or without other features and elements disclosed herein. The methods or flowcharts may be implemented in a computer program, software or firmware tangibly embodied in a computer-readable storage medium for execution by a specifically programmed computer or processor.

[0310] Certain embodiments are described in this disclosure as including logic or a number of components or modules. Modules may be software modules (*e.g.*, code, or machine-readable instructions stored on non-transitory machine-readable medium) or hardware modules. A hardware module is a tangible unit capable of performing certain operations and

may be configured or arranged in a certain manner. A hardware module may comprise dedicated circuitry or logic that is permanently configured (*e.g.*, as a special-purpose processor, such as a field programmable gate array (FPGA) or an application-specific integrated circuit (ASIC), a digital signal processor (DSP), etc.) to perform certain operations. A hardware module may also comprise programmable logic or circuitry (*e.g.*, as encompassed within a general-purpose processor or other programmable processor) that is temporarily configured by software to perform certain operations. The decision to implement a hardware module in dedicated and permanently configured circuitry, or in temporarily configured circuitry (*e.g.*, configured by software) may be driven by cost and time considerations.

[0311] When implemented in software, the techniques may be provided as part of the operating system, a library used by multiple applications, a particular software application, etc. The software may be executed by one or more general-purpose processors or one or more special-purpose processors.

[0312] Upon reading this disclosure, those of skill in the art will appreciate additional and alternative structural and functional designs for handling mobility between BSs through the principles disclosed herein. Thus, while particular embodiments and applications have been illustrated and described above, it is to be understood that the disclosed embodiments are not limited to the precise construction and components disclosed herein. Various modifications, changes, and variations, which will be apparent to those of ordinary skill in the art, may be made in the arrangement, operation and details of the method and apparatus disclosed herein without departing from the spirit and scope defined in the appended claims.

What is claimed is:

1. A wireless communication method performed by a distributed unit, DU, (174) of a base station, BS, (104), the method comprising:

receiving (1204), from a centralized unit, CU, (172) of the BS (104), a request to prepare a first cell (124C) for lower-layer triggered mobility, LTM, for a user equipment, UE, (102) to switch from a serving cell (124A) to the first cell (124C);

generating (1206) an LTM DU configuration for communication with the first cell (124C);

generating (1208) a first transmission configuration indicator, TCI, state configuration specifying at least one TCI state for the communication with the first cell (124C); and

transmitting (1210), to the CU (172), the LTM DU configuration and the first TCI state configuration.

2. The method of Claim 1, further comprising:

transmitting, to the UE, an LTM command directing the UE to access the first cell based on the first TCI state configuration.

3. The method of Claim 1 or 2, further comprising:

detecting the UE has switched to the first cell; and

transmitting, to the CU, a notification signal that the UE is connected to the first cell.

4. The method of any of Claims 1 to 3, wherein the request includes a second TCI state configuration, and the generating the first TCI state configuration is performed based on the second TCI state configuration.

5. The method of any of Claims 1 to 4, further comprising:

generating a serving DU configuration based on the LTM DU configuration and the first TCI state configuration; and

transmitting the serving DU configuration to the CU.

6. The method of Claim 5, wherein the serving DU configuration is for the serving cell or for the first cell.

7. The method of any of Claims 1 to 6, wherein the transmitting, to the CU, the LTM DU configuration and the first TCI state configuration comprises:

transmitting, to the CU, a first DU-to-CU message including the LTM DU configuration; and

transmitting, to the CU, a second DU-to-CU message including the first TCI state configuration.

8. The method of Claim 7, wherein:

the first DU-to-CU message includes a first UE Context Setup Response message or a first UE Context Modification Response message; and

the second DU-to-CU message includes a second UE Context Setup Response message or a second UE Context Modification Response message.

9. The method of any of Claims 1 to 6, wherein the transmitting, to the CU, the LTM DU configuration and the first TCI state configuration comprises:

transmitting, to the CU, in a single DU-to-CU message, the LTM DU configuration and the first TCI state configuration.

10. The method of claim 9, wherein the single DU-to-CU message includes a UE Context Setup Response message or a UE Context Modification Response message.

11. A wireless communication method performed by a centralized unit, CU, (172) of a base station, BS, (104), the method comprising:

receiving (904), from a first distributed unit, DU, (174) of the BS (104), a first lower-layer triggered mobility, LTM, DU configuration for a user equipment, UE, (102) to communicate with a first cell (124C), different from a serving cell (124A);

receiving (910), from the first DU (174), a first transmission configuration indicator, TCI, state configuration specifying at least one TCI state for the UE to communicate with the first cell (124C); and

transmitting (918), to the UE (102), the LTM DU configuration and the first TCI state configuration.

12. The method of Claim 11, further comprising:

transmitting (1204) a CU-to-DU message, to the first DU, requesting to prepare the first cell (124C) for LTM; and

receiving (1210) a DU-to-CU message including the first LTM DU configuration and the first TCI state configuration.

13. The method of any of Claims 11 or 12, further comprising:

transmitting the first TCI state configuration to a second DU, wherein the first cell is associated with the first DU.

14. The method of Claim 13, wherein the BS is a first BS, and the second DU is a target DU of the first BS or a second BS.

15. The method of any of Claims 11 to 14, further comprising:

transmitting a second TCI state configuration to the first DU, wherein the first TCI state configuration is generated based on the second TCI state configuration.

16. The method of any of Claims 11 to 15, further comprising:

receiving, from a serving DU, a serving DU configuration generated based on the LTM DU configuration; and

transmitting the serving DU configuration to the UE, wherein the serving DU configuration is for the serving cell or for the first cell.

17. A wireless communication method performed by a distributed unit, DU, (174) of a base station, BS, (104), the method comprising:

receiving (1302), from a centralized unit, CU, (172) of the BS (104), a CU-to-DU message including a transmission configuration indicator, TCI, state configuration, the TCI state configuration including at least one TCI state for lower-layer triggered mobility, LTM, for a user equipment, UE, (102) to communicate with a first cell (124C), different from a serving cell (124A); and

transmitting (1307), to the UE (102), an LTM command instructing the UE (102) to switch from the serving cell (124A) to the first cell (124C) based on the at least one TCI state, the LTM command including an identifier, ID, of the at least one TCI state.

18. The method of Claim 15, wherein the CU-to-DU message includes a UE Context Setup Request message or a UE Context Modification Request message.

19. A communication device (170, 172, 174) comprising a transceiver (282), a processor (283) and computer-readable storage media (284) storing executable instructions for the processor to perform any of the methods recited in claims 1-18, using the transceiver.

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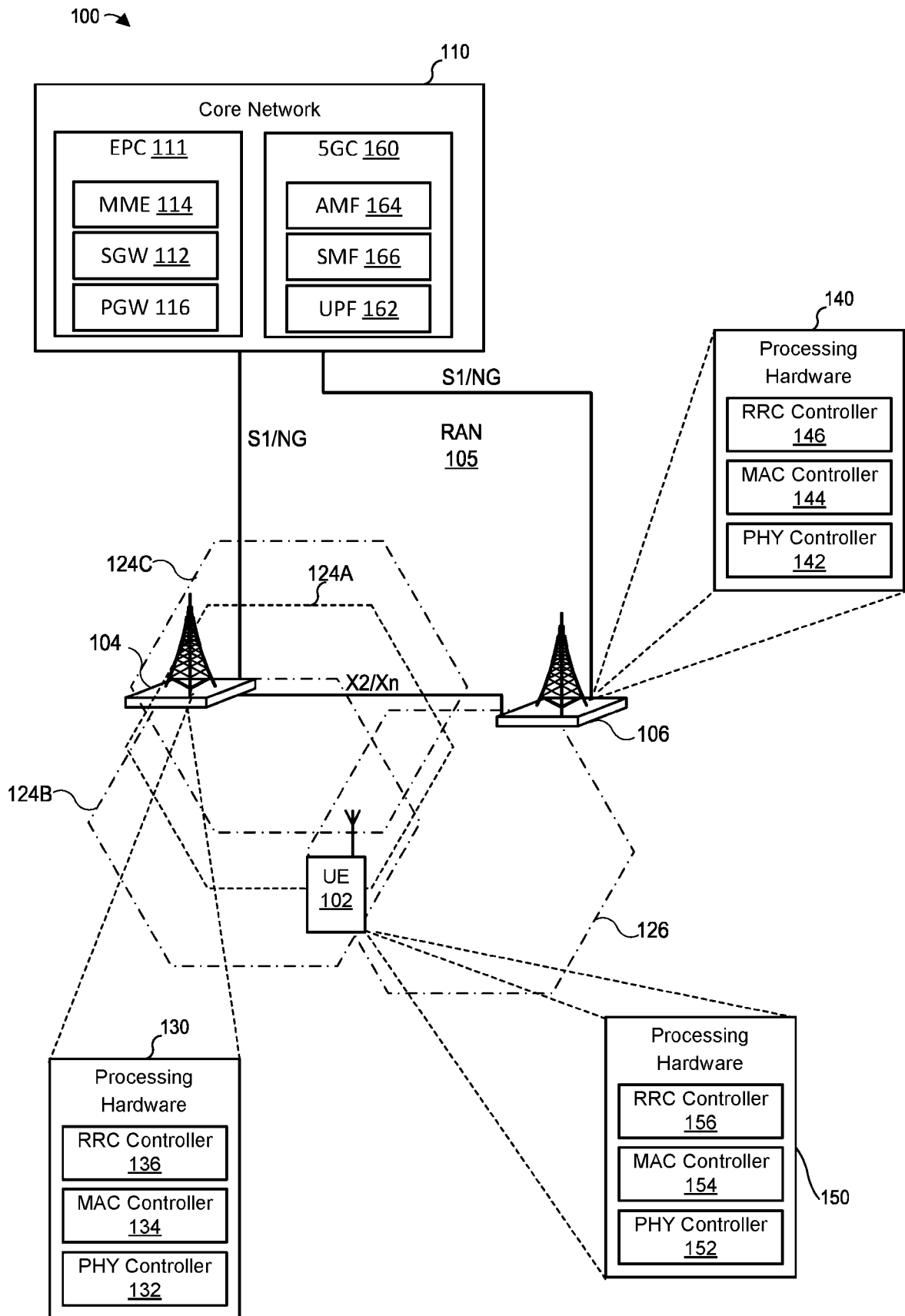


