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DUAL ACTIVE PROTOCOL STACK OPERATION FOR HANDOVER AND PSCELL CHANGE

Abstract

A central unit (CU) of a distributed base station for configuring a dual active protocol stack (DAPS) procedure at a UE communicating with the distributed base station via a source distributed unit (DU) (i) determines (1002) that the UE is to perform the DAPS procedure in order to disconnect from the source DU and connect to a target DU; and (ii) transmits (1008), to the source DU, an indication that the source DU is to continue communicating with the UE during the DAPS procedure.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This patent application is a continuation of U.S. patent application Ser. No. 17/798,657 entitled “DUAL ACTIVE PROTOCOL STACK OPERATION FOR HANDOVER AND PSCELL CHANGE” and filed on Aug. 10, 2022, which is a national stage application, filed under 35 U.S.C. § 371, of International Application No. PCT/US21/17323, filed Feb. 10, 2021 and entitled “DUAL ACTIVE PROTOCOL STACK OPERATION FOR HANDOVER AND PSCELL CHANGE,” which claims priority to and the benefit of U.S. Provisional Patent Application No. 62/976,346, filed on Feb. 13, 2020 and entitled “DUAL ACTIVE PROTOCOL STACK OPERATION FOR HANDOVER AND PSCELL CHANGE,” and which also claims priority to and the benefit of U.S. Provisional Patent Application No. 63/004,825, filed on Apr. 3, 2020 and entitled “DUAL ACTIVE PROTOCOL STACK OPERATION FOR HANDOVER AND PSCELL CHANGE,” the entire disclosures of which are hereby incorporated by reference herein in their entireties.

FIELD OF THE DISCLOSURE

[0002] This disclosure relates generally to wireless communications and, more particularly, to dual active protocol stack (DAPS) operations related to handover and primary secondary cell (PSCell) change procedures.

BACKGROUND

[0003] 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.

[0004] 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 specification TS 36.323) and New Radio (NR) (see 3GPP specification TS 38.323) provides sequencing of protocol data units (PDUs) in the uplink direction (from a user device, also known as a user equipment (UE), to a base station) as well as in the downlink direction (from the base station to the UE). Further, the PDCP sublayer provides services for signaling radio bearers (SRBs) to the Radio Resource Control (RRC) sublayer. The PDCP sublayer also provides services for data radio bearers (DRBs) to a Service Data Adaptation Protocol (SDAP) sublayer or a protocol layer such as an Internet Protocol (IP) layer, an Ethernet protocol layer, and an Internet Control Message Protocol (ICMP) layer. Generally speaking, the UE and a base station can use SRBs to exchange RRC messages as well as non-access stratum (NAS) messages, and can use DRBs to transport data on a user plane.

[0005] UEs can use several types of SRBs and DRBs. When operating in dual connectivity (DC), the cells associated with the base station operating as the master node (MN) define a master cell group (MCG), and the cells associated with the base station operating as the secondary node (SN) define the secondary cell group (SCG). 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 also can be referred to as MCG SRBs. SRB3 resources allow the

UE and the SN to exchange RRC messages related to the SN, and can be referred to as SCG SRBs. Split SRBs allow the UE to exchange RRC messages directly with the MN via lower layer resources of the MN and the SN. Further, DRBs terminated at the MN and using the lower-layer resources of only the MN can be referred as MCG DRBs, DRBs terminated at the SN and using the lower-layer resources of only the SN can be referred as SCG DRBs, and DRBs terminated at the MCG but using the lower-layer resources of the MN, the SN, or both the MN and the SN can be referred to as split DRBs.

[0006] The UE in some scenarios can concurrently utilize resources of multiple nodes (e.g., base stations or components of a distributed base station) of a radio access network (RAN), 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 base station operates as the MN that covers a primary cell (PCell), and the other base station operates as the 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 base station at a time. One base station and/or the UE determines that the UE should establish a radio connection with another base station. For example, one base station can determine to hand the UE over to the second base station, and initiate a handover procedure. The UE in other scenarios can concurrently utilize resources of a RAN node (e.g., a single base station or a component of a distributed base station), interconnected by a backhaul.

[0007] 3GPP TS 36.300 v15.6.0 and 38.300 v15.6.0 describe legacy procedures for handover (or called reconfiguration with sync) scenarios. These procedures involve messaging (e.g., RRC signaling and preparation) among RAN nodes and the UE. UEs can perform handover procedures to switch from one cell to another, whether in single connectivity (SC) or DC operation. The UE may handover from a cell of a serving base station to a target cell of a target base station, or from a cell of a first distributed unit (DU) of a serving base station to a target cell of a second DU of the same base station, depending on the scenario.

[0008] 3GPP TS 37.340 v15.7.0 describes legacy procedures for a UE to change PSCells in DC scenarios. These procedures involve messaging (e.g., RRC signaling and preparation) among RAN nodes and the UE. The UE may perform PSCell change from a PSCell of a serving SN to a target PSCell of a target SN, or from a PSCell of a source distributed unit (DU) of a base station to a PSCell of a target DU of the same base station, depending on the scenario.

[0009] More recently, 3GPP has been discussing dual active protocol stack (DAPS) handover and DAPS PSCell change procedures for achieving Oms user data interruption during handover and PSCell change. Generally, the length of interruption experienced at the UE depends on a time difference between the time when a radio link connection at a source cell is released and the time when a radio link connection at a target cell is established. If the release time is no earlier than the established time, achieving Oms user data interruption is possible. Using a DAPS, the UE can simultaneously communicate with the source cell while establishing a radio link connection at the target cell, and subsequently stop communicating with the source cell after establishing a radio link connection at the target cell, when performing DAPS handover and PSCell change.

[0010] In some cases, the RAN can provide a DAPS configuration (e.g., a DAPS handover configuration, a DAPS PSCell change configuration) to the UE for the UE to perform a DAPS handover or DAPS PSCell change, respectively. However, in some of these scenarios, the UE and/or RAN do not properly handle the DAPS configuration. For example, the UE may fail to perform DAPS handover or DAPS PSCell change upon receiving the DAPS configuration from a source RAN node, and as a consequence, the UE performs an RRC connection reestablishment procedure with the source RAN node to recover the reconfiguration failure, thereby causing data interruption. As another example, the source RAN node may be unaware that the UE is capable of DAPS handover or DAPS PSCell change, and as a consequence, fail to instruct the UE **102** to perform DAPS handover or DAPS PSCell change.

SUMMARY

[0011] Generally speaking, a UE and one or more base stations operating in a RAN implement the techniques of this disclosure to prepare the UE to perform DAPS handover or DAPS PSCell change upon receiving a corresponding DAPS configuration (or an indication of the corresponding DAPS configuration). Using these techniques, for example, the RAN can configure a UE communicating with a base station via a plurality of cells to release some of the cells, so that radio frequency (RF) chain(s) or transceiver(s) of the UE that were previously operating when communicating with the released cells become available for use to perform DAPS handover or DAPS PSCell change. As another example, the RAN can configure a UE communicating in dual connectivity (DC) with a master node (MN) and a secondary node (SN) to release the SN, so that RF chain(s) or transceiver(s) of the UE that were previously operating when communicating with the released SN become available for use to perform DAPS handover or DAPS PSCell change.

[0012] One example implementation of these techniques is a method, in a RAN, for enabling execution of a DAPS procedure at a UE. The method includes determining, by processing hardware, that the UE is to release at least one cell via which the UE communicates with the RAN, prior to executing the DAPS procedure. The method also includes causing, by the processing hardware, the UE to release the at least one cell. The method also includes transmitting, by the processing hardware, a command to the UE to execute the DAPS procedure.

[0013] Another example implementation of these techniques is a method, in a central unit (CU) of a distributed base station, for configuring a dual active protocol stack (DAPS) procedure at a UE communicating with the distributed base station via a source distributed unit (DU). The method includes determining, by the processing hardware and to the UE, that the UE is to perform the DAPS procedure to disconnect from the source DU and connect to a target DU. The method also includes transmitting, by the processing hardware and to the source DU, an indication that the source DU is to continue communicating with the UE during the DAPS procedure. The method also includes transmitting, in response to determining that the UE has begun communicating with the target DU, a release indication to the target DU, the release indication causing the target DU to release the DAPS procedure. The method also includes subsequently to transmitting the release indication, causing the source DU to release the UE context.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1**A is a block diagram of an example system in which a RAN and a UE can implement the techniques of this disclosure for managing DAPS procedures, including DAPS handover and DAPS PSCell change;

[0015] FIG. **1**B is a block diagram of an example base station in which a centralized unit (CU) and a distributed unit (DU) can operate in the system of FIG. **1**A;

[0016] FIG. **2** is a block diagram of an example protocol stack, according to which the UE of FIG. **1**A can communicate with base stations of FIG. **1**A;

[0017] FIG. **3** is a messaging diagram of an example scenario in which a RAN prepares a DAPS handover procedure for a UE by releasing M of N cells via which the UE communicates with a source base station of the RAN prior to the UE performing DAPS handover to a target base station of the RAN;

[0018] FIG. **4** is a messaging diagram of an example scenario in which a RAN prepares a DAPS handover procedure for a UE by releasing a source SN of the RAN prior to the UE performing DAPS handover to a target SN of the RAN;

[0019] FIG. **5** is a messaging diagram of an example scenario in which a RAN prepares a UE to perform DAPS handover, from a source DU of a base station of the RAN to a target DU of a base station;

[0020] FIG. **6** is a messaging diagram of an example scenario in which an MN of the RAN initiates a DAPS PSCell change procedure for a UE, from a source SN to a target SN;

[0021] FIG. **7** is a messaging diagram of an example scenario in which an SN of the RAN initiates a DAPS PSCell change procedure for a UE, from a source cell of the SN to a target cell of the SN;

[0022] FIG. **8** is a messaging diagram of an example scenario in which a RAN prepares a UE to perform DAPS PSCell change, from a source DU of a base station of the RAN to a target DU of the base station;

[0023] FIG. **9** is a flow diagram depicting an example method for preparing a UE to perform DAPS handover, from a source DU of a base station to a target DU of the base station;

[0024] FIG. **10** is a flow diagram depicting an example method for preparing a UE to perform DAPS PSCell change, from a source DU of a base station to a target DU of the base station; and

[0025] FIG. **11** is a flow diagram depicting an example method in a central unit (CU) of a distributed base station for configuring a DAPS procedure at a UE communicating with the distributed base station via a source distributed unit (DU).

DETAILED DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1**A depicts an example wireless communication system **100** that can implement DAPS operation techniques of this disclosure. The wireless communication system **100** includes a UE **102**, as well as base stations **104**, **106**A, **106**B that are connected to a core network (CN) **110**. The base stations **104**, **106**A, **106**B can be any suitable type, or types, of base stations, such as an evolved node B (eNB), a next-generation eNB (ng-eNB), or a 5G Node B (gNB), for example. As a more specific example, the base station **104** can be an eNB or a gNB, and the base stations **106**A and **106**B can be gNBs.

[0027] The base station **104** supports a cell **124**, the base station **106**A supports a cell **126**A, and the base station **106**B supports a cell **126**B. The cell **124** partially overlaps with both of cells **126**A and **126**B, such that the UE **102** can be in range to communicate with base station **104** while simultaneously being in range to communicate with base station **106**A or **106**B (or in range to detect or measure the signal from both base stations **106**A or **106**B, etc.). The overlap can make it possible for the UE **102** to hand over between cells (e.g., from cell **124** to cell **126**A or **126**B) or base stations (e.g., from base station **104** to base station **106**A or base station **106**B) before the UE **102** experiences radio link failure, for example. Moreover, the overlap allows the various dual connectivity (DC) scenarios discussed below. For example, the UE **102** can communicate in DC with the base station **104** (operating as an MN) and the base station **106**A (operating as an SN) and, upon completing a handover, can communicate with the base station **106**B (operating as an MN). As another example, the UE **102** can communicate in DC with the base station **104** (operating as an MN) and the base station **106**A (operating as an SN) and, upon completing an SN change, can communicate with the base station **104** (operating as an MN) and the base station **106**B (operating as an SN).