Figure 1A

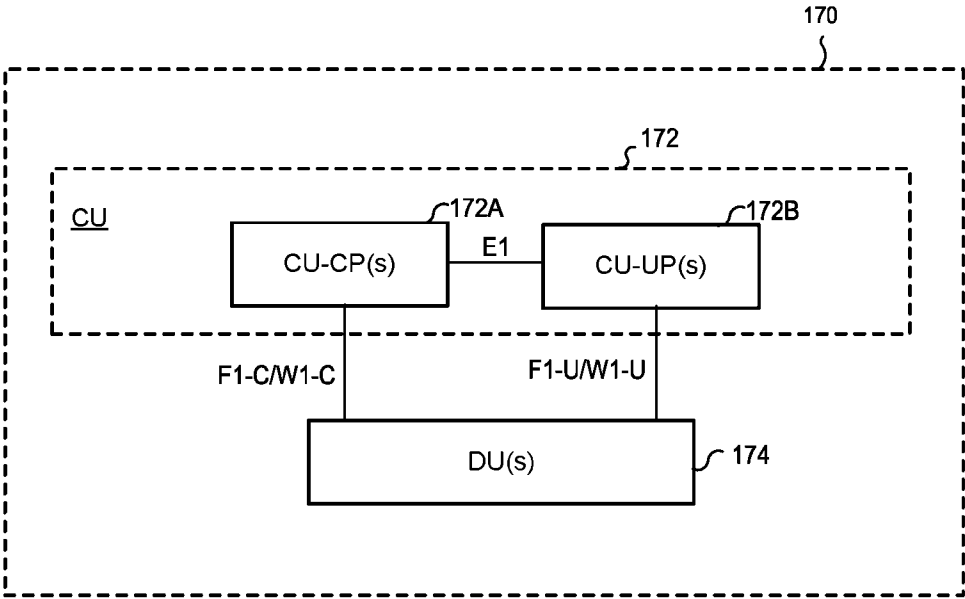


Figure 1B

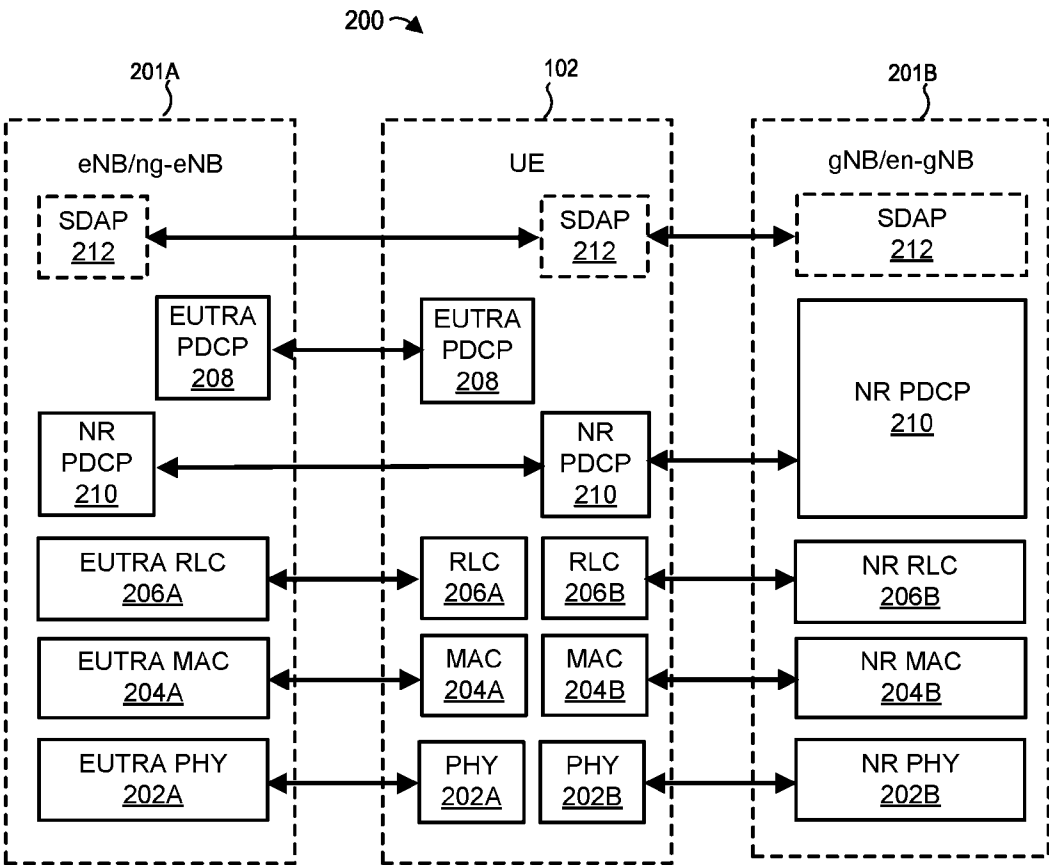


Figure 2A

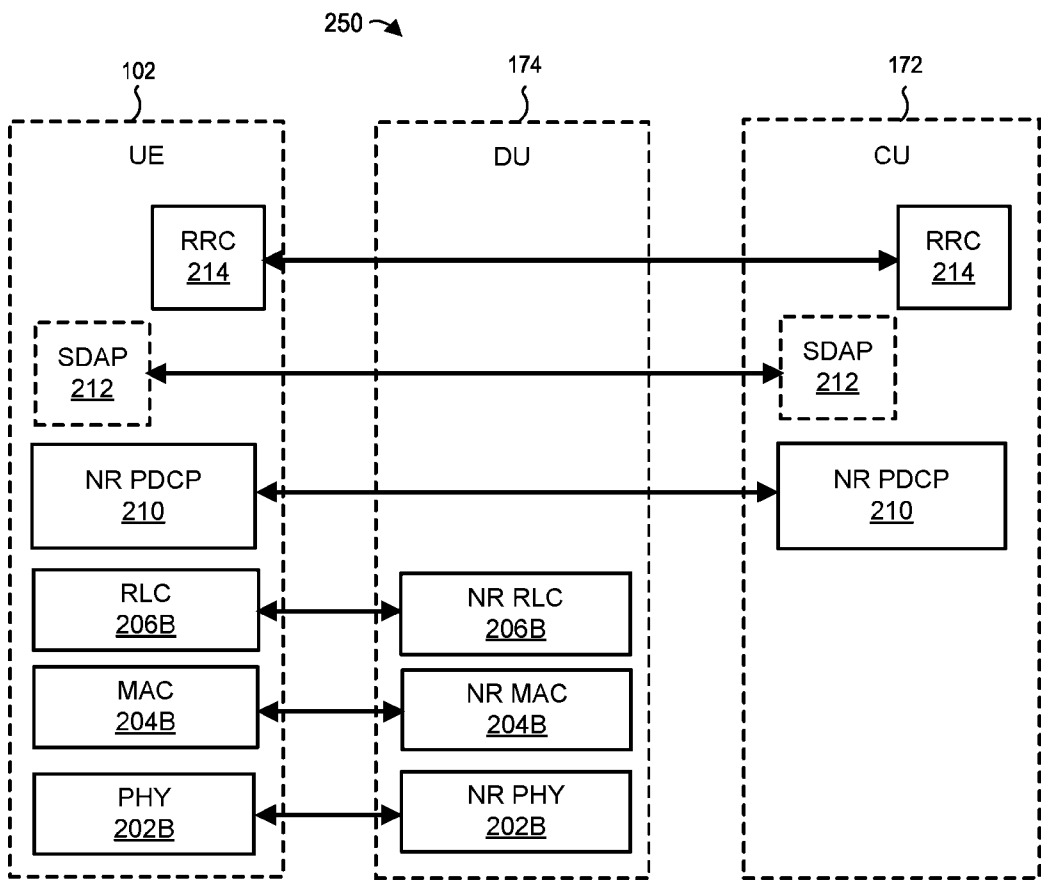


Figure 2B

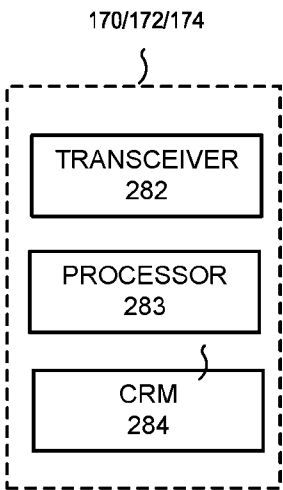