[0028] More particularly, when the UE **102** is in DC with the base station **104** and the base station **106**A, the base station **104** operates as a master eNB (MeNB), a master ng-eNB (Mng-eNB), or a master gNB (MgNB), and the base station **106**A operates as a secondary gNB (SgNB) or a secondary ng-eNB (Sng-eNB). In implementations and scenarios where the UE **102** is in SC with the base station **104** but is capable of operating in DC, the base station **104** operates as an MeNB, an Mng-eNB or an MgNB, and the base station **106**A operates as a candidate SgNB (C-SgNB) or a candidate Sng-eNB (C-Sng-eNB). Although various scenarios are described below in which the base station **104** operates as an MN and the base station **106**A (or **106**B) operates as an SN or T-SN, any of the base stations **104**, **106**A, **106**B generally can operate as an MN, an SN or a T-SN in different scenarios. Thus, in some implementations, the base station **104**, the base station **106**A, and the base station **106**B can implement similar sets of functions and each support MN, SN, and T-SN operations.

[0029] In operation, the UE **102** can use a radio bearer (e.g., a DRB or an SRB) that at different times terminates at an MN (e.g., the base station **104**) or an SN (e.g., the base station **106**A). For example, after handover to the base station **106**B, the UE **102** can use a radio bearer (e.g., a DRB or an SRB) that at different times terminates at the base station **106**B. The UE **102** can apply one or more security keys when communicating on the radio bearer, in the uplink (from the UE **102** to a base station) and/or downlink (from a base station to the UE **102**) direction.

[0030] The base station **104** includes processing hardware **130**, which can include one or more general-purpose processors (e.g., central processing units (CPUs) and a computer-readable memory storing machine-readable instructions executable on the one or more general-purpose processor(s), and/or special-purpose processing units. The processing hardware **130** in the example implementation in FIG. **1**A includes a base station RRC controller **132** that is configured to manage or control RRC configurations and RRC procedures. For example, the base station RRC controller **132** can be configured to support RRC messaging associated with DAPS handover and DAPS PSCell change procedures, and/or to support the necessary operations when the base station **104** operates as an MN, as discussed below.

[0031] The base station **106**A includes processing hardware **140**, which can include one or more general-purpose processors (e.g., CPUs) and a computer-readable memory storing machine-readable instructions executable on the general-purpose processor(s), and/or special-purpose processing units. The processing hardware **140** in the example implementation of FIG. **1**A includes a base station RRC controller **142** that is configured to manage or control RRC configurations and RRC procedures. For example, the base station RRC controller **142** can be configured to support RRC messaging associated with DAPS handover and DAPS PSCell change procedures, and/or to support the necessary operations when the base station **106**A operates as an SN or target SN (T-SN), as discussed below. While not shown in FIG. **1**A, the base station **106**B can include processing hardware similar to the processing hardware **140** of the base station **106**A.

[0032] The UE **102** includes processing hardware **150**, which can include one or more general-purpose processors (e.g., CPUs) and a computer-readable memory storing machine-readable instructions executable on the general-purpose processor(s), and/or special-purpose processing units. The processing hardware **150** in the example implementation of FIG. **1**A includes a UE RRC controller **152** that is configured to manage or control RRC configurations RRC procedures. For example, the UE RRC controller **152** can be configured to support RRC messaging associated with DAPS handover and DAPS PSCell change procedures in accordance with any of the implementations discussed below.

[0033] The CN **110** can be an evolved packet core (EPC) **111** or a fifth-generation core (5GC) **160**, both of which are depicted in FIG. **1**A. The base station **104** can 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 as a gNB that supports the NR radio interface as well as an NG interface for communicating with the 5GC **160**. The base station **106**A can be an EN-DC gNB (en-gNB) with an S1 interface to the EPC **111**, an en-gNB that does not connect to the EPC **111**, a gNB that supports the NR radio interface and an NG interface to the 5GC **160**, or a ng-eNB that supports an EUTRA radio interface and an NG interface to the 5GC **160**. To directly exchange messages with each other during the scenarios discussed below, the base stations **104**, **106**A, and **106**B can support an X2 or Xn interface.

[0034] Among other components, the EPC **111** can include a Serving Gateway (S-GW) **112** and a Mobility Management Entity (MME) **114**. The S-GW **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 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, and the SMF **166** is configured to manage PDU sessions.

[0035] Generally, the wireless communication network **100** can include any suitable number of base stations supporting NR cells and/or EUTRA cells. For example, base station **104** and base station **106**A can also support cells **122** and **123**, respectively. More particularly, the EPC **111** or the 5GC **160** can be connected to any suitable number of base stations 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 can also 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, for example.

[0036] As indicated above, the wireless communication system **100** can support various procedures (e.g., DAPS handover, DAPS PSCell change, etc.) and modes of operation (e.g., SC or DC). Example operation of various procedures that can be implemented in the wireless communication system **100** will now be described.

[0037] In some implementations, the wireless communication system **100** supports a legacy handover preparation procedure (i.e., a non-DAPS handover preparation procedure). In one scenario, for example, the base station **104** can perform a non-DAPS handover preparation procedure to configure the UE **102** to handover from a cell **124** of the base station **104** to a cell **126**A of the base station **106**A. In this scenario, the base station **104** and the base station **106**A operate as a source base station (S-BS) or a source MN (S-MN), and a target base station (T-BS) or a target MN (T-MN), respectively. In the non-DAPS handover preparation procedure, the base station **104** sends a Handover Request message to the base station **106**A. In response to the Handover Request message, the base station **106**A includes configuration parameters configuring radio resources for the UE **102** in a handover command message, includes the handover command message in a Handover Request Acknowledge message, and sends the Handover Request Acknowledge message to the base station **104**. In turn, the base station **104** transmits the handover command message to the UE **102** and subsequently discontinues (or stops) transmitting data to or receiving data from the UE **102**.

[0038] Upon receiving the handover command message, the UE **102** hands over to the base station **106**A via cell **126**A and communicates with the base station **106**A by using the configuration parameters in the handover command message. Particularly, in response to the handover command message, the UE **102** disconnects from the cell **124** (or the base station **104**), performs a random access procedure with the base station **106**A via the cell **126**A, and transmits a handover complete message to the base station **106**A via the cell **126**A.

[0039] In some implementations, the wireless communication system **100** supports a DAPS handover preparation procedure. In one scenario for example, the base station **104** can perform a DAPS handover preparation procedure to configure the UE **102** to hand over from a cell **124** of the base station **104** to a cell **126**B of the base station **106**B. In this scenario, the base station **104** and the base station **106**B operate as an S-BS or an S-MN, and a T-BS or a T-MN, respectively. In the DAPS handover preparation procedure, the base station **104** sends a Handover Request message to the base station **106**B. In some implementations, the base station **104** can explicitly request DAPS handover in the Handover Request message, e.g., by including a DAPS indicator in the Handover Request message. In response to the Handover Request message, and to accept the request for DAPS handover, the base station **106**B includes configuration parameters configuring radio resources for the UE **102** in a handover command, includes the handover command message in a Handover Request Acknowledge message, and sends the Handover Request Acknowledge message to the base station **104**. In some implementations, the base station **106**B can indicate DAPS handover in the handover command message, e.g., by including a DAPS handover configuration or a DAPS handover indicator in the handover command message, or can include an indicator in the

Handover Request Acknowledge message. In turn, the base station **104** transmits the handover command message to the UE **102**.

[0040] Upon receiving the handover command message, the UE **102** hands over to the base station **106**B via cell **126**B and communicates with the base station **106**B by using the configuration parameters in the handover command message. Particularly, in response to the handover command message, whereas in the non-DAPS handover preparation procedure the UE **102** disconnects from the cell **124** (or the base station **104**), the UE **102** in the DAPS handover preparation procedure maintains the connection to the base station **104** via cell **124**, performs a random access procedure with the base station **106**B via cell **126**B, and transmits a handover complete message to the base station **106**B via cell **126**B.

[0041] In maintaining the connection to the base station **104** via cell **124** in the DAPS handover preparation procedure, the UE **102** effectively has two links, i.e., a source MCG link with the base station **104** and a target MCG link with the base station **106**B. The UE **102** can continue receiving data (i.e., downlink data) from the base station **104** until the UE **102** receives an indication from the base station **106**B to release the source MCG link with the base station **104**. The UE **102** can continue transmitting data (e.g., new uplink data transmission or retransmission of PDCP SDUs) to the base station **104** until the UE **102** either successfully completes the random access procedure with the base station **106**B or receives the indication from the base station **106**B to release the MCG link with the base station **104**.

[0042] In some implementations, in the handover preparation procedure scenarios above, the wireless communication system **100** supports DC operation. In one scenario, for example, after the UE **102** connects to the base station **104**, the base station **104** can perform an SN addition procedure to add the base station **106**A as an SN, thereby configuring the UE **102** to operate in DC with the base stations **104** and **106**A. At this point, the base stations **104** and **106**A operate as an MN and an SN, respectively. Later on, the MN **104** can initiate the non-DAPS or DAPS handover preparation procedures to handover the UE **102** to the T-MN **106**B.

[0043] In some implementations, the wireless communication system **100** supports a legacy PSCell change preparation procedure (i.e., a non-DAPS PSCell change preparation procedure). In one scenario, for example, the UE **102** is initially in DC with the MN **104** (e.g., via PCell **124**) and the SN **106**A (via a PSCell **123**). The SN **106**A can provide a configuration for the T-PSCell **126**A, for the UE **102**. The UE **102** stops communicating with the SN **106**A via PSCell **123** and attempts to connect to the T-PSCell **126**A after receiving the configuration for the T-PSCell **126**A. In another scenario, for example, while the UE **102** is in DC with the MN **104** and the SN **106**A, the MN **104** determines to change the SN of the UE **102** from the base station **106**A (which may be referred to as the source SN or S-SN) to the base station **106**B (which may be referred to as the target SN or T-SN) as part of the non-DAPS PSCell change procedure. The UE **102** stops communicating with the S-SN **106**A via PSCell **123** and attempts to connect to the T-SN **106**B via T-PSCell **126**B after receiving the configuration for the T-PSCell **126**B.

[0044] In some implementations, the wireless communication system **100** supports DAPS PSCell change. In one scenario, for example, the UE **102** is initially in DC with the MN **104** (e.g., via PCell **124**) and the SN **106**A (via a PSCell **123**). The SN **106**A can provide a configuration for the T-PSCell **126**A, for the UE **102**. The UE **102** continues communicating with the SN **106**A via PSCell **123** while attempting to connect to the T-PSCell **126**A after receiving the configuration for the T-PSCell **126**A. After the T-PSCell **126**A begins to operate as the PSCell **126**A for the UE **102**, the UE **102** stops communicating with the SN **106**A via PSCell **123**. In another scenario, for example, while the UE **102** is in DC with the MN **104** and the SN **106**A, the MN **104** determines to change the SN of the UE **102** from the base station **106**A (which may be referred to as the source SN or S-SN) to the base station **106**B (which may be referred to as the target SN or T-SN) as part of the DAPS PSCell change procedure. The UE **102** continues communicating with the S-SN **106**A via PSCell **123** while attempting to connect to the T-SN **106**B via T-PSCell **126**B after receiving the configuration for the T-PSCell **126**B. After the T-PSCell **126**B begins to operate as the PSCell **126**B for the UE **102**, the UE **102** stops communicating with the S-SN **106**A via PSCell **123**.

[0045] In different configurations or scenarios of the wireless communication system **100**, the base station **104** can operate as an MeNB, an Mng-eNB, or an MgNB, the base station **106**B can operate as an MeNB, an Mng-eNB, an MgNB, an SgNB, or an Sng-eNB, and the base station **106**A can operate as an SgNB or an Sng-eNB. The UE **102** can communicate with the base station **104** and the base station **106**A or **106**B via the same radio access technology (RAT), such as EUTRA or NR, or via different RATs.

[0046] When the base station **104** is an MeNB and the base station **106**A is an SgNB, the UE **102** can be in EUTRA-NR DC (EN-DC) with the MeNB **104** and the SgNB **106**A. When the base station **104** is an Mng-eNB and the base station **106**A is an SgNB, the UE **102** can be in next generation (NG) EUTRA-NR DC (NGEN-DC) with the Mng-eNB **104** and the SgNB **106**A. When the base station **104** is an MgNB and the base station **106**A is an SgNB, the UE **102** can be in NR-NR DC (NR-DC) with the MgNB **104** and the SgNB **106**A. When the base station **104** is an MgNB and the base station **106**A is an Sng-eNB, the UE **102** can be in NR-EUTRA DC (NE-DC) with the MgNB **104** and the Sng-eNB **106**A.

[0047] FIG. **1**B depicts an example, distributed implementation of any one or more of the base stations **104**, **106**A, **106**B. In this implementation, the base station **104**, **106**A, or **106**B includes a centralized unit (CU) **172** and one or more distributed units (DUs) **174**. The CU **172** includes processing hardware, such as one or more general-purpose processors (e.g., CPUs) and a computer-readable memory storing machine-readable instructions executable on the general-purpose processor(s), and/or special-purpose processing units. For example, the CU **172** can include the processing hardware **130** or **140** of FIG. **1**A. The processing hardware can include a base station RRC controller (e.g., RRC controller **142**) configured to manage or control one or more RRC configurations and/or RRC procedures when the base station (e.g., base station **106**A) operates as an SN.

[0048] Each of the DUs **174** also includes processing hardware that can include one or more general-purpose processors (e.g., CPUs) and computer-readable memory storing machine-readable instructions executable on the one or more general-purpose processors, and/or special-purpose processing units. For example, the processing hardware can include a medium access control (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 base station (e.g., base station **106**A) operates as a MN or an SN. The process hardware can also include a physical layer controller configured to manage or control one or more physical layer operations or procedures.

[0049] FIG. **2** illustrates, in a simplified manner, an example dual active protocol stack (DAPS) **200** according to which the UE **102** can communicate with an eNB/ng-eNB or a gNB (e.g., one or more of the base stations **104**, **106**A, **106**B).

[0050] In the example stack **200**, a physical layer (PHY) **202**A of EUTRA provides transport channels to the EUTRA MAC sublayer **204**A, which in turn provides logical channels to the EUTRA RLC sublayer **206**A. The EUTRA RLC sublayer **206**A in turn provides RLC channels to the EUTRA PDCP sublayer **208** and, in some cases, to the NR PDCP sublayer **210**. Similarly, the NR PHY **202**B provides transport channels to the NR MAC sublayer **204**B, which in turn provides logical channels to the NR RLC sublayer **206**B. The NR RLC sublayer **206**B in turn provides RLC channels to the NR PDCP sublayer **210**. The UE **102**, in some implementations, supports both the EUTRA and the NR stack as shown in FIG. **2**, to support handover between EUTRA and NR base stations and/or to support DC over EUTRA and NR interfaces. Further, as illustrated in FIG. **2**, the UE **102** can support layering of NR PDCP **210** over EUTRA RLC **206**A.

[0051] The EUTRA PDCP sublayer **208** and the NR PDCP sublayer **210** receive packets (e.g., from an Internet Protocol (IP) layer, layered directly or indirectly over the PDCP layer **208** or **210**) that can be referred to as service data units (SDUs), and output packets (e.g., to the RLC layer **206**A or **206**B) that can 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.”

[0052] On a control plane, the EUTRA PDCP sublayer **208** and the NR PDCP sublayer **210** can provide SRBs to exchange RRC messages, for example. On a user plane, the EUTRA PDCP sublayer **208** and the NR PDCP sublayer **210** can provide DRBs to support data exchange.

[0053] In scenarios where the UE **102** operates in EUTRA/NR DC (EN-DC), with the base station **104** operating as an MeNB and the base station **106**A operating as an SgNB, the wireless communication system **100** can provide the UE **102** with an MN-terminated bearer that uses EUTRA PDCP sublayer **208**, or an MN-terminated bearer that uses NR PDCP sublayer **210**. The wireless communication system **100** in various scenarios can also provide the UE **102** with an SN-terminated bearer, which uses only the NR PDCP sublayer **210**. The MN-terminated bearer can be an MCG bearer or a split bearer. The SN-terminated bearer can be an SCG bearer or a split bearer. The MN-terminated bearer can be an SRB (e.g., SRB1 or SRB2) or a DRB. The SN-terminated bearer can be an SRB or a DRB.

[0054] FIGS. **3** through **8** illustrate message sequences between the UE **102** and various base stations of the RAN (including base stations **104**, **106**A and/or **106**B), for a number of scenarios and implementations relating to DAPS handover and DAPS PSCell change procedures.

[0055] In particular, FIG. **3** through FIG. **5** correspond to DAPS handover scenarios in which a base station initiates a DAPS handover procedure for a UE. FIG. **6** through FIG. **8** correspond to DAPS PSCell change scenarios in which a base station initiates a DAPS PSCell change procedure for a UE.

[0056] Referring first to FIG. **3**, according to a DAPS handover scenario **300**, the base station **104** operates as a source base station (S-BS) for the UE **102**, and the base station **106**B operates as a target base station (T-BS).

[0057] Initially, the UE **102** communicates **302** data (e.g., uplink (UL) data PDUs and/or downlink (DL) data PDUs) with the S-BS **104** via N cells using carrier aggregation (CA), where N is a whole number greater than one, by using an S-BS configuration. The N cells include PCell **124** and one or more secondary cells (SCells), such as cell **122**. In some scenarios, the UE **102** communicates **302** data in SC with the S-BS **104**, or communicates **302** data in DC with the S-BS **104** operating as an MN and an SN (e.g., the base station **106**A) not shown in FIG. **3**.

[0058] Later in time, the S-BS **104** determines **304** to initiate DAPS handover for the T-BS **106**B and the UE **102** to communicate, e.g., blindly or in response to detecting a suitable event. For example, the determination **304** can occur in response to the S-BS **104** receiving one or more measurement results from the UE **102** that are above (or below) one or more predetermined thresholds, or calculating a filtered result (from the measurement result(s)) that is above (or below) a predetermined threshold. In another example, the suitable event can be that the UE **102** is moving toward the T-BS **106**B. In yet another example, the suitable event can be one or more measurement results, generated or obtained by the S-BS **104** based on measurements of signals received from the UE **102**, being above (or below) one or more predetermined thresholds.

[0059] In response to the determination **304**, the S-BS **104** transmits **306** an RRC reconfiguration message to the UE **102** to configure the UE **102** to release M cells, where M is a whole number less than N (i.e., $0<M<N$). The M cells can be one, some, or all of the SCells covered by the S-BS **104**. In response to the RRC reconfiguration message, the UE **102** releases **308** the M cells (i.e., the UE **102** disconnects from the M cells). As a result, RF chain(s) or transceiver(s) of the UE **102** that were previously operating in communicating with the S-BS **104** via the M cells become available for use to communicate with the T-BS **106**B during and after a successful DAPS handover, while those that are communicating with the S-BS **104** via the N-M cells are still in use. In releasing **308** the M cells, the UE **102** and the S-BS **104** update the S-BS configuration by excluding

configurations relevant to the released M cells, and continue **309** communicating with each other (i.e., via N-M cells) by using the updated S-BS configuration. In some implementations, if the RRC reconfiguration message also includes an indication to update (e.g., adds, modifies or releases) configuration parameters not relevant to the M cells, the UE **102** and the S-BS **104** can update the S-BS configuration accordingly. The UE **102** then transmits **310** an RRC reconfiguration complete message to the S-BS **104**.

[0060] In some implementations, if the UE **102** at event **302** communicates data with the S-BS **104** via P cells, where 0<P≤N-M, events **306**, **308**, **309**, and **310** may be omitted.

[0061] After determining **304** to initiate DAPS handover, the S-BS **104** also sends **312** a Handover Request message to the T-BS **106**B. In response, the T-BS **106**B generates **314** a handover command message that includes a DAPS handover configuration or an indication for the DAPS handover configuration in a field or an IE (e.g., a dapsConfig field, a dapsHO-Config field, a daps-HO field or a daps-HO-Config field), includes the handover command message in a Handover Request Acknowledge message, and sends **316** the Handover Request Acknowledge message to the S-BS **104**. In turn, the S-BS **104** transmits **318** the handover command message to the UE **102**. The handover command message also includes one or more random access configurations needed by the UE **102** to handover to the T-BS **106**B, and in some implementations, includes additional fields, such as a mobility field (e.g., mobilityControlInfo field or a reconfiguration WithSync field), which can include some or all of the random access configurations.

[0062] The DAPS handover configuration enables the UE **102** to use a DAPS (e.g., DAPS **200**) to communicate with the S-BS **104** (using the updated S-BS configuration) and T-BS **106**B (during and after a successful DAPS handover). As such, in response to receiving **318** the handover command message, the UE **102** and the S-BS **104** continue **320** communicating with each other using the updated S-BS configuration while the UE **102** attempts to handover to the T-BS **106**B in accordance with the handover command message. In attempting to perform the DAPS handover, the UE **102** initiates **322** a random access procedure with the T-BS **106**B via a target cell (e.g., PCell **126**B) covered by the T-BS **106**B, e.g., by using one or more random access configurations in the handover command message received **318** from the S-BS **104**. After gaining access to a channel, the UE **102** transmits **324** a handover complete message to the T-BS **106**B via the target cell during or after successfully completing the random access procedure. After the T-BS **106**B identifies the UE **102** during the random access procedure, the UE **102** communicates **326** control signals and data (e.g., UL data PDUs or DL data PDUs) with the T-BS **106**B via the target cell by using the DAPS handover configuration in or otherwise indicated in the handover command message. The DAPS handover configuration enables the UE **102** to continue communicating with the S-BS **104** while simultaneously communicating with the T-BS **106**B.

[0063] In response to identifying the UE **102** during the random access procedure or receiving **324** the handover complete message, the T-BS **106**B sends **328** a Handover Success message to the S-BS **104**. After receiving the Handover Success message, the S-BS **104** stops **330** communicating with the UE **102**. In some implementations, the S-BS **104** can transmit a sequence number (SN) Status Transfer message to the T-BS **106**B in response to the Handover Success message. In some implementations, before or after transmitting the Handover Success message, the T-BS **106**B can send an explicit stop indication message to the S-BS **104**, which in turn can stop **330** communicating with the UE **102** in response to the explicit stop indication. In other implementations, the S-BS **104** stops **330** communicating with the UE **102** in response to generating the SN Status Transfer message. After receiving the SN Status Transfer message from the S-BS **104**, the T-BS **106**B can send a Context Release message to the S-BS **104** to release a UE Context of the UE **102**.

[0064] As the UE **102** no longer needs to use the DAPS to continue communicating with the S-BS **104**, the T-BS **106**B can send **332** an RRC reconfiguration message that includes a DAPS release indicator to the UE **102**, e.g., via the target cell, before transmitting **328** the Handover Success message, after transmitting **328** the Handover Success message, or simultaneously with the Handover Success message. In response to the RRC reconfiguration message, the UE **102** can transmit **334** an RRC reconfiguration complete message to the T-BS **106**B and stop **336** communicating (i.e., UL and/or DL communication) with the S-BS **104**. In some implementations, in response to the DAPS release indicator, a RF chip, receiver, or a transceiver of the UE **102** used to communicate with the S-BS **104** during the DAPS handover can enter into low power consumption mode, sleep mode, or be turned off entirely if the DAPS handover is an inter-frequency handover. The events **322**, **324**, **326**, **328**, **330**, **332**, **334** are collectively referred to in FIG. **3** as the DAPS handover and DAPS release procedure **350**.

[0065] In some implementations, the S-BS **104** determines to configure the UE **102** to release M cells according to a DAPS handover capability in a UE Capability information element (IE) of a message (e.g., in a UECapabilityInformation message) received from the UE **102**, the CN **110** (e.g., via a S1 or NG interface message), or another base station (e.g., the base station **106**A, the base station **106**B, or other base station not shown in FIG. **1**A) via an X2 or Xn interface. The S-BS **104** can include the UE Capability IE in the Handover Request message in event **312** so that the T-BS **106**B is aware of the DAPS handover capability of the UE **102**. The UE Capability IE can be a UE-NR-Capability IE as defined in 3GPP TS 38.331 or a UE-EUTRA-Capability IE as defined in 3GPP TS 36.331.