Figure 2C

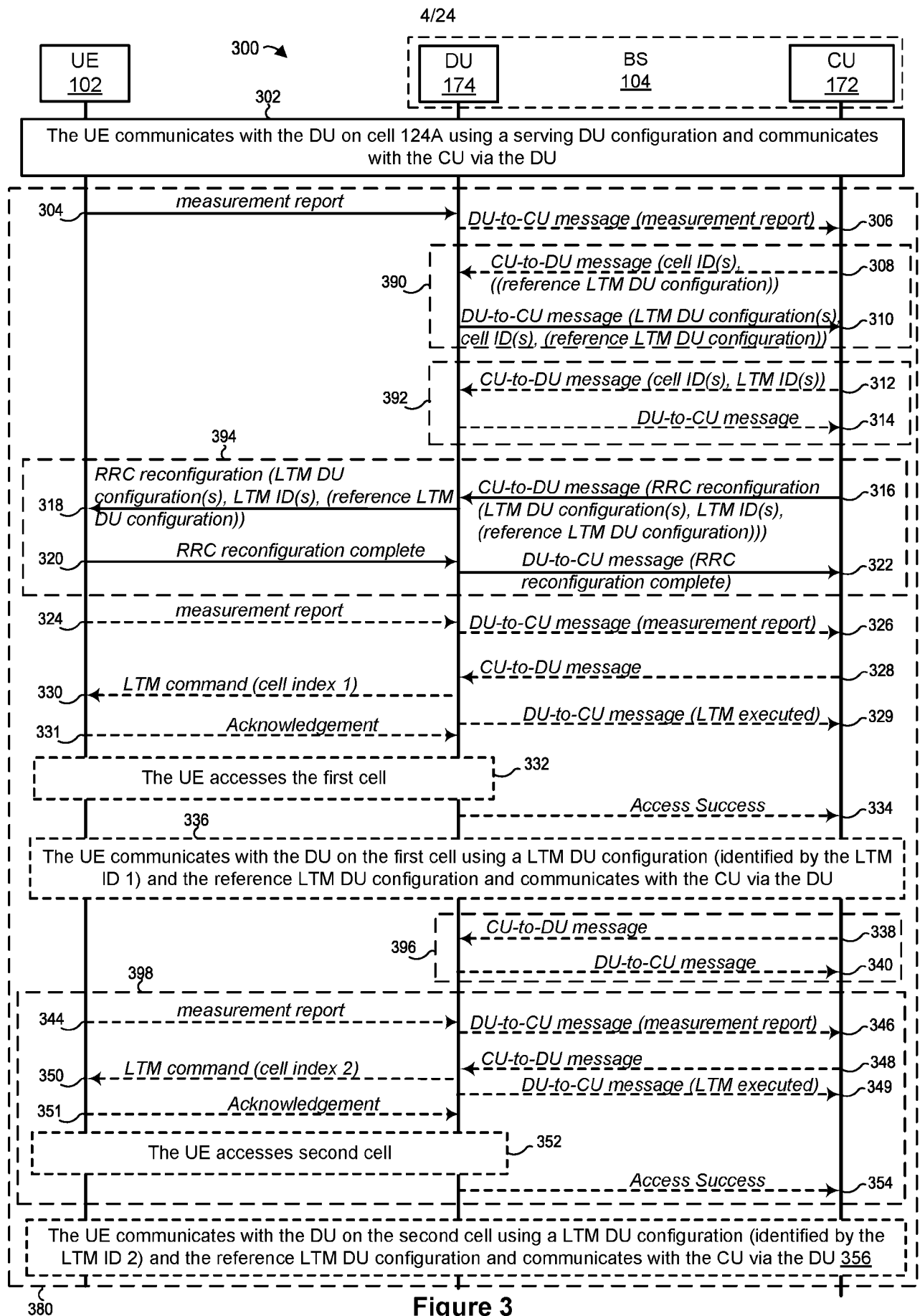


Figure 3

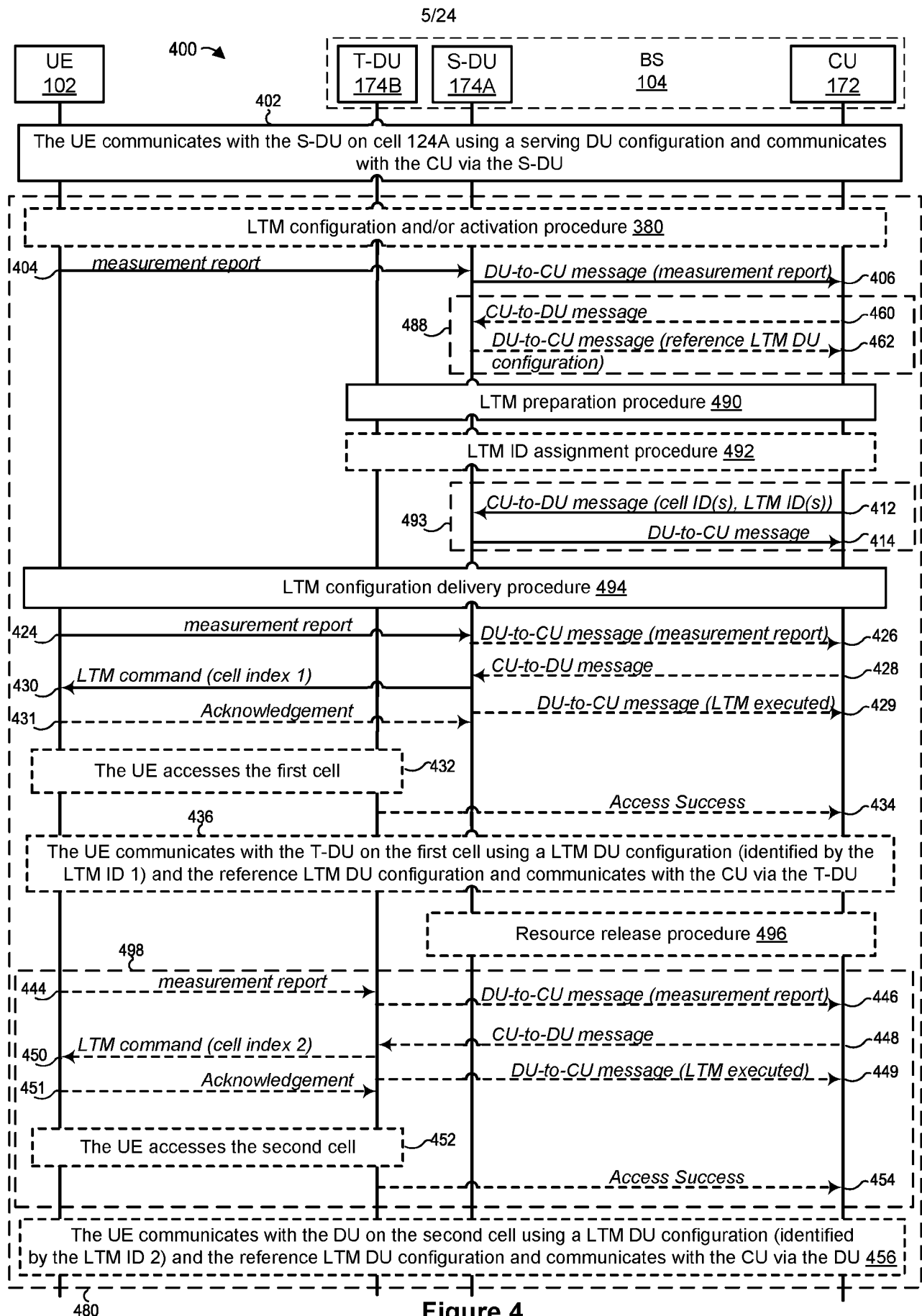


Figure 4

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500A