[0066] For example, if the DAPS handover capability indicates that the UE **102** is not capable of CA, the S-BS **104** can configure the UE **102** to release all SCells (i.e., N-1 SCells). In another example, if the DAPS handover capability indicates that the UE **102** is capable of communicating with the S-BS **104** using CA in N-P cells associated to one or more particular frequency bands during DAPS handover, where P is a whole number greater than or equal to 0 and less than or equal to M (i.e., $0 \le P \le M$), the S-BS **104** can configure the UE **102** to release M cells if N-M cells are associated to some or all of the one or more particular frequency bands. In yet another example, if the DAPS handover capability indicates that the UE **102** is not capable of DAPS handover, the S-BS **104** can perform a non-DAPS handover preparation procedure with the T-BS **106**B. In such an example, instead of generating the handover command message that includes the DAPS handover configuration (or an indication for the DAPS handover configuration) at event **314**, the T-BS **106**B generates a handover command message that excludes the DAPS handover configuration (or the indication for the DAPS handover configuration).

[0067] In other implementations, the S-BS **104** determines to configure the UE **102** to release N-1 cells if the S-BS **104** is unaware whether the UE **102** is capable of DAPS handover with CA. The S-BS **104** can ensure that the UE **102** can perform DAPS handover by releasing the N-1 cells.

Inter-Frequency DAPS Handover

[0068] In some implementations, the DAPS handover capability indicates that the UE **102** is capable of inter-frequency DAPS handover for one or more frequency bands. In one implementation, the DAPS handover capability can further specify that the UE **102** is capable of inter-frequency DAPS handover for frequency division duplex (FDD) and/or time division duplex (TDD) mode, using one or more indicators included in the DAPS handover capability. In another implementation, the UE Capability IE can specify that the UE **102** is capable of inter-frequency DAPS handover for FDD and/or TDD mode, using an inter-frequency handover capability field/IE included in the UE Capability IE. Therefore, the S-BS **104** or T-BS **106**B can determine whether the UE **102** is capable of inter-frequency DAPS handover for one or more frequency bands, and if further specified, for FDD and/or TDD mode, according to the DAPS handover capability and/or the UE Capability IE. If the UE Capability IE does not include the DAPS handover capability, irrespective of including the inter-frequency handover capability field/IE, the S-BS **104** or T-BS **106**B determines that the UE **102** is capable of the inter-frequency non-DAPS handover.

[0069] In some implementations, the UE Capability IE includes DC/CA band combination field(s)/IE(s) to indicate that the UE **102** is capable of performing CA on one or more bands (e.g., FDD band(s) only, TDD band(s) only, FDD band(s) and TDD band(s)). The CA band combination field(s)/IE(s) can designate respective CA band combination(s) (e.g., a first CA band combination and a second CA band combination), each CA band combination indicating the band(s). In one implementation, the DAPS handover capability can be included in the CA band combination field(s)/IE(s) to indicate that the UE **102** is capable of the inter-frequency DAPS handover associated to the CA band combination(s) indicated in the CA band combination field(s)/IE(s). Thus, support of the DAPS handover can be on a per CA band combination basis. For example, if the UE **102** supports DAPS handover associated to a first CA band combination but not a second CA band combination, the UE **102** includes the DAPS handover capability in a first CA band combination field/IE designating the first CA band combination, and excludes the DAPS handover capability in a second CA band combination field/IE designating the second CA band combination. Therefore, the S-BS **104** or T-BS **106**B can determine whether the UE **102** is capable of inter-frequency DAPS handover according to the DAPS handover capability and the CA band combination field(s)/IE(s).

[0070] In an example scenario, cell **124** operates on a first DL carrier frequency and a first UL carrier frequency, and cell **126**B operates on a second DL carrier frequency and a second UL carrier frequency. Cells **124** and **126**B can be either FDD cells or TDD cells. As examples, if the first DL carrier frequency and the first UL carrier frequency belong to a TDD band (i.e., the cell **124** is a TDD cell), the first DL carrier frequency and the first UL carrier frequency are the same or overlapped carrier frequencies. If the first DL carrier frequency and the first UL carrier frequency belong to an FDD band (i.e., the cell **124** is an FDD cell), the DL carrier frequency and the UL carrier frequency are different carrier frequencies. If the second DL carrier frequency and the second UL carrier frequency belong to a TDD band (i.e., the cell **126**B is a TDD cell), the second DL carrier frequency and the second UL carrier frequency are the same carrier frequency. If the second DL carrier frequency and the second UL carrier frequency belong to an FDD band (i.e., the cell **126**B is an FDD cell), the second DL carrier frequency and the second UL carrier frequency are different carrier frequencies. If the UE **102** is capable of the inter-frequency DAPS handover, the S-BS **104** requests the T-BS **106**B to configure cell **126**B in the Handover Request message for the inter-frequency DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message. Similarly, if the UE **102** is capable of the inter-frequency non-DAPS handover, the S-BS **104** requests the T-BS **106**B to configure cell **126**B in the Handover Request message for the inter-frequency non-DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message.

FDD-TDD DAPS Handover

[0071] In some implementations, the DAPS handover capability indicates that the UE **102** is capable of FDD-TDD DAPS handover (i.e., DAPS handover from an FDD cell to a TDD cell and/or vice versa). In one implementation, the DAPS handover capability can further specify that the UE **102** is capable of FDD-TDD DAPS handover using one or more indicators included in the DAPS handover capability. For example, the DAPS handover capability can include a single indicator indicating that the UE **102** is capable of FDD-TDD DAPS handover from an FDD cell (in a specific or any FDD band supported by the UE **102**) to a TDD cell (in a specific or any TDD band supported by the UE **102**), and/or vice versa. In other implementations, an FDD-TDD handover capability field/IE included in the UE Capability IE can indicate that the UE **102** is capable of the FDD-TDD DAPS handover. The S-BS **104** or T-BS **106** can determine whether the UE **102** is capable of FDD-TDD DAPS handover according to the DAPS handover capability and/or the FDD-TDD handover capability field/IE. If the UE Capability IE does not include the DAPS handover capability, irrespective of including the FDD-TDD handover capability field/IE, the S-BS **104** or T-BS **106** determines that the UE **102** is capable of the FDD-TDD non-DAPS handover.

[0072] In an example scenario, one of the cells **124** and **126**B is a TDD cell, and the other is an

FDD cell. If the UE **102** is capable of the FDD-TDD DAPS handover, the S-BS **104** requests the T-BS **106**B to configure cell **126**B in the Handover Request message for the FDD-TDD DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message. Similarly, if the UE **102** is capable of the FDD-TDD non-DAPS handover, the S-BS **104** requests the T-BS **106**B to configure cell **126**B in the Handover Request message for the FDD-TDD non-DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message.

Intra-Frequency DAPS Handover

[0073] In some implementations, the DAPS handover capability indicates that the UE **102** is capable of intra-frequency DAPS handover for one or more frequency bands. In another implementation, the UE Capability IE can specify that the UE **102** is capable of intra-frequency DAPS handover, using an indication included in the UE Capability IE. Therefore, the S-BS **104** or T-BS **106**B can determine whether the UE **102** is capable of intra-frequency DAPS handover according to the DAPS handover capability and/or the UE Capability IE. For example, if the UE Capability IE includes an indication that the UE **102** does not support the intra-frequency DAPS handover, or if the UE Capability IE does not include the DAPS handover capability, the S-BS **104** or T-BS **106** determines that the UE **102** is capable of intra-frequency non-DAPS handover. As another example, if the UE Capability IE includes the DAPS handover capability and an indication that the UE **102** supports intra-frequency DAPS handover, the S-BS **104** or T-BS **106**B determines that the UE **102** is capable of the intra-frequency DAPS handover.

[0074] In an example scenario, cells **124** and **126**B are either TDD cells or FDD cells and operate on the same or overlapped carrier frequencies. If the UE **102** is capable of the intra-frequency DAPS handover, the S-BS **104** can request the T-BS **106**B to configure the cell **126**B in the Handover Request message for the intra-frequency DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message. Similarly, if the UE **102** is capable of the intra-frequency non-DAPS handover, the S-BS **104** requests the T-BS **106**B to configure cell **126**B in the Handover Request message for the intra-frequency non-DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message.

Inter-RAT DAPS Handover

[0075] In some implementations, the DAPS handover capability indicates that the UE **102** is capable of inter-RAT DAPS handover using one or more indicators. For example, the DAPS handover capability can include a single indicator indicating that the UE **102** is capable of inter-RAT DAPS handover from a cell of a first RAT (or a cell in a specific band in the first RAT) to a cell of a second RAT (or a cell in a specific band in the second RAT). In other implementations, the UE Capability IE can specify that the UE **102** is capable of inter-RAT DAPS handover, using an inter-RAT handover capability field/IE included in the UE Capability IE that indicates that the UE **102** is capable of inter-RAT DAPS handover from a first RAT to a second RAT. Therefore, the S-BS **104** or T-BS **106** can determine whether the UE **102** is capable of inter-RAT DAPS handover according to the DAPS handover capability and/or the UE Capability IE. If the UE Capability IE does not include the DAPS handover capability, irrespective of including the inter-RAT handover capability field/IE, the S-BS **104** or T-BS **106** determines that the UE **102** is capable of the inter-RAT non-DAPS handover.

[0076] In an example scenario, cell **124** operates in the first RAT (e.g., EUTRA) and cell **126**B operates in the second RAT (e.g., NR). If the UE **102** is capable of the inter-RAT DAPS handover, the S-BS **104** can request the T-BS **106**B to configure the cell **126**B in the Handover Request message for the inter-RAT DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message. Similarly, if the UE **102** is capable of the inter-RAT non-DAPS handover, the S-BS **104** requests the T-BS **106**B to configure cell **126**B in the Handover Request message for the inter-RAT non-DAPS handover, and the T-BS **106**B configures the cell **126**B in the handover command message.

Synchronous or Asynchronous DAPS Handover

[0077] In some implementations, the DAPS handover capability indicates that the UE **102** is capable of synchronous DAPS handover, asynchronous DAPS handover, or both, using one or more indicators. For example, the DAPS handover capability can include a “synchronous” indicator or an “asynchronous” indicator indicating that the UE **102** is capable of synchronous or asynchronous DAPS handover, respectively. In another example, the DAPS handover capability can include the “synchronous” indicator indicating that the UE **102** is only capable of synchronous DAPS handover, or include the “asynchronous” indicator indicating that the UE **102** is capable of both synchronous DAPS handover and asynchronous DAPS handover.
[0078] The “synchronous” and/or “asynchronous” indicators can be generic for or associated to all types of DAPS handover discussed above (e.g., intra-frequency DAPS handover, inter-frequency DAPS handover, FDD-TDD DAPS handover, and/or inter-RAT DAPS handover) that the UE **102** supports. If the UE **102** only supports synchronous DAPS handover for all of the DAPS handover types that the UE supports (i.e., the UE **102** does not support asynchronous DAPS handover), and the S-BS **104** and T-BS **106**B are asynchronous base stations, the S-BS **104** can send a Handover Request message to the T-BS **106**B to request the T-BS **106**B to prepare non-DAPS handover for the UE **102**, and the T-BS **106**B can configure the non-DAPS handover in the handover command message, in one implementation. In another implementation, the S-BS **104** can send a Handover Request message to the T-BS **106**B to request the T-BS **106**B to prepare DAPS handover for the UE **102**, but the T-BS **106**B can still configure the non-DAPS handover in the handover command message, and optionally notify the S-BS **104** of the non-DAPS handover for the UE **102**. Otherwise, if the UE **102** supports asynchronous DAPS handover, the S-BS **104** can send a Handover Request message to the T-BS **106**B to request the T-BS **106**B to prepare DAPS handover for the UE **102**.
[0079] In one scenario, the S-BS **104** determines that the T-BS **106**B is an asynchronous base station and subsequently requests the T-BS **106**B to prepare non-DAPS handover for a particular UE (e.g., UE **102**) that only supports synchronous DAPS handover, and DAPS handover for a particular UE that only supports asynchronous DAPS handover. In another scenario, the T-BS **106**B determines that the S-BS **104** is an asynchronous base station and subsequently prepares non-DAPS handover for a particular UE that only supports synchronous DAPS handover, and DAPS handover for a particular UE that only supports asynchronous DAPS handover. In either scenario, the T-BS **106**B can determine whether the UE supports synchronous DAPS handover and/or asynchronous DAPS handover based on a DAPS capability in a UE Capability IE of the particular UE received from the S-BS **104**.
[0080] Alternatively, the “synchronous” and/or “asynchronous” indicators can be specific for or associated to a particular type of DAPS handover discussed above that the UE **102** supports. For example, if the UE **102** supports inter-frequency DAPS handover and FDD-TDD DAPS handover, the UE **102** indicates first “synchronous” and/or “asynchronous” indicators for the inter-frequency DAPS handover and second “synchronous” and/or “asynchronous” indicators for the FDD-TDD DAPS handover. If the UE **102** only supports synchronous DAPS handover for a specific DAPS handover type, and the S-BS **104** and the T-BS **106**B are asynchronous base stations that support the specific DAPS handover type, the S-BS **104** can send a Handover Request message to the T-BS **106**B to request the T-BS **106**B to prepare non-DAPS handover for the UE **102**, in one implementation. In another implementation, the S-BS **104** can send a Handover Request message to the T-BS **106**B to request the T-BS **106**B to prepare DAPS handover for the UE **102**, but the T-BS **106**B can still configure the non-DAPS handover in the handover command message, and optionally notify the S-BS **104** of the non-DAPS handover for the UE **102**.
[0081] In some implementations, the RRC reconfiguration procedure (i.e., events **306**, **308**, **309**, **310**) and the DAPS handover preparation procedure (e.g., events **312**, **314**, **316**) can be performed in parallel, or in sequence. For example, the S-BS **104** sends **312** the Handover Request message before or after transmitting **306** the RRC reconfiguration message or receiving **310** the RRC

reconfiguration complete message, in one implementation. In another implementation, the S-BS **104** sends **312** the Handover Request message and sends **306** the RRC reconfiguration message at the same time.
[0082] In one implementation, the UE **102** stops transmitting and retransmitting UL data PDUs and/or control signals on PUCCH(s) to the S-BS **104** after successfully completing **322** the random access procedure. In another implementation, the UE **102** stops transmitting new UL data PDUs to the S-BS **104** but continues to retransmit UL data PDU(s) to the S-BS **104** if requested by the S-BS **104** after successfully completing **322** the random access procedure, until event **336** occurs. In such implementations, the UE **102** can continue DL communication (i.e., receiving control signals, reference signals, DL PDUs, etc.) with the S-BS **104** and/or transmit control signals (e.g., HARQ acknowledgement, HARQ negative acknowledgement and/or channel state information) on PUCCH(s) to the S-BS **104** until event **332** occurs or a DAPS release timer at the UE **102** expires. In one implementation, the T-BS **106**B configures a time value for the DAPS release timer in the handover command message or the RRC reconfiguration message in event **332**. Upon receiving **318** the handover command message or receiving **332** the RRC reconfiguration message, the UE **102** starts the DAPS release timer. If the DAPS release timer expires, the UE **102** stops **336** communicating with the S-BS **104**. Alternatively, the UE **102** uses a predetermined timer value if the T-BS **106**B does not include the timer value in the handover command message or the RRC reconfiguration message. The T-BS **106**B can include a timer value in the Handover Success message, which can be the same timer value in the RRC reconfiguration message in event **332** or larger than the timer value in the handover command message in event **318**.
[0083] In some implementations and scenarios, the UE **102** exchanges RRC message with the S-BS **104** via SRB(s) (e.g., SRB1, SRB2 and/or SRB4) using the updated S-BS configuration before receiving the handover command message. The S-BS **104** can also include a DRB configuration in the updated S-BS configuration. The T-BS **106**B includes multiple configuration parameters in the handover command message to configure radio resources for the UE **102** to communicate with the T-BS **106**B via target PCell **126**B. The multiple configuration parameters can configure zero, one, or more radio bearers, including SRB(s) (e.g., SRB1, SRB2 and/or SRB4) and/or DRB(s). The UE **102** can exchange RRC messages with the T-BS **106**B via the SRB(s) (i.e., SRB(s) for the target). The T-BS **106**B can associate or otherwise specify the DAPS handover configuration to a radio bearer (e.g., DRB), such as by including the DAPS handover configuration in a DRB configuration (e.g., DRB-ToAddMod IE) in the handover command message. After the UE **102** receives the handover command message and while the UE **102** is performing the DAPS procedure, the UE **102** suspends the SRB(s) with the S-BS **104** (i.e., SRB(s) for the source). If the UE **102** fails the random access procedure at event **322**, the UE **102** can perform a RRC connection reestablishment procedure with the S-BS **104** or the T-BS **106**B. The UE **102** resumes one or all of the SRB(s) associated with the S-BS **104** in response to the RRC connection reestablishment procedure. The SRB(s) associated with the S-BS **104** and the SRB(s) associated with the T-BS **106**B can be the same or different instances. If the SRBs are different instances, the UE **102** releases the SRB(s) associated with the T-BS **106**B in response to the RRC connection reestablishment procedure. If the SRBs are different instances, the UE **102** releases the SRB(s) associated with the S-BS **104** after or in response to the success completion of the random access procedure or the DAPS release at event **332**.
[0084] In some implementations, the T-BS **106**B can configure SCell(s) of the T-BS **106**B in the multiple configuration parameters in the handover command message to configure radio resources for the UE **102** to communicate with the T-BS **106**B via the SCell(s). In one such implementation, the T-BS **106**B can include one or more SCell configurations configuring the SCell(s) and their states in the handover command message, and the UE **102** can determine the states of the SCell(s) according to the one or more SCell configurations. Particularly, the T-BS **106**B can configure the SCell(s) to first be in deactivated state(s) while the UE **102** performs the DAPS procedure, and then

transition to activated state(s) after releasing the DAPS at event **332**. The T-BS **106**B can transmit RRC message(s), MAC control element(s), or downlink control information (DCI) command(s) to the UE **102** to configure the SCell(s) to be in activated state(s).

[0085] In some implementations, while performing the DAPS procedure, the UE **102** keeps an SCell of the S-BS **104** in activated state if the SCell is among the N-M cells, e.g., not released at event **306**. The UE **102** can release the SCell of the S-BS **104** in response to the DAPS release at event **332**. In other implementations, the T-BS **106**B can include a release indication of the SCell of the S-BS **104** in the handover command message that is transmitted to the UE **102**, and the UE **102** does not release the SCell in response to the handover command message, and instead releases the SCell in response to the DAPS release at event **332**. In yet other implementations, the T-BS **106**B can include a release indication of the SCell of the S-BS **104** in the RRC reconfiguration message at event **332**, and the UE **102** does not release the SCell of the S-BS **104** in response to the handover command message, and instead releases the SCell in response to the release indication.

[0086] In some implementations, the T-BS **106**B may not configure an SCell to the UE **102** in the handover command message. The T-BS **106**B can later transmit RRC reconfiguration message(s) to the UE **102** to configure SCell(s) of the T-BS **106**B. In response, the UE **102** can transmit an RRC reconfiguration complete message to the T-BS **106**B via the target PCell **126**B or a configured SCell for each of the RRC reconfiguration message(s).

[0087] In some implementations, the S-BS **104** transmits the updated S-BS configuration in a Handover Request message to the T-BS **106**B, so that the T-BS **106**B is aware of any pre-existing configurations known by the UE **102** to determine additional configuration(s) the UE **102** may still need to handover from the S-BS **104** to the T-BS **106**B and communicate with the T-BS **106**B after the handover. In one implementation, the S-BS **104** includes the updated S-BS configuration in a HandoverPreparationInformation IE (or RRC inter-node message), and includes the HandoverPreparationInformation IE in the Handover Request message. In another implementation, the S-BS **104** includes the updated S-BS configuration in an RRC message (e.g., RRC reconfiguration message), includes the RRC message in a HandoverPreparationInformation IE, and then includes the HandoverPreparationInformation IE in the Handover Request message. If the T-BS **106**B determines that configuration(s) in addition to the updated S-BS configuration are needed by the UE **102**, the T-BS **106**B can include the additional configuration(s) in the handover command message.

[0088] In some implementations, the updated S-BS configuration can include a CellGroupConfig IE that configures the PCell **124** and can configure zero, one, or more SCells of the S-BS **104**. The updated S-BS configuration can be an RRCReconfiguration message, RRCReconfiguration-IEs, or the CellGroupConfig IE conforming to 3GPP TS 38.331, or an RRCConnectionReconfiguration message or RRCConnectionReconfiguration-IEs conforming to 3GPP TS 36.331. In some implementations, the updated S-BS configuration can include configurations in the CellGroupConfig IE, RRCReconfiguration-IEs or RRCConnectionReconfiguration-IEs.

[0089] In some implementations, the S-BS **104** consists of CU **172** and one or more DUs **174** as shown in FIG. **1**B. The DU(s) **174** can generate the S-BS configuration or at least a portion of the S-BS configuration, and send the S-BS configuration (or portion) to the CU **172**. The CU **172** can generate the remainder of the S-BS configuration if the DU **174** only generated a portion of the S-BS configuration. The DU(s) **174** can communicate with the UE **102** via the portion of the S-BS configuration, and the CU **172** can communicate with the UE **102** via the remainder of the S-BS configuration, in one implementation. For example, the S-BS configuration (or portion) generated by the DU **174** can include the one or more random access configurations, a physical downlink control channel (PDCCH) configuration, physical uplink control channel (PUCCH) configuration, etc. The remainder of the S-BS configuration generated by the CU **172** can include an SRB configuration, a DRB configuration, a security configuration, and/or a measurement configuration. In other implementations, the DU **174** can include a cell group configuration (e.g., CellGroupConfig IE) in the S-BS configuration, and the CU **172** can include a radio bearer configuration (RadioBearerConfig IE) in the S-BS configuration. The DU(s) **174** can include one or more configuration parameters to update the S-BS configuration in the RRC reconfiguration message, so that the DU(s) **174** and the UE **102** can continue communicating with each other by using the updated S-BS configuration (e.g., at event **309**). The DU(s) **174** can send the one or more configuration parameters to the CU **172**.

[0090] In some implementations, the T-BS **106** consists of CU **172** and one or more DUs **174** as shown in FIG. **1**B. The UE **102** can perform **322** the random access procedure with at least one of the DU(s) **174**. The DU **174** can include some configurations (e.g., one or more random access configurations, a physical downlink control channel (PDCCH) configuration, physical uplink control channel (PUCCH) configuration) in the handover command message and send the configurations to the CU **172**. The CU **172** can include other configurations (e.g., an SRB configuration, a DRB configuration, a security configuration and/or a measurement configuration) in the handover command message. In other implementations, the DU **174** can include a cell group configuration (e.g., CellGroupConfig IE) in the handover command message, and the CU **172** can include a radio bearer configuration (e.g., RadioBearerConfig IE) in the handover command message.

[0091] In some implementations, if the S-BS **104** is a gNB, the handover command message can be an RRCReconfiguration message, the S-BS configuration can be an RRCReconfiguration-IEs as defined in 3GPP TS 38.331, the handover complete message can be an RRCReconfigurationComplete message, and the RRC reconfiguration message and the RRC reconfiguration complete message can be an RRCReconfiguration message and an RRCReconfigurationComplete message, respectively.

[0092] In some implementations, if the S-BS **104** is an eNB or an ng-eNB, the handover command message can be an RRCConnectionReconfiguration message, the S-BS configuration can be an RRCConnectionReconfiguration-r8-IEs as defined in 3GPP TS 36.331, the handover complete message can be an RRCConnectionReconfigurationComplete message, and the RRC reconfiguration message and the RRC reconfiguration complete message can be an RRCConnectionReconfiguration message and an RRCConnectionReconfigurationComplete message, respectively.

[0093] In some implementations, the S-BS **104** can combine the RRC reconfiguration message (at event **306**) and the handover command message (at event **318**) into an RRC message. For example, the S-BS **104** can generate an RRC message (e.g., an RRC reconfiguration message) for releasing the M cells that includes the handover command message, and transmit the RRC message to the UE **102** at event **318**. The S-BS **104** can include the handover command message in a DAPS handover related field/IE. The handover command message may or may not include a DAPS handover related field/IE to indicate the DAPS handover. If the RRC message is an RRC reconfiguration message, the UE **102** need not transmit an RRC reconfiguration complete message to the S-BS **104** in response to the RRC reconfiguration message. If the RRC message and the handover command message are RRC reconfiguration messages, the UE **102** can include a transaction identifier in the handover complete message (i.e., a RRC reconfiguration complete message) and set the transaction identifier to a value identical to the value of a transaction identifier in the handover command message rather than to a value of a transaction identifier in the RRC message. Accordingly, the RRC message and the handover command message may have different transaction identifier values, and therefore the T-BS **106**B can determine that the handover complete message is associated to the handover command message based on the identical transaction identifiers.