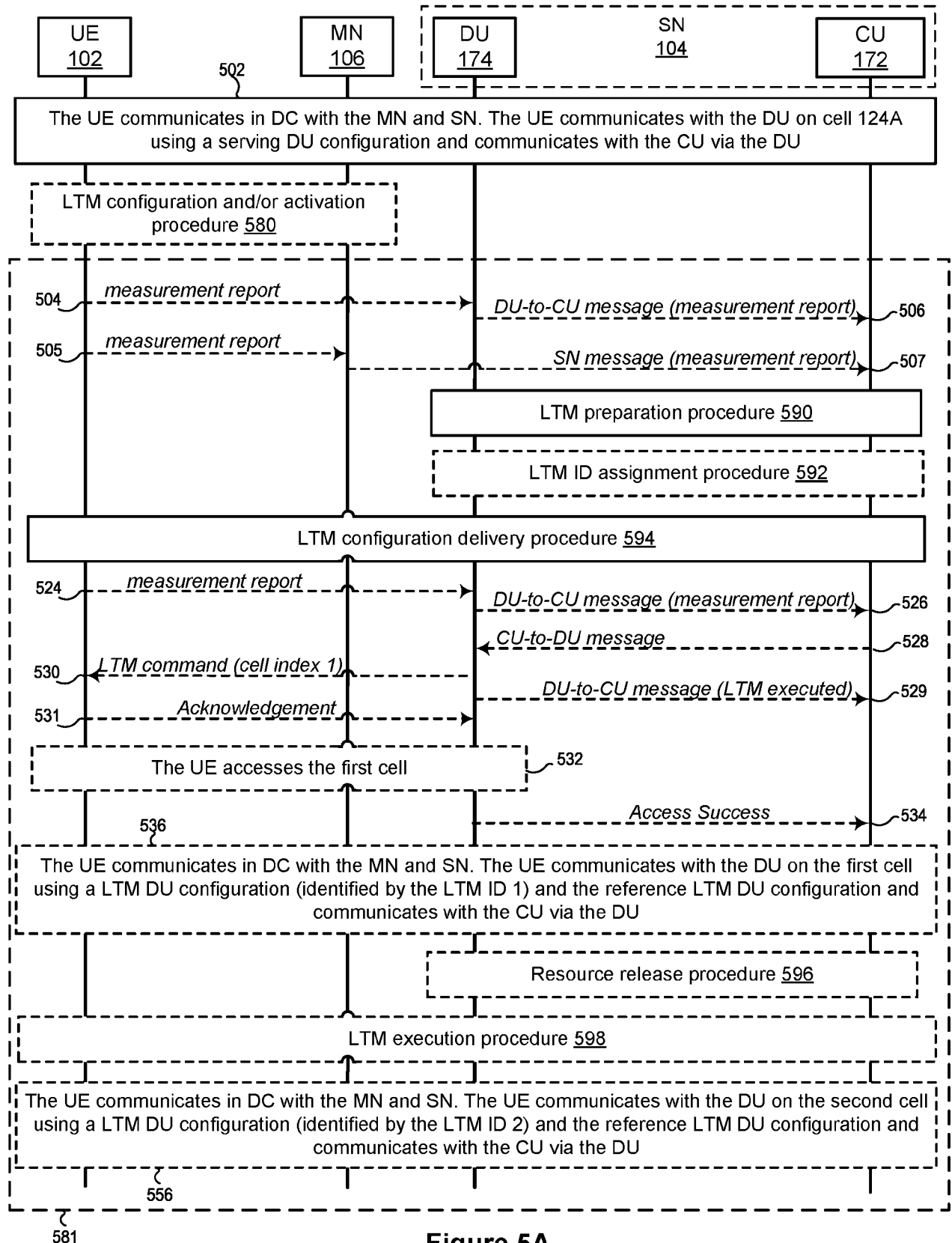


Figure 5A

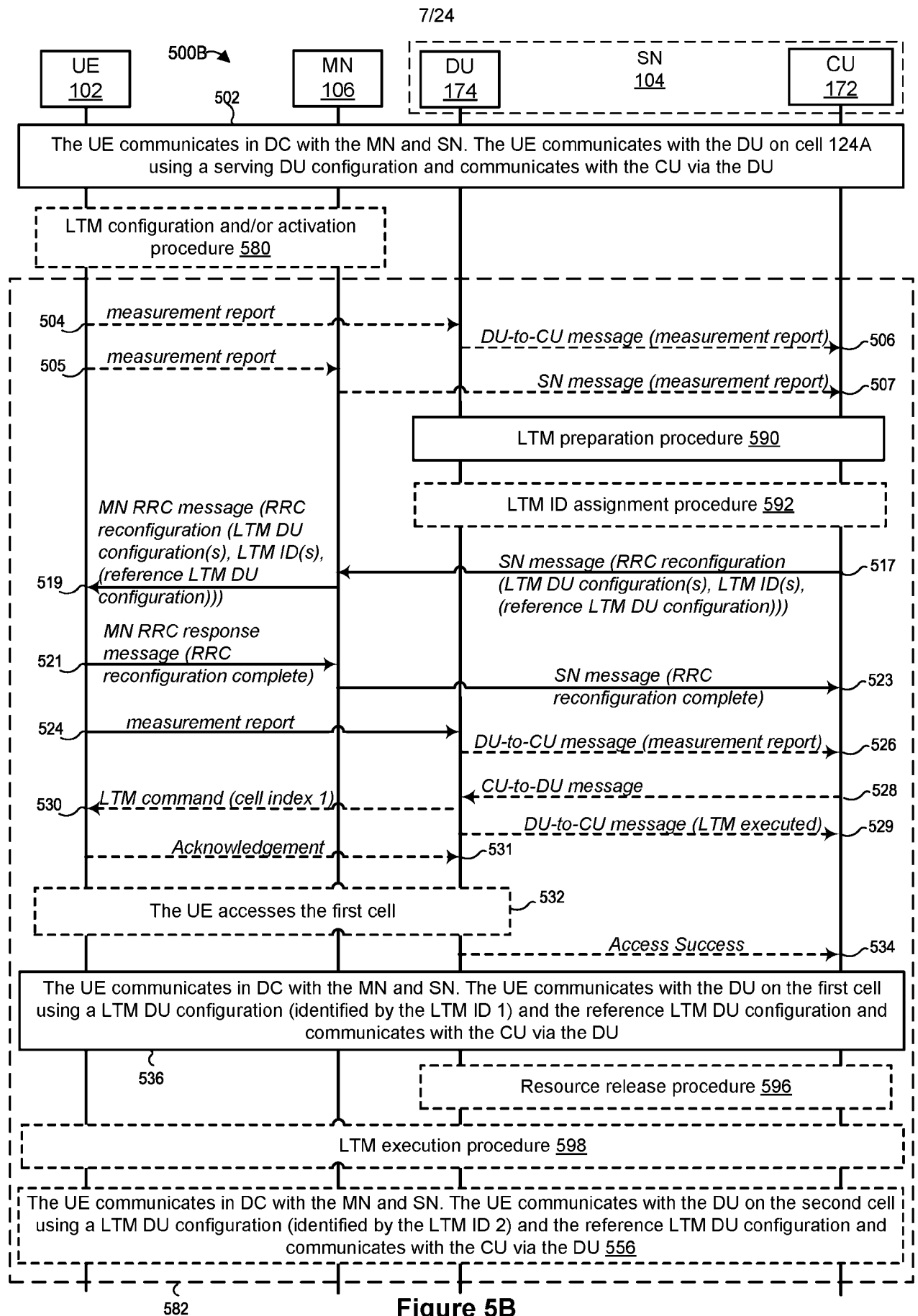


Figure 5B

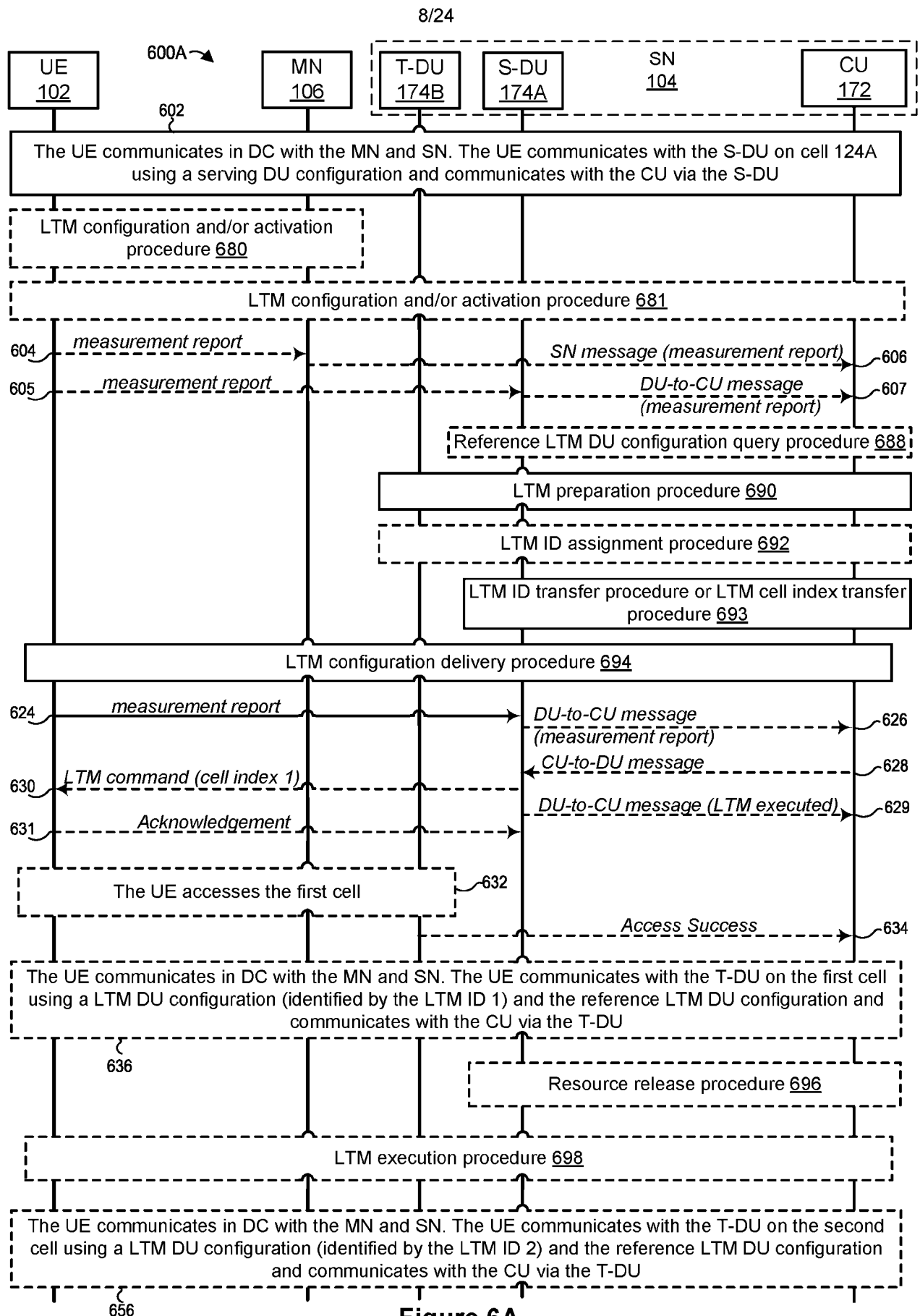
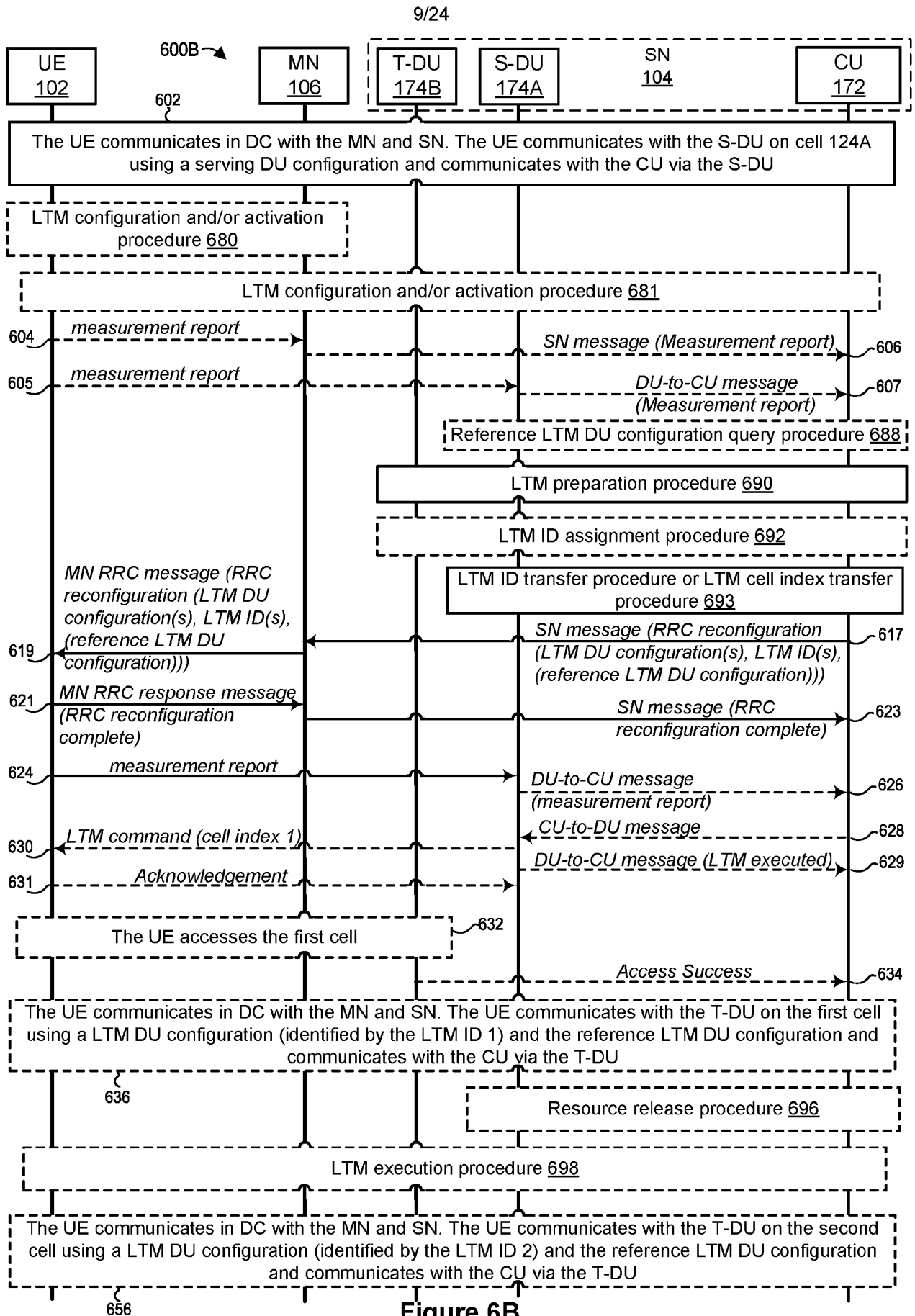