[0094] In FIG. **4**, in a DAPS handover scenario **400**, the base station **104** operates as an MN for the UE **102**, the base station **106**A operates as an SN for the UE **102**, and the base station **106**B operates as a T-BS for the UE **102**.

[0095] Initially, the UE **102** in DC communicates **402** data (e.g., UL data PDUs and/or DL data PDUs) with the MN **104** and SN **106**A, e.g., by using an MN configuration (similar to the S-BS configuration in event **302**) and an SN configuration, respectively.

[0096] Later in time, the MN **104** determines **404** to initiate DAPS handover for the T-BS **106**B and the UE **102** to communicate, e.g., blindly or in response to detecting a suitable event, similar to those described with respect to FIG. **3**.

[0097] In response to the determination **404**, the MN **104** performs **405** an SN Release procedure with the SN **106**A (e.g., the MN **104** sends an SN Release Request message to the SN **106**A, which in turn sends an SN Release Request Acknowledge message to the MN **104**), and transmits **406** an RRC reconfiguration message to the UE **102** to configure the UE **102** to release the SN **106**A. The MN **104** can transmit the RRC reconfiguration message before or after transmitting the SN Release Request message or receiving the SN Release Request Acknowledge message.

[0098] In response to receiving the RRC reconfiguration message, the UE **102** stops **408** communicating with the SN **106**A. As a result, RF chain(s) or transceiver(s) of the UE **102** that were previously operating in communicating with the SN **106**A become available for use to communicate with the T-BS **106**B during and after a successful DAPS handover, while those that are communicating with the MN **104** are still in use. The UE **102** and the MN **104** continue **409** communicating with each other (i.e., in SC), similar to event **309**.

[0099] The UE **102** then transmits **410** an RRC reconfiguration complete message to the MN **104**, and releases the SN configuration, in some implementations.

[0100] After determining **404** to initiate DAPS handover, the MN **104** also sends **412** a Handover Request message to the T-BS **106**B, similar to event **312**. In response, the T-BS **106**B generates **414** a handover command message, similar to event **314**, and sends **416** the Handover Request Acknowledge message to the MN **104**, similar to event **316**. In turn, the MN **104** transmits **418** the handover command message to the UE **102**, similar to event **318**.

[0101] In response to receiving **418** the handover command message, the UE **102** and the MN **104** continue **420** communicating with each other while the UE **102** attempts to handover to the T-BS **106**B in accordance with the handover command message, similar to event **320**. Subsequently, the UE **102**, MN **104**, and T-BS **106**B collectively perform a DAPS handover and DAPS release procedure **450**, similar to procedure **350**. As a result, the UE **102** stops **436** communicating with the MN **104**, similar to event **336**.

[0102] In some implementations, if the DAPS handover capability of the UE **102** indicates that the UE **102** is not capable of communicating in DC but capable of CA, the MN **104** can configure the UE **102** to communicate in SC with the MN **104** via N cells. Therefore, the MN **104** can effectively serve as the S-BS **104** as described above with respect to FIG. **3**.

[0103] In other implementations, the S-BS **104** determines to configure the UE **102** to release the SN if the S-BS **104** is unaware whether the UE **102** is capable of DAPS handover with DC. The S-BS **104** can ensure that the UE **102** can perform DAPS handover by releasing the SN for the UE **102** at event **406**.

[0104] In some implementations, the S-BS **104** may combine the RRC reconfiguration message (at event **406**) and the handover command message (at event **410**) into an RRC message. For example, the S-BS **104** can generate an RRC message (e.g., an RRC reconfiguration message) for releasing the SN that includes the handover command message, and transmit the RRC message to the UE **102** at event **418**. The S-BS **104** can include the handover command message in a DAPS handover related field/IE. The handover command message may or may not include a DAPS handover related field/IE to indicate the DAPS handover. If the RRC message is an RRC reconfiguration message, the UE **102** need not transmit an RRC reconfiguration complete message to the S-BS **104** in response to the RRC reconfiguration message. If the RRC message and the handover command message are RRC reconfiguration messages, the UE **102** can include a transaction identifier in the handover complete message and set the transaction identifier to a value identical to the value of a transaction identifier in the handover command message rather than to a value of a transaction identifier in the RRC message. Accordingly, the RRC message and the handover command message may have different transaction identifier values, and therefore the T-BS **106**B can determine that the handover complete message is associated to the handover command message based on the identical transaction identifiers.

[0105] In FIG. **5**, in a DAPS handover scenario **500**, the base station **104** includes a CU **172** for the UE **102**, and three DUs **174** that operate as a source DU (S-DU) for the UE **102**, a target DU (T-DU) for the UE **102**, and a candidate DU (C-DU) for the UE **102**, respectively.

[0106] Initially, the UE **102** communicates **502** data with CU **172** and S-DU **174**A via cell **122** by using a BS configuration.

[0107] Later in time, the CU **172** determines **504** to initiate DAPS handover for the T-DU **174**B and the UE **102** to communicate via cell **124**, e.g., blindly or in response to detecting a suitable event, similar to those described with respect to FIG. **3**. For example, the CU **172** initiates DAPS handover in response to measurement result(s) obtained by the CU **172** from measurements on signals received from the UE **102** via S-DU **174**A.

[0108] In response to the determination **504**, the CU **172** sends **506** a UE Context Setup Request message to the T-DU **174**B. In response, the T-DU **174**B sends **508** a UE Context Setup Response message including a T-DU configuration to the CU **172**. In turn, the CU **172** generates **514** a handover command message which includes the T-DU configuration and a DAPS handover configuration or an indication for the DAPS handover configuration in a field or an IE (e.g., a dapsConfig field, a dapsHO-Config field, a daps-HO field or a daps-HO-Config field). Then the CU **172** sends **516** the handover command message to the S-DU **174**A, which in turn transmits **518** the handover command message to the UE **102**.

[0109] The DAPS handover configuration enables the UE **102** to use a DAPS to communicate with the S-DU **174**A using the BS configuration as well as T-DU **174**B using the T-DU configuration during and after a successful DAPS handover. As such, in response to the handover command message, the UE **102** and the base station **104** continue **520** communicating with each other via cell **122** using the S-DU **174**A (by using the BS configuration), while the UE **102** attempts to handover to cell **124** using the T-DU **174**B in accordance with the handover command message. In attempting to perform the DAPS handover, the UE **102** initiates **522** a random access procedure with the T-DU **174**B, e.g., by using one or more random access configurations in the T-DU configuration. After gaining access to a channel, the UE **102** transmits **523** a handover complete message to the T-DU **174**B during or after successfully completing the random access procedure, which in turn sends **524** the handover complete message to the CU **172**. After the T-DU **174**B identifies the UE **102** during the random access configuration, the UE **102** communicates **526** control signals and data with the CU **172** via the T-DU **174**B by using the T-DU configuration included in the handover command message. If the handover command message includes configurations (e.g., DAPS handover configuration) generated by the CU **172**, the UE **102** communicates **526** with the CU **172** via the T-DU **174**B by using the configurations generated by the CU **172**.

[0110] After receiving **524** the handover complete message, the CU **172** stops **530** communicating with the UE **102** via the S-DU **174**A. The CU **172** can then send **531** an RRC reconfiguration message that includes a DAPS release indicator to the T-DU **174**B, which in turn can send **532** the RRC reconfiguration message to the UE **102**. In some implementations, the CU **172** stops **530** communicating with the UE **102** after transmitting the RRC reconfiguration message to the T-DU **174**B. In response to the RRC reconfiguration message, the UE **102** can transmit **533** an RRC reconfiguration complete message to the T-DU and stop **536** communicating with the S-DU **174**A. In turn, the T-DU **174**B can send **534** the RRC reconfiguration complete message to the CU **172**.

[0111] As the UE **102** no longer needs to use the DAPS to continue communicating with the S-DU **174**A, the CU **172** can perform **540** a UE Context Release procedure with the S-DU **174**A in response to the RRC reconfiguration complete message. Particularly, the CU **172** sends a UE Context Release Command message to the S-DU **174**A, which in turn sends a UE Context Release Complete message to the CU **172** and stops communicating with the UE **102**. By performing the UE Context Release procedure in response to the RRC reconfiguration complete message, the CU **172** maintains the UE context longer relative to a non-DAPS handover procedure when performing a DAPS handover procedure. The events **522**, **523**, **524**, **526**, **530**, **531**, **532**, **533**, **534**, **540** are collectively referred to in FIG. **5** as the DAPS handover and DAPS release procedure **550**.

[0112] In some implementations, after successfully completing the random access procedure, the UE **102** can start transmitting UL data PDUs to the CU **172** via the T-DU **174**B, stop transmitting and retransmitting UL data PDUs to the S-DU **174**A, stop transmitting control signals on PUCCH(s) to the S-DU **174**A, stop transmitting new UL data PDUs to the S-DU **174**A while continuing to retransmit UL data PDU(s) to the S-DU **174**A, continue DL communication with the S-BS **104**, and/or keep transmitting control signals to the S-DU **174**A until event **532** occurs or the DAPS release timer at the UE **102** expires, as described above with respect to FIG. **3**.

[0113] In some implementations, the CU **172** performs actions similar to those of the T-BS **106**B as discussed above with respect to FIG. **3**, such as configuring a time value for the DAPS release timer.

[0114] In some implementations, the T-DU configuration can be a CellGroupConfig IE. In other implementations, the T-DU configuration can include multiple configurations such as physical layer configurations, a MAC configuration, an RLC configuration, and/or the one or more random access configurations.

[0115] In some implementations, the T-DU **174**B identifies the UE **102** if the T-DU **174**B receives a UE identifier (e.g., a cell radio network temporary identifier (C-RNTI)) or a random access preamble from the UE **102** during the random access procedure. The UE identifier or random access preamble can be assigned by the T-DU **174**B, in some implementations.

[0116] In some implementations, the CU **172** in event **516** can send a UE Context Modification Request message including the handover command message to the S-DU **174**A. The S-DU **174**A in turn can send a UE Context Modification Response message to the CU **172**. In some implementations, the CU **172** can indicate not to stop data transmission to the UE **102** in the Context Modification Request message in response to the determination **504**, so that the S-DU **174**A continues communicating with the UE **102**. For example, the CU **172** may not include a "Transmission Action Indicator" IE in the Context Modification Request message, or include a "Transmission Action Indicator" IE set to "restart" in the Context Modification Request message to indicate not to stop data transmission to the UE **102**. In other implementations, the CU **172** can include an IE indicating DAPS handover in the Context Modification Request message so that the S-DU **174**A continues communicating with the UE **102**. In yet other implementations, the CU **172** in event **516** can send a DL RRC Message Transfer message (instead of the UE Context Modification Request message) including the handover command message to the S-DU **174**A.

[0117] FIGS. **6** through FIGS. **8** correspond to DAPS PSCell change scenarios in which a base station initiates a DAPS PSCell change procedure for a UE in SC or in DC. Particularly, FIG. **6** corresponds to DAPS PSCell change scenarios involving an SN change, and FIGS. **7** and **8** correspond to DAPS PSCell change scenarios maintaining the same SN.

[0118] Referring first to FIG. **6**, according to a DAPS PSCell change scenario **600**, the base station **104** operates as an MN for the UE **102**, the base station **106**A operates as an S-SN for the UE **102**, and the base station **106**B operates as a T-SN for the UE **102**.

[0119] Initially, the UE **102** in DC communicates **602** data with the MN **104** via PCell **124** by using an MN configuration, and with the S-SN **106**A via PSCell **126**A by using an SN configuration.

[0120] Later in time, the MN **104** determines **604** to initiate DAPS PSCell change involving an SN change (i.e., MN-initiated DAPS SN addition or change procedure) for the T-SN **106**B and the UE **102** to communicate via a T-PSCell **126**B, e.g., blindly or in response to detecting a suitable event, similar to those described with respect to FIG. **3**.