Figure 6A



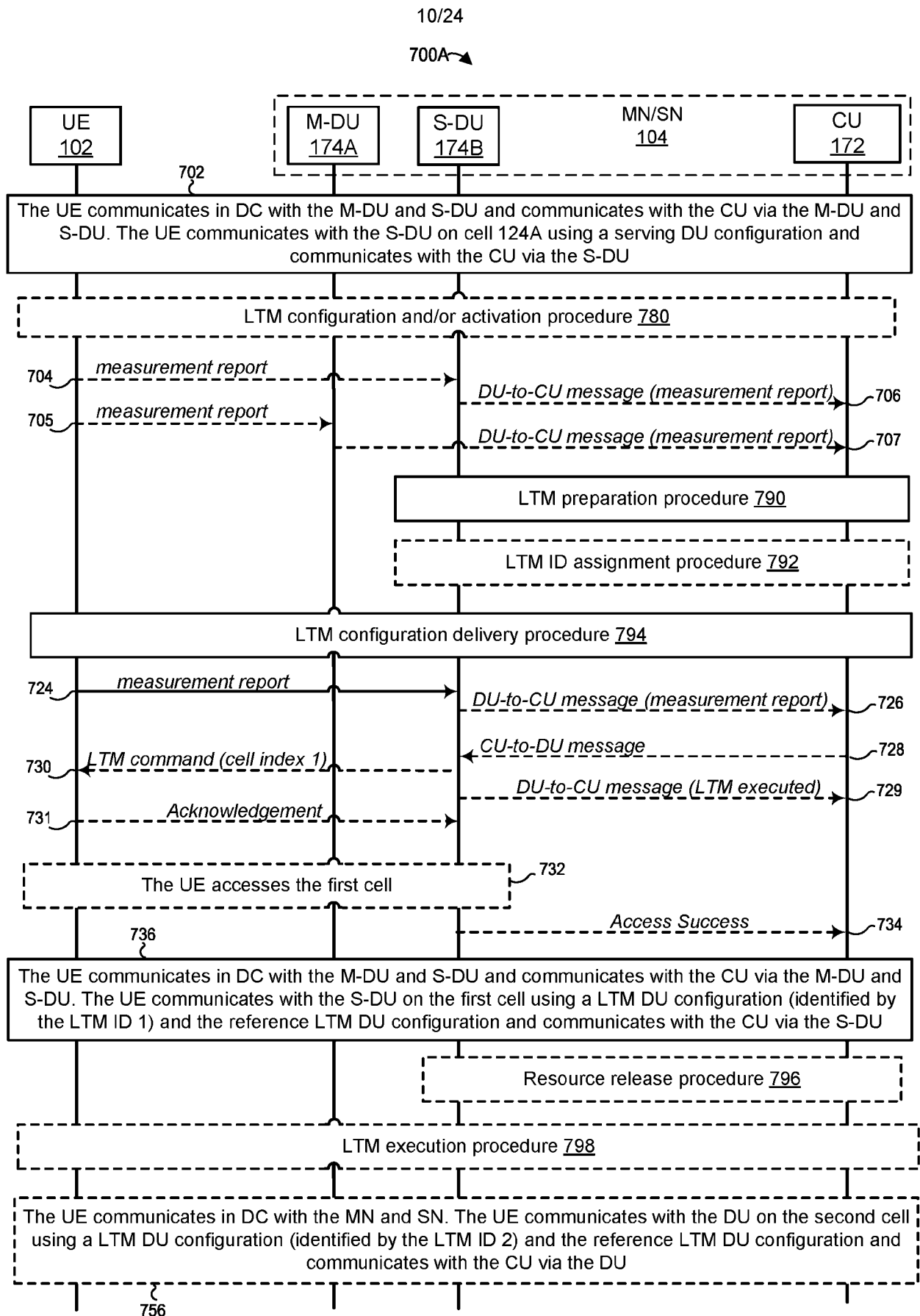


Figure 7A

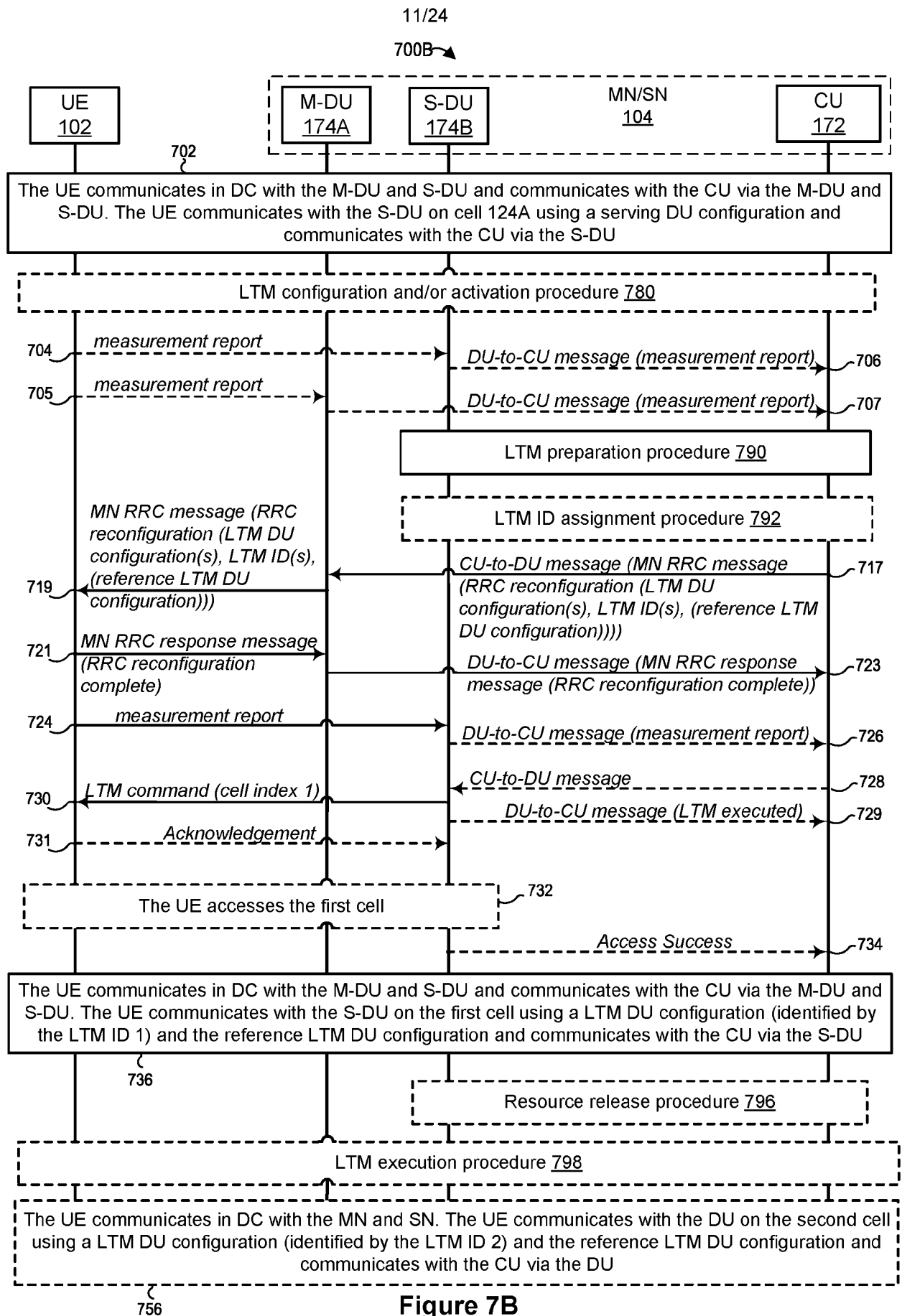


Figure 7B

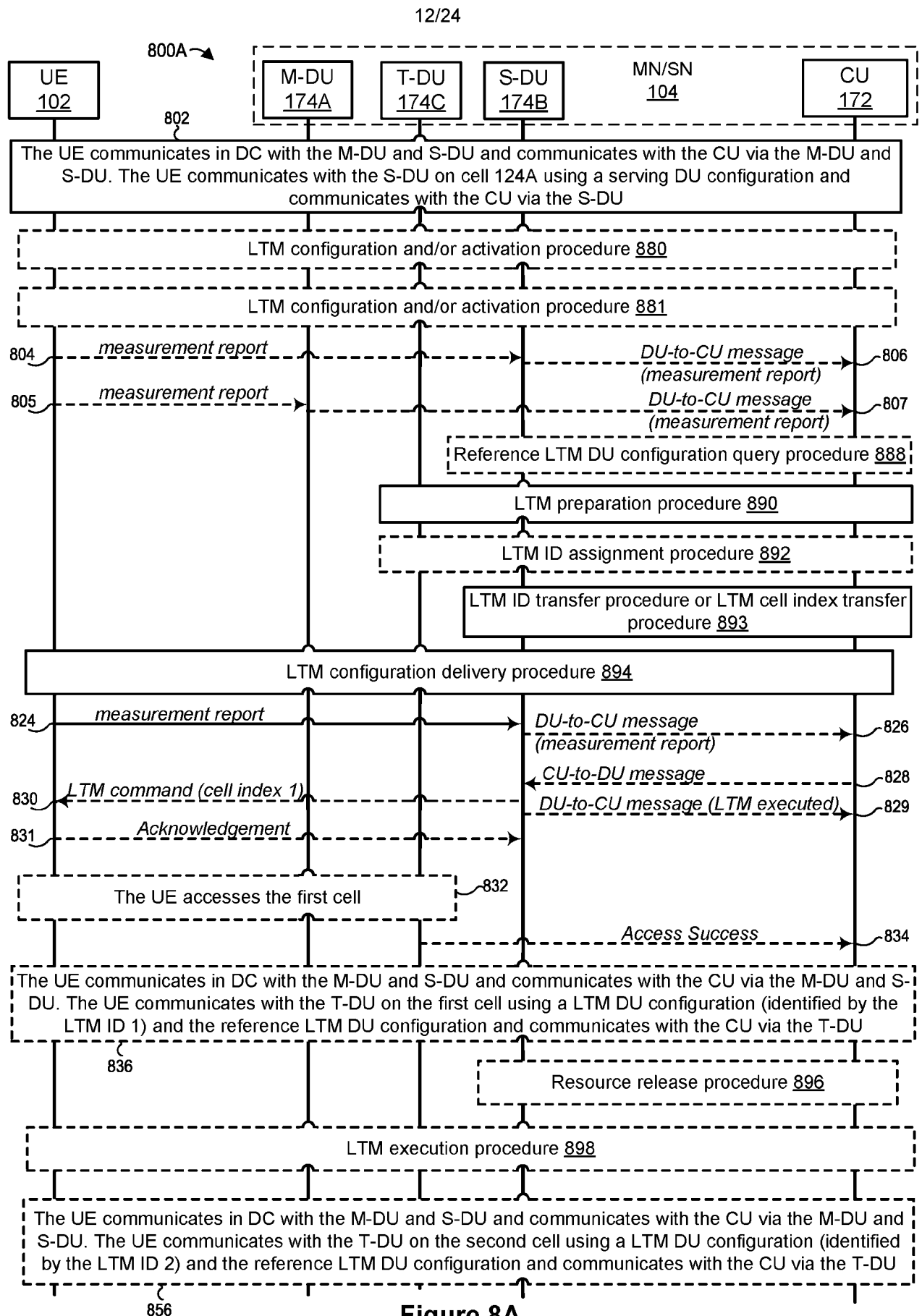