[0121] In response to the determination **604**, the MN **104** sends **612** an SN Addition Request message to the T-SN **106**B. In response, the T-SN **106**B generates **614** an RRC reconfiguration message and a DAPS PSCell change configuration (or a DAPS SN change indicator), and sends **613** the RRC reconfiguration message and the DAPS PSCell change configuration in an SN Addition Request Acknowledge message to the MN **104**. In some implementations, in response to the determination **604**, the MN **104** sends **615** an SN Release Request message (or alternatively, an SN Modification Request message) to the S-SN **106**A to request the S-SN **106**A to perform DAPS PSCell change or to continue communicating with the UE **102**. In other implementations, the MN **104** may not send an SN Release Request message (or alternatively, an SN Modification Request message) to the S-SN **106**A, causing the S-SN **106**A to continue communicating with the UE **102** as the S-SN **106**A is unaware of the DAPS SN change and therefore behaves as usual.

[0122] In response to receiving **615** the SN Release Request message or the SN Modification Request message, the S-SN **106**A continues communicating with the UE **102**, and subsequently sends **616** an SN Release Request Acknowledge message or an SN Modification Request Acknowledge message to the MN **104**, respectively.

[0123] In response to receiving **613** the RRC reconfiguration message and the DAPS PSCell change configuration from the T-SN **106**B, the MN **104** includes the RRC reconfiguration message and the DAPS PSCell change configuration in an RRC container message, and transmits **617** the RRC container message to the UE **102**. In response, the UE **102** transmits **618** an RRC container response message including an RRC reconfiguration complete message to the MN **104**. In some implementations, the MN **104** can send **619** an SN Reconfiguration Complete message to the T-SN **106**B in response to the RRC container response message. The events **604**, **612**, **614**, **613**, **615**, **616**, **617**, **618**, **619** are collectively referred to in FIG. **6** as the DAPS PSCell change preparation procedure **660**.

[0124] The DAPS PSCell change configuration enables the UE **102** to use a DAPS to communicate with the S-SN **106**A via PSCell **126**A and T-SN **106**B via T-PSCell **126**B (during and after a successful DAPS PSCell change). As such, in response to receiving **617** the RRC container message, the UE **102** and the S-SN **106**A continue **620** communicating with each other (i.e., in DC with the MN **104**) while the UE **102** attempts to perform DAPS PSCell change to the T-BS **106**B via T-PSCell **126**B in accordance with the RRC reconfiguration message included in the RRC container message. In attempting to perform the DAPS PSCell change, the UE **102** initiates **622** a random access procedure with the T-SN **106**B via T-PSCell **126**B, e.g., by using one or more random access configurations in the RRC reconfiguration message. After the T-SN **106**B identifies the UE **102** during the random access procedure (e.g., the UE **102** succeeds the contention resolution), the UE **102** communicates **626** in DC with MN **104** and the T-SN **106**B via T-PSCell **126**B by using configurations in the RRC configuration message, while continuing to communicate with the S-SN **106**A.

[0125] The MN **104** can send **628** a UE Context Release message to the S-SN **106**A after receiving **618** the RRC container response message. The S-SN **106**A stops **630** communicating with the UE **102** in response to or after receiving the UE Context Release message. Alternatively, the S-SN **106**A stops **630** communicating with the UE **102** if the S-SN **106**A does not receive DL data packets from the CN **110** (e.g., S-GW **112** or UPF **162**).

[0126] As the UE **102** no longer needs to use the DAPS to continue communicating with the S-SN **106**A, the T-SN **106**B can transmit **632** an RRC reconfiguration message that includes a DAPS release indicator to the UE **102**, e.g., via an SRB (e.g., SRB3) between the UE **102** and the T-SN **106**B or via the MN **104**. In response to the RRC reconfiguration message, the UE **102** can transmit **634** an RRC reconfiguration complete message to the T-SN **106**B via the SRB (e.g., SRB3) between the UE **102** and the T-SN **106**B or via the MN **104**, and stop **636** communicating with the S-SN **106**A. In some implementations, in response to the DAPS release indicator, a RF chip, receiver, or a transceiver of the UE **102** used to communicate with the S-SN **106**A during the DAPS PSCell change can enter into low power consumption mode, sleep mode, or be turned off entirely if the DAPS PSCell change is an inter-frequency DAPS PSCell change. The events **622**, **626**, **628**, **630**, **632**, **634** are collectively referred to in FIG. **6** as the DAPS PSCell change and DAPS release procedure **650**.

[0127] In some implementations, events **612**, **614**, and **613** occur before, after, or simultaneously with events **615**, **616**.

[0128] In some implementations, the S-SN **106**A sends a first sequence number (SN) Status Transfer message to the MN **104** after or in response to receiving **616** the SN Release Request message or the SN Modification Request message, and in turn, the MN **104** forwards content of the first SN Status Transfer message to the T-SN **106**B. The first SN Status Transfer message can convey a DL PDCP sequence number (SN) transmitter status for a DRB as a result of the DAPS PSCell change. The T-SN **106**B can configure the DRB using the DAPS PSCell change configuration. In one implementation, the DL PDCP SN transmitter status indicates PDCP SN and hyper frame number (HFN) of the first PDCP SDU that the S-SN **106**A forwards to the T-SN **106**B. The S-SN **106**A may not stop assigning PDCP SNs to DL PDCP SDUs or delivering UL packets in UL PDCP SDUs or UL PDCP SDUs to the UPF **162** until the S-SN **106**A sends a second (e.g., last) SN Status Transfer message or content of the second SN Status Transfer message to the T-SN **106**B via the MN **104**. The S-SN **106**A can send the second SN Status Transfer message to the MN **104** in response to or after the T-SN **106**B receiving **619** the SN Reconfiguration Complete message. In turn, the MN **104** can forward the second SN Status Transfer message (or the content of the second SN Status Transfer message) to the S-SN **106**A.

[0129] In some implementations, the MN **104** performs a Path Update procedure involving the CN **110** (e.g., MME **114**/S-GW **112** or AMF **164**/UPF **162**) to update the data path between the S-SN **106**A and the CN **110** to an updated data path between the T-SN **106**B and the CN **110** in response to or after transmitting the SN Reconfiguration Complete message or receiving an SN Status Transfer message from the S-SN **106**A. After updating the data path, the CN **110** sends DL data packets to the T-SN **106**B instead of the S-SN **106**A. In the Path Update procedure, the MN **104** (e.g., MeNB) in one implementation sends an E-RAB Modification Indication message to the MME **114**, which in turn performs a Bearer Modification procedure with the S-GW **112** upon receiving the E-RAB Modification Indication message. As a result, the S-GW **112** updates the data path to the T-SN **106**B. In another implementation, the MN **104** (e.g., Mng-eNB or MgNB) sends a PDU Session Resource Modify Indication message to the AMF **164**, which in turn performs a Bearer Modification procedure with the UPF **162** upon receiving the PDU Session Resource Modify Indication message. As a result, the UPF **162** updates the data path to the T-SN **106**B.

[0130] In some implementations, the MN **104** sends **628** the UE Context Release message to the S-SN **106**A after forwarding the second SN Status Transfer message or its content to the S-SN **106**A, or after completing the Path Update procedure.

[0131] In some implementations, after successfully completing the random access procedure, the UE **102** can start transmitting UL data PDUs to the T-SN **106**B via the cell **126**B, stop transmitting and retransmitting UL data PDUs to the S-SN **106**A, stop transmitting control signals on PUCCH(s) to the S-SN **106**A, stop transmitting new UL data PDUs to the S-SN **106**A while continuing to retransmit UL data PDU(s) to the S-SN **106**A, continue DL communication with the S-SN **106**A, and/or keep transmitting control signals to the S-SN **106**A until event **632** occurs or the DAPS release timer at the UE **102** expires, as described above with respect to FIG. **3**. In some implementations, the S-SN **106**A or T-SN **106**B configures a time value for the DAPS release timer in the RRC reconfiguration message. Upon receiving **617**, **632** the RRC reconfiguration message, the UE **102** starts the DAPS release timer. If the DAPS release timer expires, the UE **102** stops **636** communicating with the S-SN **106**A. Alternatively, the UE **102** uses a predetermined timer value if the S-SN **106**A or T-SN **106**B does not include the timer value in the RRC reconfiguration message.

[0132] In some implementations, the T-SN **106**B includes multiple configuration parameters in the RRC reconfiguration message to configure radio resources for the UE **102** to communicate with the T-SN **106**B via the PSCell **126**B. The multiple configuration parameters can configure physical layer, medium access control (MAC) layer, and radio link control bearers. The DAPS PSCell change configuration can be associated or specific to a radio bearer (e.g., DRB). For example, the T-SN **106**B can include the DAPS PSCell change configuration in an RB configuration (e.g., RadioBearerConfig IE, DRB-ToAddModList IE or DRB-ToAddMod IE) in the SN Addition Request Acknowledge message at event **613**, and the MN **104** can include the RB configuration in the RRC container message at event **617**. The S-SN **106**A can also configure the particular DRB and transmit a RB configuration configuring the particular DRB to the UE **102**.

[0133] In some implementations, the T-SN **106**B can configure SCell(s) of the T-SN **106**B in the multiple configuration parameters in the RRC reconfiguration message to configure radio resources for the UE **102** to communicate with the T-SN **106**B via the SCell(s). In one such implementation, the T-SN **106**B can include one or more SCell configurations configuring the SCell(s) and their states in the RRC reconfiguration message at event **614**, and the UE **102** can determine the states of the SCell(s) according to the one or more SCell configurations. Particularly, the T-SN **106**B can configure the SCell(s) to first be in deactivated state(s) while the UE **102** performs the DAPS procedure, and then transition to activated state(s) after releasing the DAPS at event **632**. The T-SN **106**B can transmit RRC message(s), MAC control element(s), or DCI command(s) to the UE **102** to configure the SCell(s) to be in activated state(s).

[0134] In some implementations, while performing the DAPS procedure, the UE **102** keeps an SCell of the S-SN **106**A in activated state if the SCell is configured at event **602**. The UE **102** can release the SCell of the S-SN **106**A in response to the DAPS release at event **632**. In other implementations, the T-SN **106**B can include a release indication of the SCell of the S-SN **106**A in the RRC reconfiguration message **614** that is transmitted to the UE **102**, and the UE **102** does not release the SCell in response to the RRC reconfiguration message at event **614**, and instead releases the SCell in response to the DAPS release at event **632**. In yet other implementations, the T-SN **106**B can include a release indication of the SCell of the S-SN **106**A in the RRC reconfiguration message at event **632** that is transmitted to the UE **102**, and the UE **102** does not release the SCell of the S-SN **106**A in response to the handover command message, and instead releases the SCell in response to the release indication.

[0135] In some implementations, the T-SN **106**B may not configure an SCell to the UE **102** in the RRC reconfiguration message. The T-SN **106**B can later transmit RRC reconfiguration message(s) to the UE **102** to configure SCell(s) of the T-SN **106**B. In response, the UE **102** can transmit an RRC reconfiguration complete message to the T-SN **106**B via the PSCell **126**B or a configured SCell for each of the RRC reconfiguration message(s).

[0136] In some implementations, the T-SN **106**B identifies the UE **102** if the T-SN **106**B receives a UE identifier (e.g., a C-RNTI) or a random access preamble from the UE **102** during the random access procedure. The UE identifier or random access preamble can be assigned by the T-SN **106**B, in some implementations.

[0137] If the S-SN **106**A is a gNB, the RRC reconfiguration message can be an RRCReconfiguration message and the RRC reconfiguration complete message can be an RRCReconfigurationComplete message as defined in 3GPP TS 38.331. If the S-SN **106**A is an ng-eNB, the RRC reconfiguration message can be an RRCConnectionReconfiguration message and the RRC reconfiguration complete message can be an RRCConnectionReconfigurationComplete message as defined in 3GPP TS 36.331.

Inter-Frequency DAPS PSCell Change

[0138] Similar to the manner in which the DAPS handover capability discussed above in FIG. **3** can indicate that the UE **102** is capable of inter-frequency DAPS handover for one or more frequency bands, or for FDD and/or TDD modes, the DAPS PSCell change capability can indicate that the UE **102** is capable of inter-frequency DAPS PSCell change for one or more frequency bands, or for FDD or TDD modes. The MN **104**, S-SN **106**A, or T-SN **106**B determines that the UE **102** is capable of the inter-frequency DAPS PSCell change for one or more frequency bands by referring to the DAPS PSCell change capability.