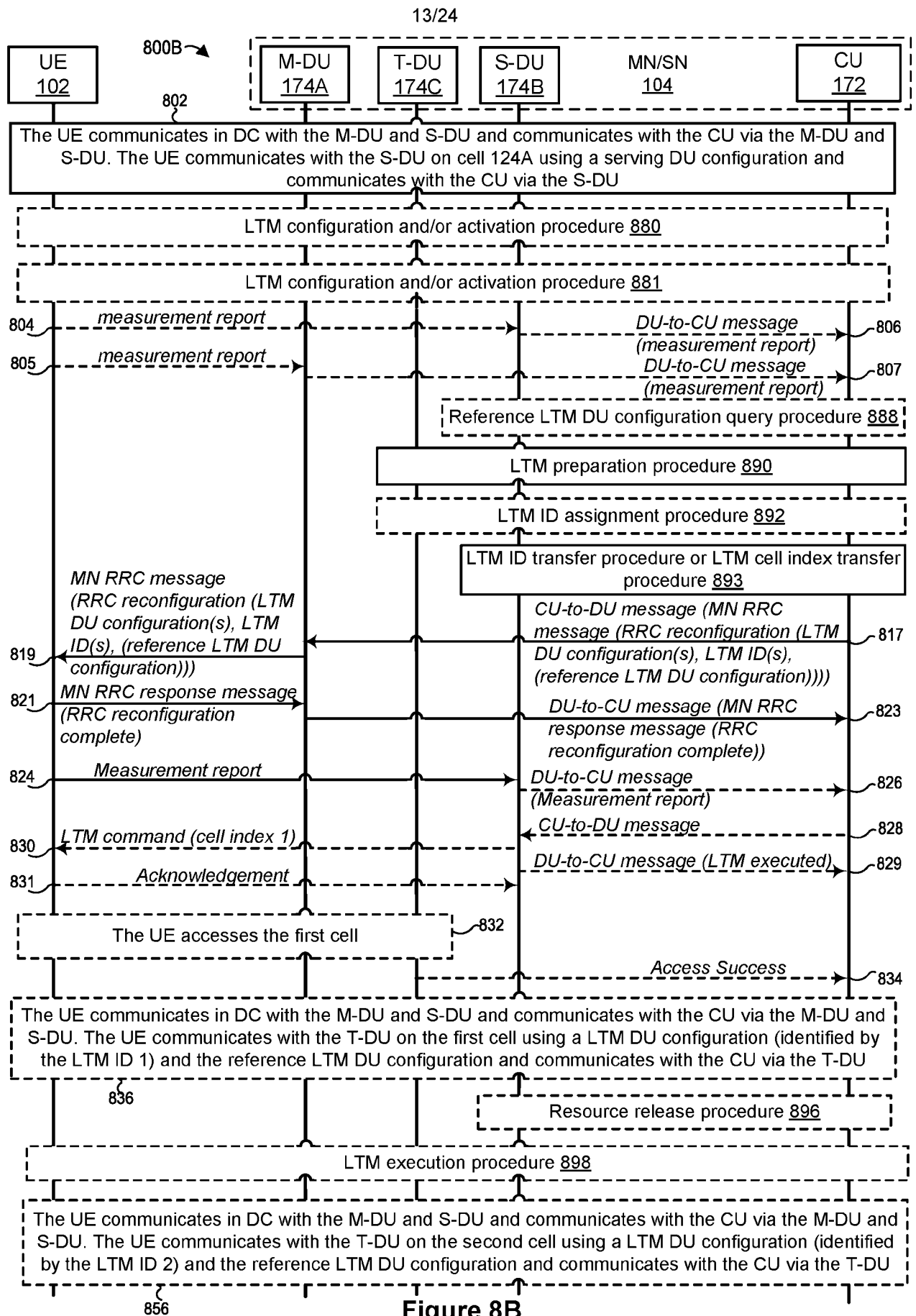
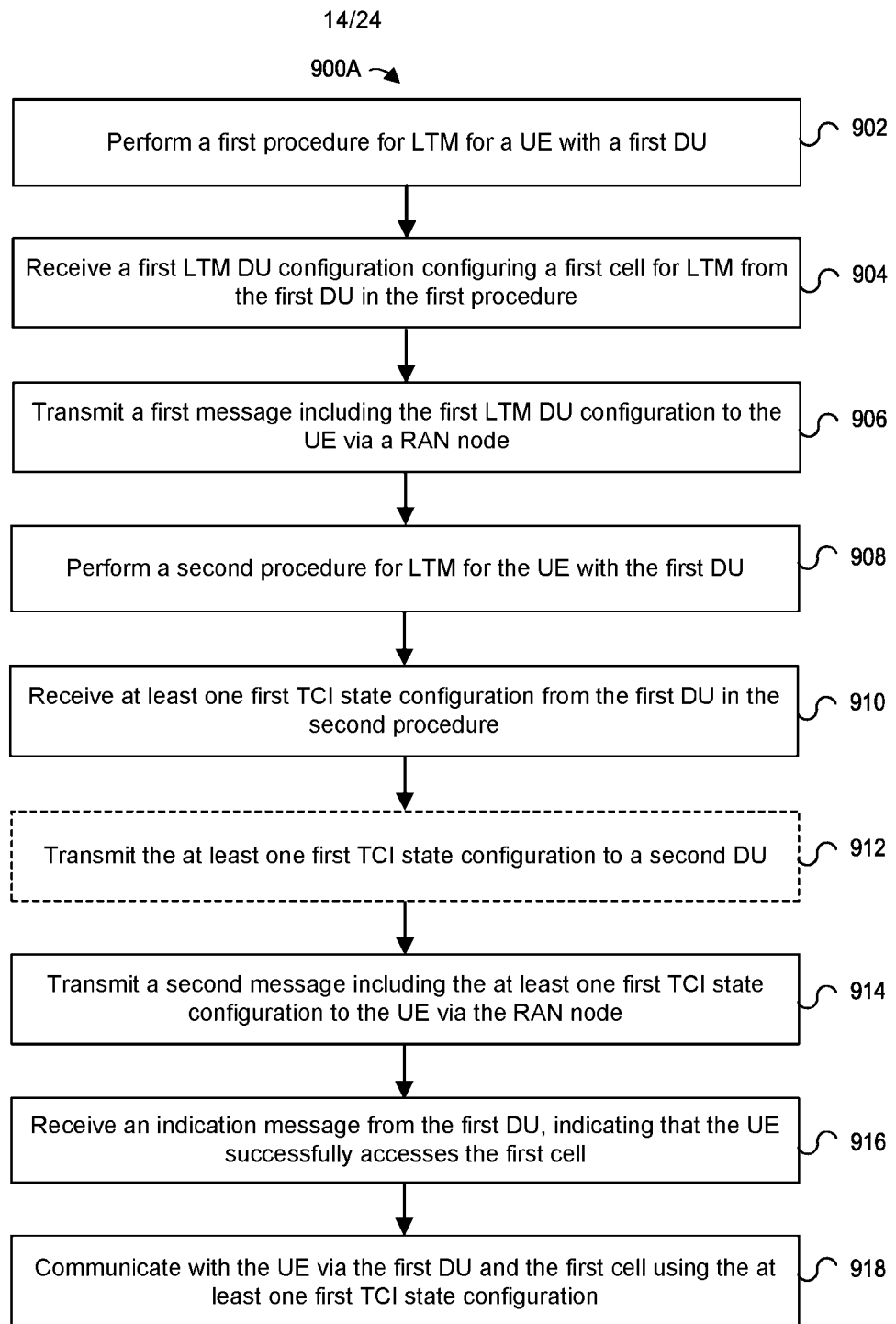
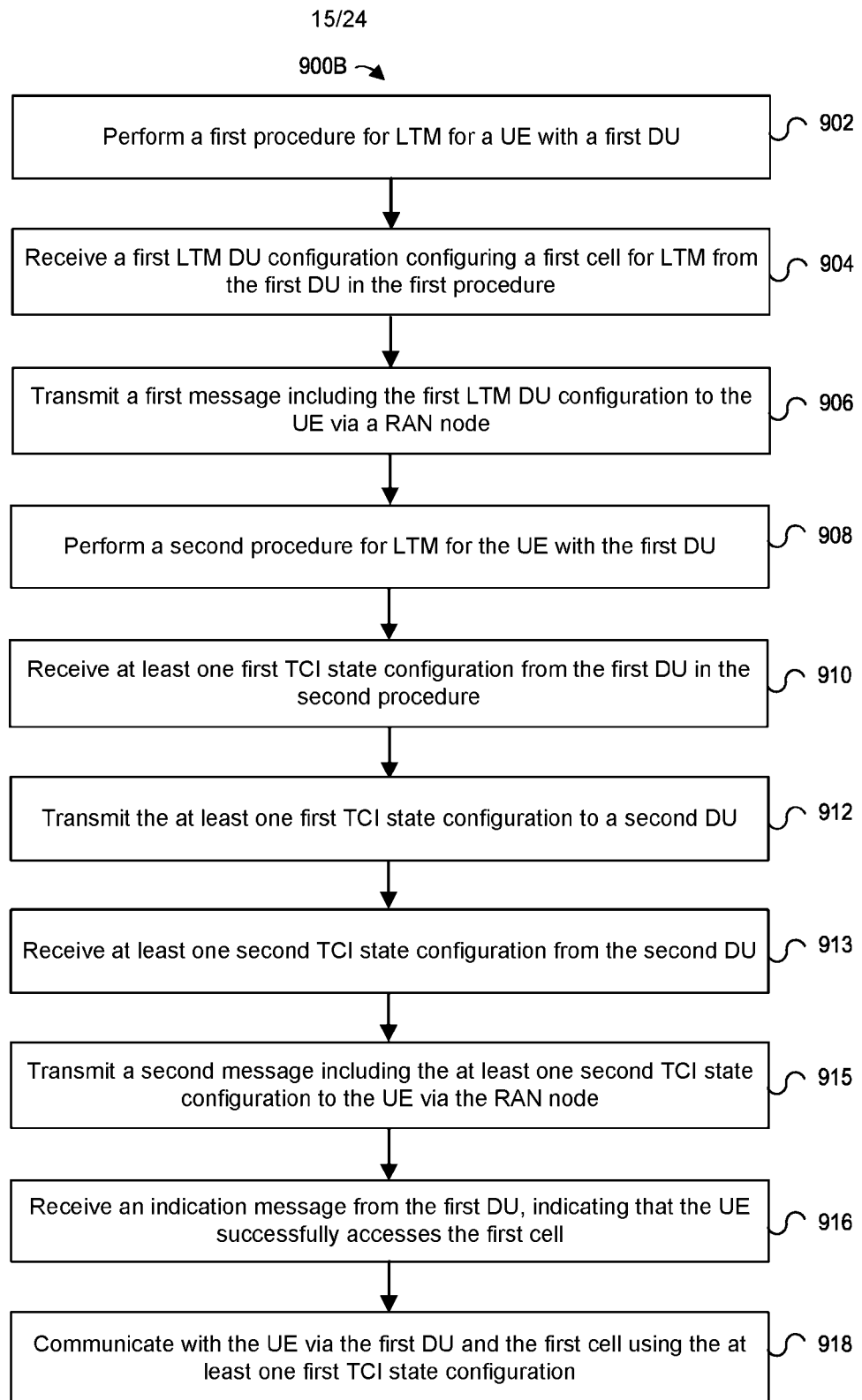
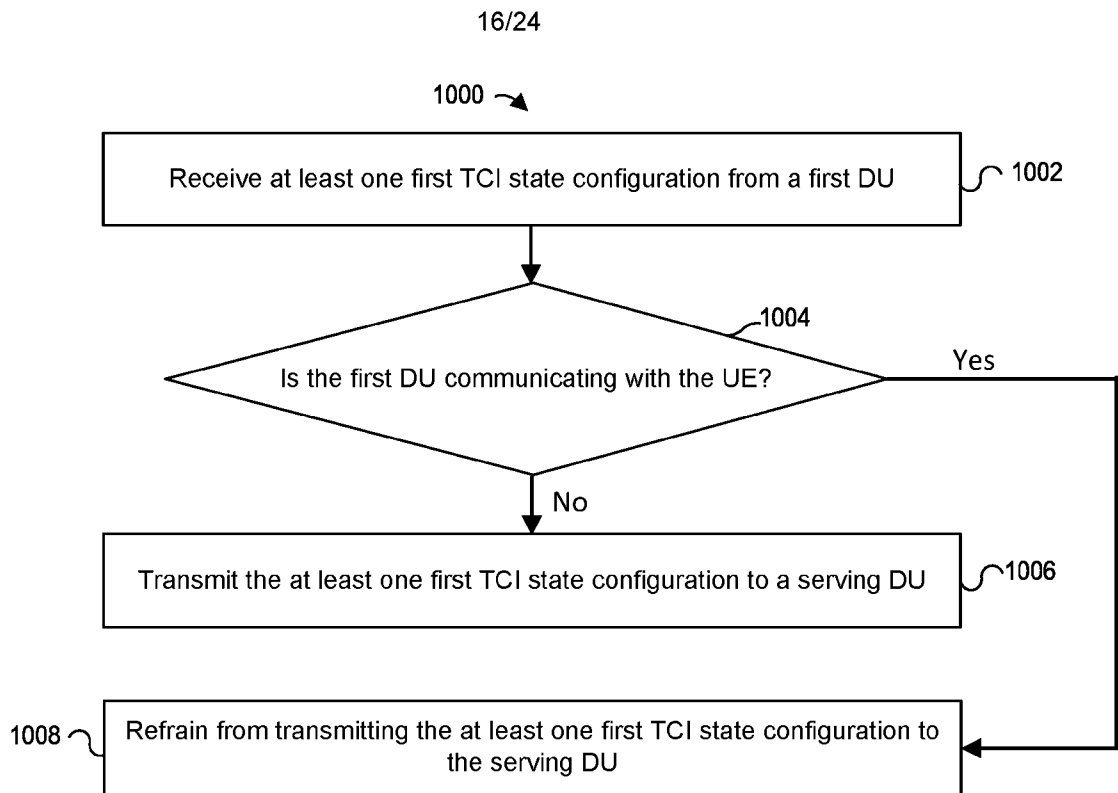


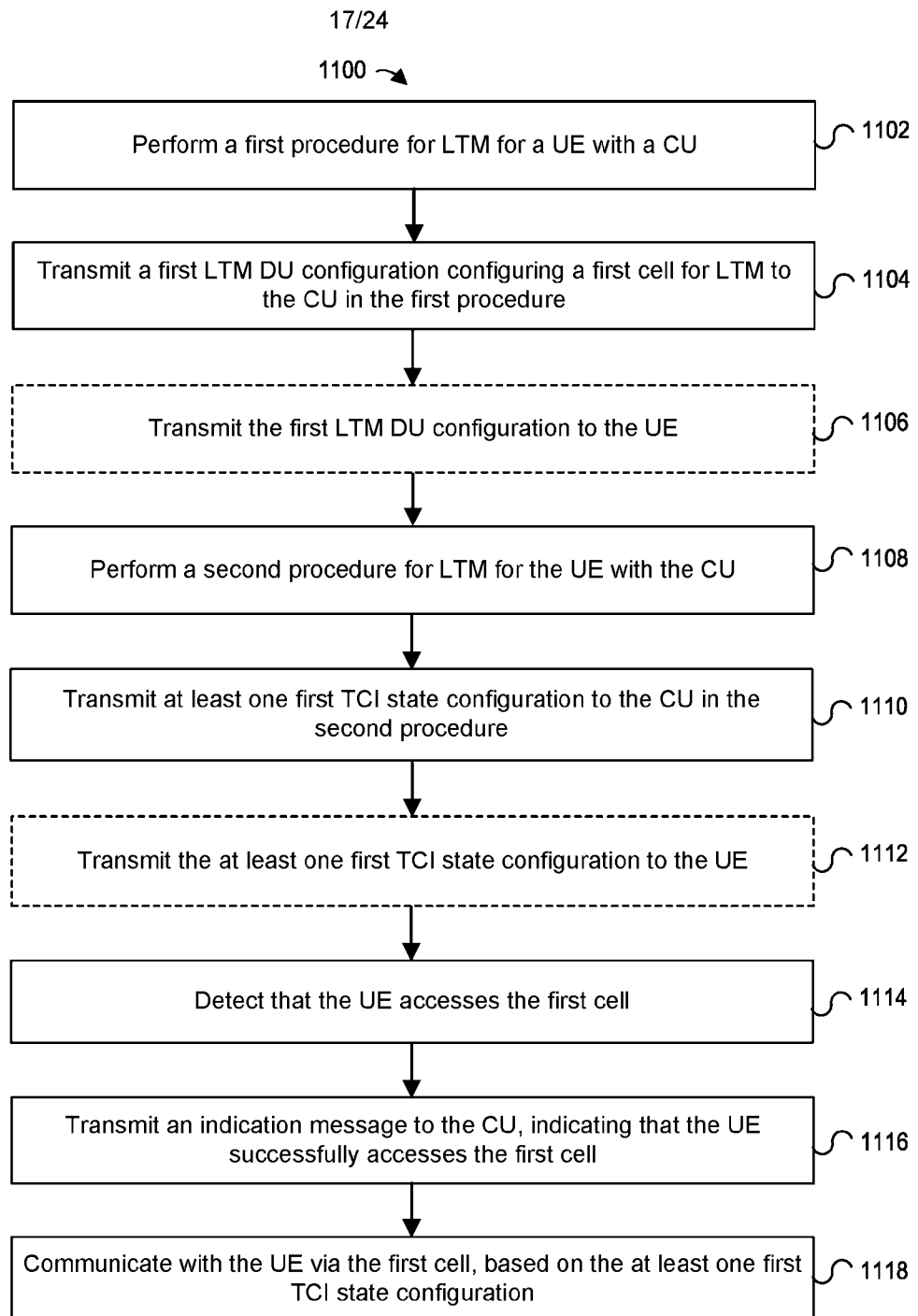
Figure 8A

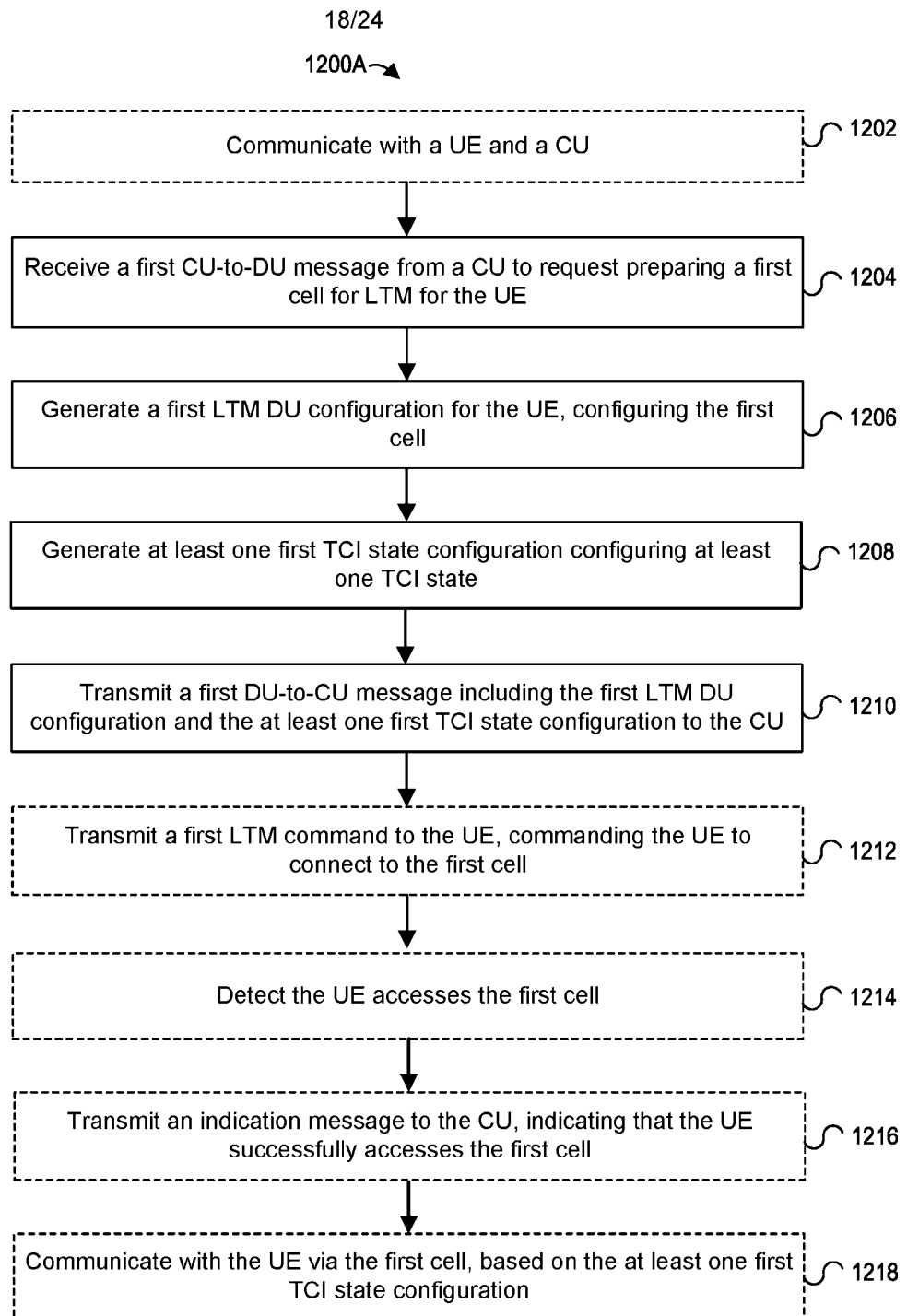


**Figure 9A**

**Figure 9B**

**Figure 10**

**Figure 11**

**Figure 12A**

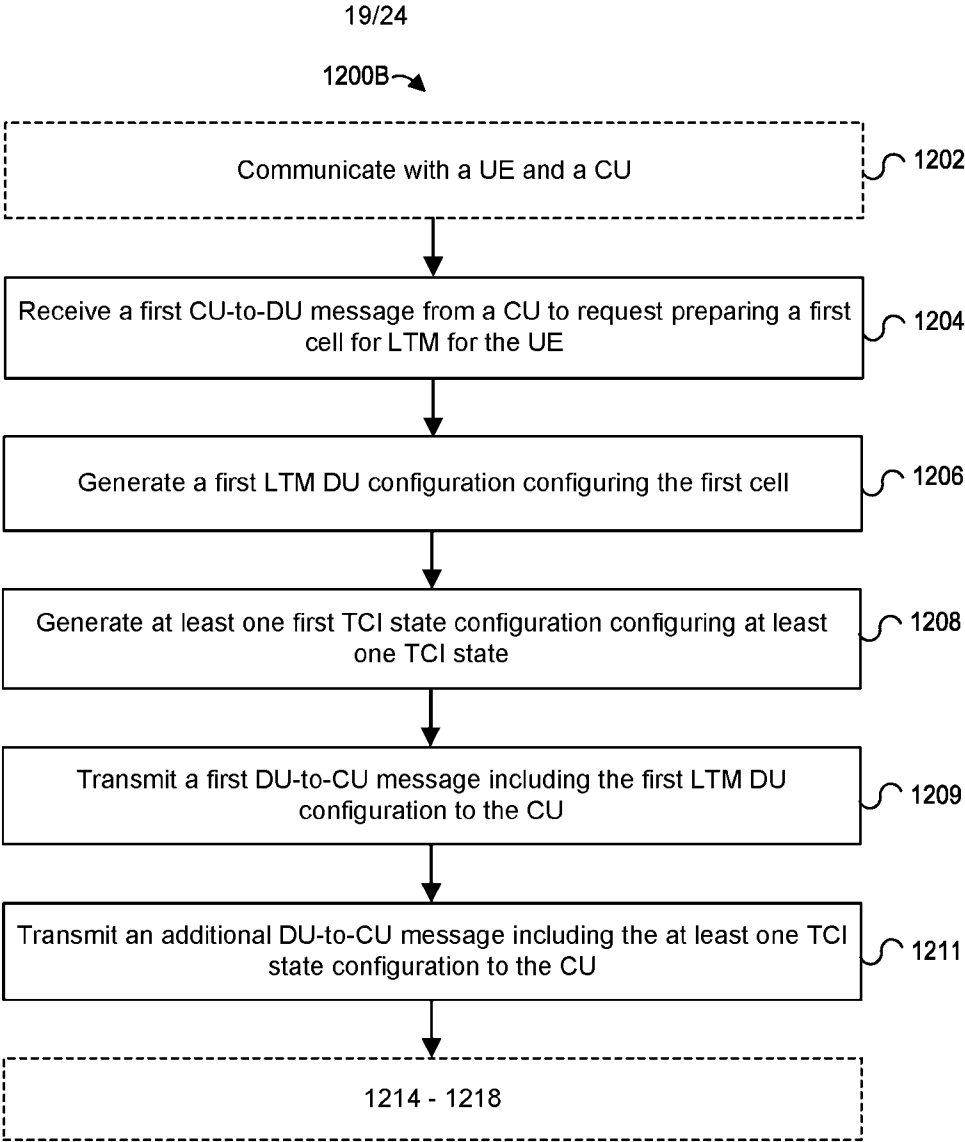
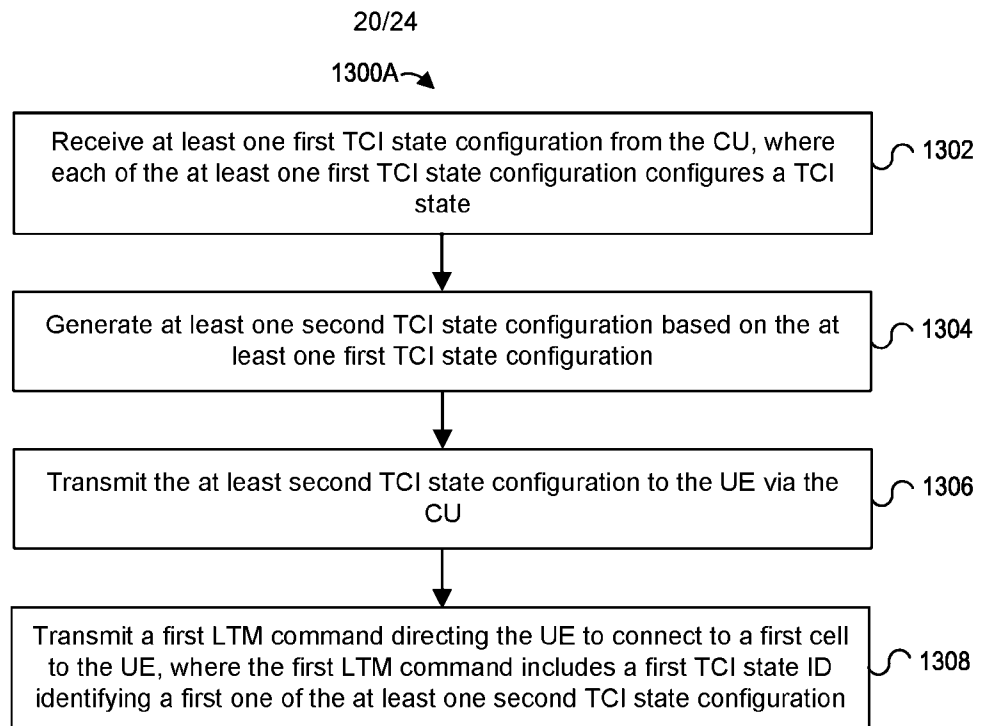
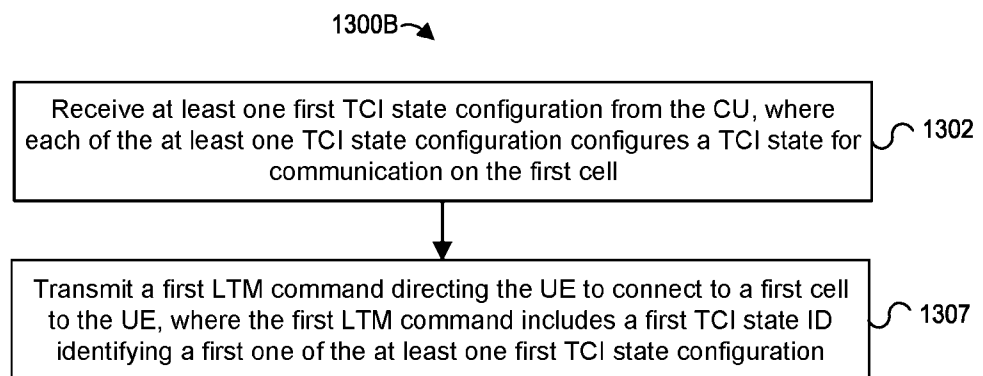
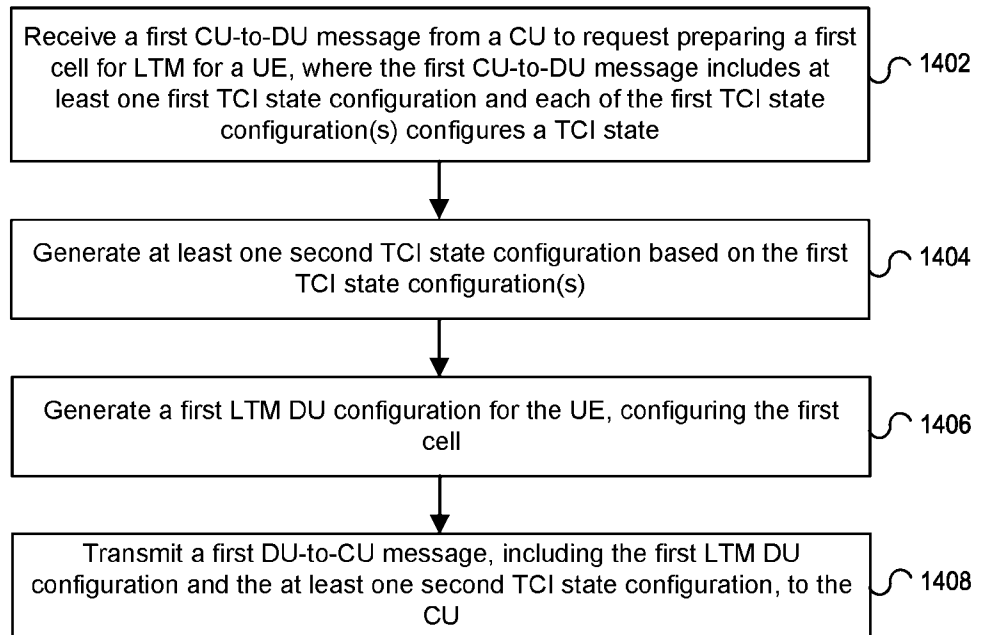


Figure 12B

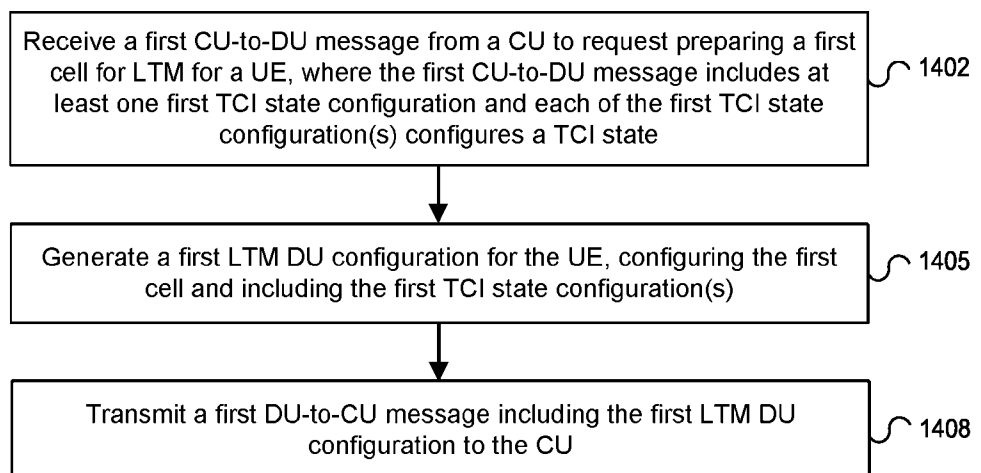
**Figure 13A****Figure 13B**

21/24

1400A

**Figure 14A**

1400B

**Figure 14B**

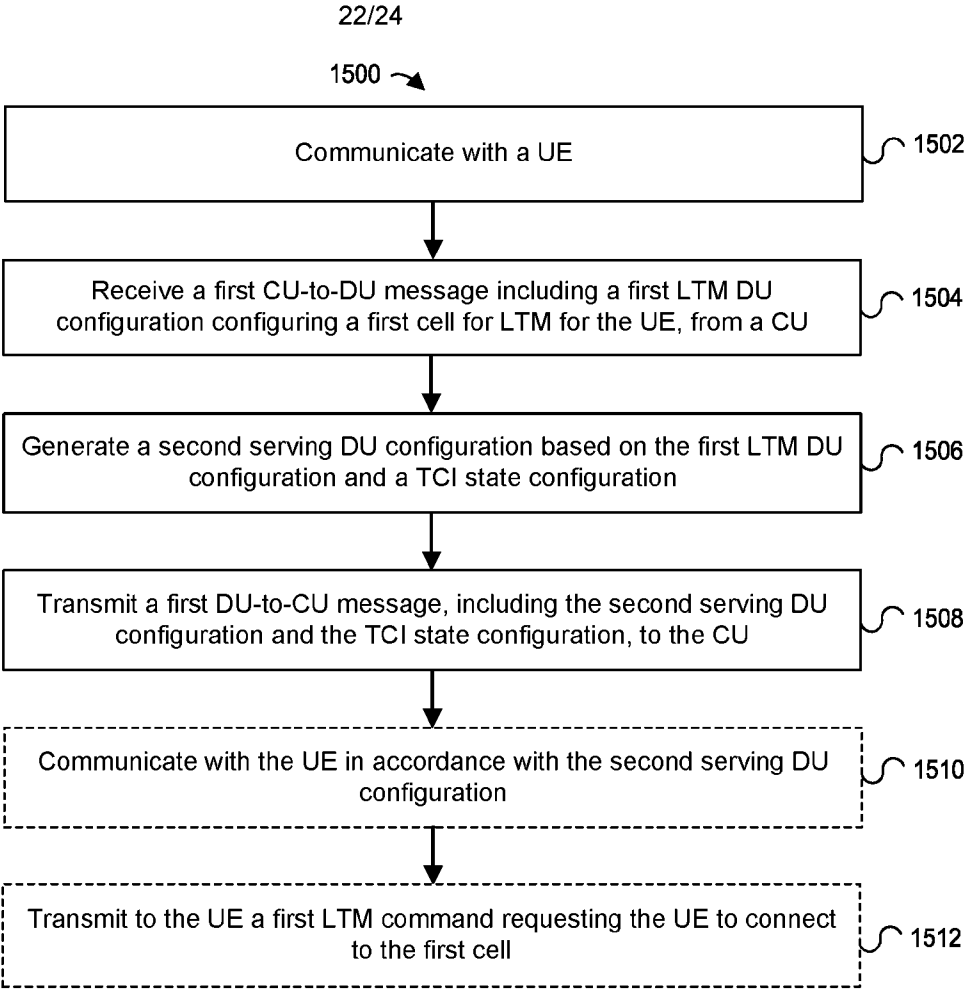


Figure 15

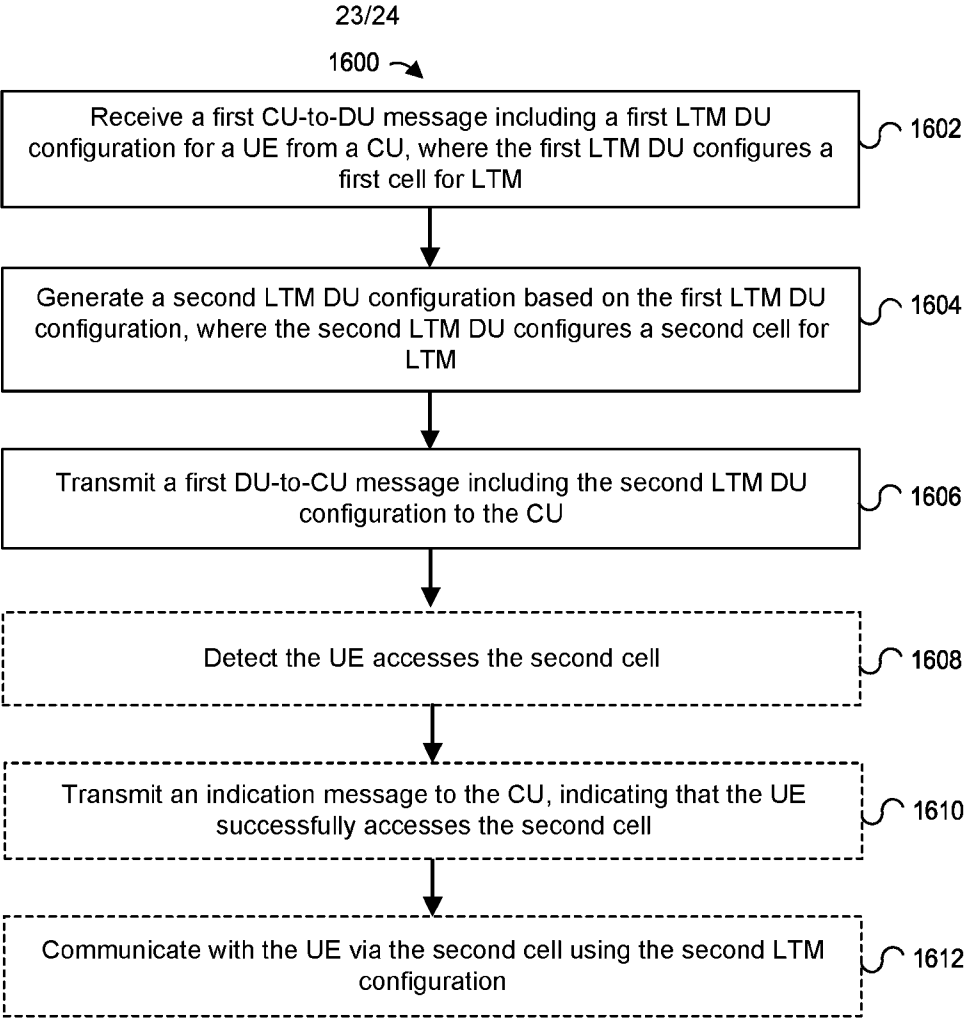
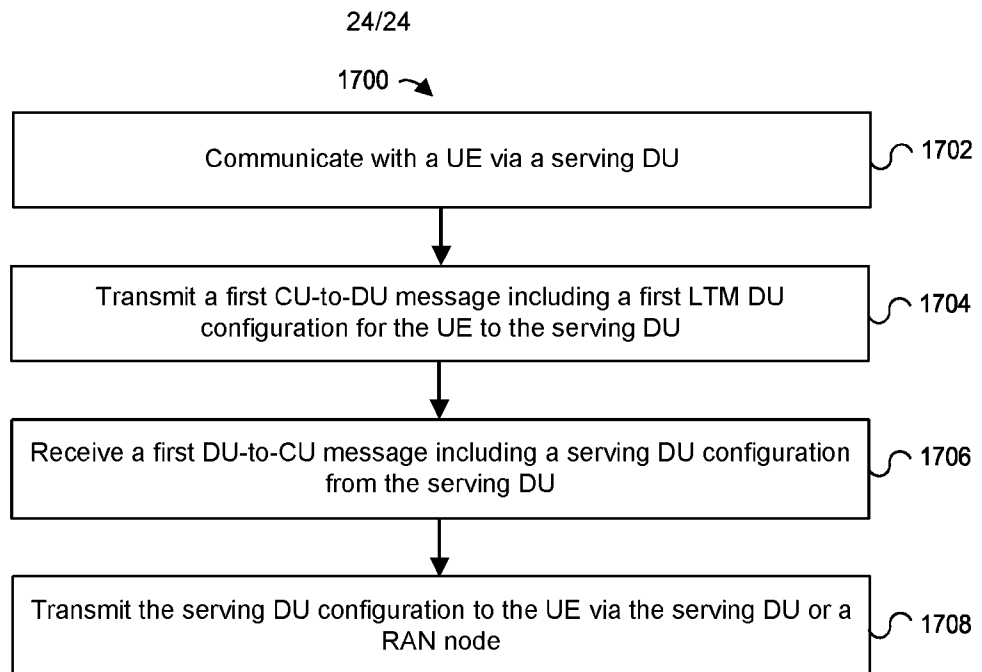
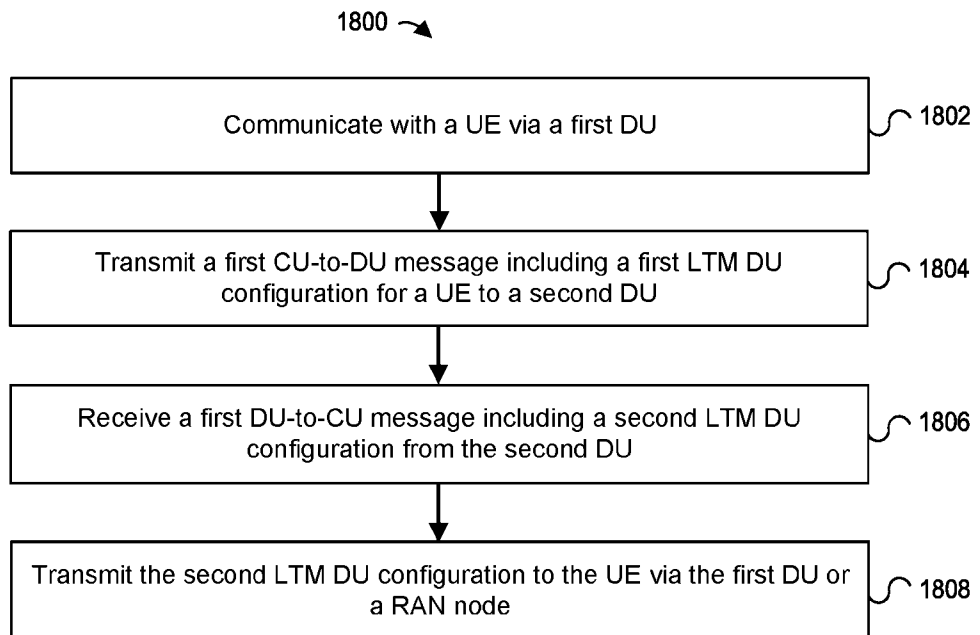


Figure 16

**Figure 17****Figure 18**

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2024/032991

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W36/08 H04W36/00
ADD. H04W88/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LIWEI QIU ET AL: "Solutions for L1/L2 based inter-cell mobility", 3GPP DRAFT; R3-226230; TYPE DISCUSSION; NR_MOB_ENH2, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. 3GPP RAN 3, no. Toulouse, FR; 20221114 - 20221118 3 November 2022 (2022-11-03), XP052223714, Retrieved from the Internet: URL:https://www.3gpp.org/ftp/TSG_RAN/WG3_I u/TSGR3_118/Docs/R3-226230.zip R3-226230.docx [retrieved on 2022-11-03] pag. 6, 3, 14, 7 fig. 3 ----- - / - -	1 - 19



Further documents are listed in the continuation of Box C.



See patent family annex.

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"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

18 September 2024

Date of mailing of the international search report

30/09/2024

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Authorized officer

Domingos, Luis

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2024/032991

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HUAWEI: "(TP for L1L2Mob BLCR for TS 38.401): F1 signalling impact on the incoming LSs for LTM", 3GPP DRAFT; R3-232824, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG3, no. Incheon, KR; 20230522 - 20230526 21 May 2023 (2023-05-21), XP052395033, Retrieved from the Internet: URL:https://ftp.3gpp.org/Meetings_3GPP_SYN C/RAN3/Docs/R3-232824.zip R3-232824.docx [retrieved on 2023-05-21]	1-15, 17-19
A	pag. 7-8 -----	16
A	WO 2022/234540 A1 (ERICSSON TELEFON AB L M [SE]) 10 November 2022 (2022-11-10) the whole document -----	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2024/032991

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2022234540	A1	10-11-2022	NONE