[0139] Similar to the manner in which the DAPS handover capability discussed above in FIG. **3** can indicate that the UE **102** is capable of DAPS handover which may or may not exclude the intra-frequency DAPS handover, the DAPS PSCell change capability can generally indicate that the UE **102** is capable of DAPS PSCell change which may or may not exclude the intra-frequency DAPS PSCell change. Similar to the manner in which the UE Capability IE discussed above in FIG. **3** can include one or more DC/CA band combination fields/IEs, the MN **104**, S-SN **106**A, T-SN **106**B can determine that the UE **102** is capable of the inter-frequency DAPS PSCell change by referring to the DAPS PSCell change capability and the DC/CA band combination field/IE in a similar manner described above in FIG. **3**.

[0140] In some implementations or scenarios, the cells **126**A and **126**B are similar to cells **124** and **126**B discussed above in FIG. **3**. Similar to the manner in which the S-BS **104** requests the T-BS **106**B to configure DAPS handover or non-DAPS inter-frequency handover in the Handover Request message discussed above in FIG. **3**, the MN **104** can request the DAPS PSCell change or non-DAPS PSCell change in the SN Addition Request message. Similar to the manner in which the T-BS **106**B configures cell **126**B in the handover command message discussed above in FIG. **3**, the T-BS **106**B configures the cell **126**B in the RRC reconfiguration message.

Intra-Frequency DAPS PSCell Change

[0141] Similar to the manner in which the DAPS handover capability discussed above in FIG. **3** can indicate that the UE **102** is capable of intra-frequency DAPS handover for one or more frequency bands, and similar to the manner in which the DAPS PSCell change capability can indicate that the UE **102** is capable of intra-frequency DAPS handover for FDD and/or TDD modes, the DAPS PSCell change capability can indicate that the UE **102** is capable of intra-frequency DAPS PSCell change for one or more frequency bands, or for FDD and/or TDD modes.

[0142] Similar to the manner in which the UE Capability IE discussed above in FIG. **3** can include one or more DC/CA band combination fields/IEs, the MN **104**, S-SN **106**A, T-SN **106**B can determine that the UE **102** is capable of the intra-frequency DAPS PSCell change by referring to the DAPS PSCell change capability and the DC/CA band combination field/IE in a similar manner described above in FIG. **3**.

[0143] In some implementations or scenarios, the cells **126**A and **126**B are similar to cells **124** and **126**B discussed above in FIG. **3**. Similar to the manner in which the S-BS **104** requests the T-BS **106**B to configure DAPS handover or non-DAPS intra-frequency handover in the Handover Request message discussed above in FIG. **3**, the MN **104** can request the DAPS PSCell change or non-DAPS PSCell change in the SN Addition Request message. Similar to the manner in which the T-BS **106**B configures cell **126**B in the handover command message discussed above in FIG. **3**, the T-SN **106**B configures the cell **126**B in the PSCell change command message.

Synchronous or Asynchronous DAPS PSCell Change

[0144] Similar to the manner in which the DAPS handover capability discussed above in FIG. **3** can indicate that the UE **102** is capable of synchronous DAPS handover and/or asynchronous DAPS handover (e.g., using “synchronous” and/or “asynchronous” indicators), the DAPS PSCell change capability indicates that the UE **102** is capable of synchronous DAPS PSCell change and/or asynchronous DAPS PSCell change.

[0145] Similar to the manner in which the S-BS **104** can send a Handover Request message to request the T-BS **106**B to prepare the DAPS handover or non-DAPS handover in the handover command message discussed above in FIG. **3**, the MN **104** can send an SN Addition Request message to request the T-SN **106**B to prepare the DAPS PSCell change or non-DAPS PSCell change in an RRC reconfiguration message.

[0146] In FIG. **7**, whereas in FIG. **6** the DAPS PSCell change scenario involves an SN change (i.e., a change from S-SN **106**A to T-SN **106**B), in FIG. **7** the DAPS PSCell change scenario **700** does not involve an SN change.

[0147] Initially, the UE **102** in DC communicates **702** data with the MN **104** via PCell **124** by using an MN configuration, and with the SN **106**A via PSCell **123** by using an SN configuration.

[0148] Later in time, whereas in FIG. **6** the MN **104** determines **604** to initiate DAPS PSCell change involving an SN change (i.e., MN-initiated DAPS SN addition or change procedure) for the T-SN **106**B and the UE **102** to communicate via a T-PSCell **126**B, in FIG. **7** the SN **106**A determines **704** to initiate DAPS PSCell change without involving an SN change (i.e., SN-initiated DAPS PSCell change procedure) for the SN **106**A and the UE **102** to communicate via a T-PSCell **126**A, e.g., blindly or in response to detecting a suitable event, similar to those described with respect to FIG. **3**.

[0149] In response to the determination **704**, the SN **106**A generates **714** an RRC reconfiguration message that includes a DAPS PSCell change configuration (or a DAPS PSCell change indicator), similar to event **614**, and transmits **717** the RRC reconfiguration message to the UE **102**.

[0150] The DAPS PSCell change configuration enables the UE **102** to use a DAPS to communicate with the SN **106**A via PSCell **123** and via T-PSCell **126**A (during and after a successful DAPS PSCell change). As such, in response to receiving **717** the RRC reconfiguration message, the UE **102** and the SN **106**A continue **720** communicating with each other (i.e., in DC with the MN **104**) while the UE **102** attempts to perform DAPS PSCell change to the T-PSCell **126**A in accordance with the RRC reconfiguration message. In attempting to perform the DAPS PSCell change, the UE **102** initiates **722** a random access procedure with the T-PSCell **126**A, e.g., by using one or more random access configurations in the RRC reconfiguration message. After the SN **106**A identifies the UE **102** during the random access procedure via the T-PSCell **126**A, the UE **102** communicates **726** in DC with MN **104** and the SN **106**A via the T-PSCell **126**A by using configurations in the RRC configuration message, while continuing to communicate via the PSCell **123**. The UE **102** can also send **724** an RRC reconfiguration complete message to the SN **106**A after performing the random access procedure.

[0151] After receiving **724** the RRC reconfiguration complete message or if the SN **106**A does not receive DL data packets from the CN **110** via PSCell **123**, the SN **106**A stops **730** communicating with the UE **102** via the PSCell **123**.

[0152] As the UE **102** no longer needs to use the DAPS to continue communicating with the SN **106**A via the PSCell **123**, the SN **106**A can transmit **732** an RRC reconfiguration message that includes a DAPS release indicator to the UE **102**, e.g., via an SRB (e.g., SRB3) between the UE **102** and the SN **106**A or via the MN **104**. In response to the RRC reconfiguration message, the UE **102** can transmit **734** an RRC reconfiguration complete message to the SN **106**A via the SRB (e.g., SRB3) between the UE **102** and the SN **106**A or via the MN **104**, and stop **736** communicating with the S-SN **106**A via the PCell **123**. The events **722**, **724**, **726**, **730**, **732**, **734** are collectively referred to in FIG. **7** as the DAPS PSCell change and DAPS release procedure **750**.

[0153] In FIG. **8**, in a DAPS PSCell change scenario **800**, the base station **106**, which serves as an SN, includes a CU **172** for the UE **102**, and two DUs **174** that operate as a source DU (S-DU) for the UE **102** and a target DU (T-DU) for the UE **102**, respectively. Alternatively, the base station **106**, includes a CU **172** for the UE **102**, and three DUs **174** that operate as a master DU (M-DU) for the UE **102**, a source DU (S-DU) for the UE **102**, and a target DU (T-DU) for the UE **102**, respectively.

[0154] Initially, the UE **102** in DC communicates **802** data with the MN **104** via cell **122** and the base station **106**A (which includes the CU **172** and S-DU **174**A) via PSCell **123** by using an SN configuration. Alternatively, the UE **102** in DC communicates **802** data with the M-DU **174** of the base station **106**A and the CU **172** and S-DU **174**A of the base station **106**A via PSCell **123** by using a BS configuration

[0155] Later in time, the CU **172** determines **804** to initiate DAPS PSCell change for the T-DU **174**B and the UE **102** to communicate via PSCell **126**A, e.g., blindly or in response to detecting a suitable event, similar to those described with respect to FIG. **3**. For example, the CU **172** initiates DAPS PSCell change in response to measurement result(s) obtained by the CU **172** from measurements on signals received from the UE **102** via S-DU **174**A.

[0156] In response to the determination **804**, the CU **172** sends **806** a UE Context Setup Request message to the T-DU **174**B. In response, the T-DU **174**B sends **808** a UE Context Setup Response message including a T-DU configuration to the CU **172**. In turn, the CU **172** generates **814** an RRC reconfiguration message which includes the T-DU configuration and a DAPS PSCell change configuration or an indication for the DAPS PSCell change configuration in a field or an IE. Then the CU **172** sends **816** the RRC reconfiguration message to the S-DU **174**A, which in turn transmits **818** the RRC reconfiguration message to the UE **102**.

[0157] The DAPS PSCell change configuration enables the UE **102** to use a DAPS to communicate with the S-DU **174**A via PSCell **123** as well as T-DU **174**B via T-PSCell **126**A using the T-DU configuration during and after a successful DAPS PSCell change. As such, in response to the RRC reconfiguration message, the UE **102** and the base station **106** continue **820** communicating with each other via the S-DU **174**A by using the BS configuration, while the UE **102** attempts to perform DAPS PSCell change to the T-DU **174**B via T-PSCell **126**A in accordance with the RRC reconfiguration message. In attempting to perform the DAPS PSCell change, the UE **102** initiates **822** a random access procedure with the T-DU **174**B, e.g., by using one or more random access configurations in the T-DU configuration. After gaining access to a control channel, the UE **102** transmits **823** an RRC reconfiguration complete message to the T-DU **174**B during or after successfully completing the random access procedure, which in turn sends **824** the RRC reconfiguration complete message to the CU **172**. After the T-DU **174**B identifies the UE **102** during the random access configuration, the UE **102** communicates **826** control signals and data with the CU **172** via the T-DU **174**B by using the T-DU configuration included in the RRC reconfiguration message. If the RRC reconfiguration message includes configurations (e.g., DAPS PSCell change configuration) generated by the CU **172**, the UE **102** communicates **826** with the CU **172** via the T-DU **174**B by using the configurations generated by the CU **172**.

[0158] After receiving **824** the RRC reconfiguration complete message, the CU **172** stops **830** communicating with the UE **102** via the S-DU **174**A. The CU **172** can then send **831** an RRC reconfiguration message that includes a DAPS release indicator to the T-DU **174**B, which in turn can send **832** the RRC reconfiguration message to the UE **102**. In some implementations, the CU **172** stops **830** communicating with the UE **102** after transmitting the RRC reconfiguration message to the T-DU **174**B. In response to the RRC reconfiguration message, the UE **102** can transmit **833** an RRC reconfiguration complete message to the T-DU **174**B and stop **836** communicating with the S-DU **174**A. In turn, the T-DU **174**B can send **834** the RRC reconfiguration complete message to the CU **172**.

[0159] As the UE **102** no longer needs to use the DAPS to continue communicating with the S-DU **174**A, the CU **172** can perform **840** a UE Context Release procedure with the S-DU **174**A in response to the RRC reconfiguration complete message. Particularly, the CU **172** sends a UE Context Release Command message to the S-DU **174**A, which in turn sends a UE Context Release Complete message to the CU **172** and stops communicating with the UE **102**. By performing the UE Context Release procedure in response to the RRC reconfiguration complete message, the CU **172** maintains the UE context longer relative to a non-DAPS PSCell change procedure when performing a DAPS PSCell change procedure. The events **822**, **823**, **824**, **826**, **830**, **831**, **832**, **833**, **834**, **840** are collectively referred to in FIG. **8** as the DAPS PSCell change and DAPS release procedure **850**.

[0160] In some implementations, the CU **172** in event **816** can send a UE Context Modification

Request message including the RRC reconfiguration message to the S-DU **174**A. The S-DU **174**A in turn can send a UE Context Modification Response message to the CU **172**. In some implementations, the CU **172** can indicate not to stop data transmission to the UE **102** in the Context Modification Request message in response to the determination **804**, so that the S-DU **174**A continues communicating with the UE **102**. For example, the CU **172** may not include a “Transmission Action Indicator” IE in the Context Modification Request message, or include a “Transmission Action Indicator” IE set to “restart” in the Context Modification Request message to indicate not to stop data transmission to the UE **102**. In other implementations, the CU **172** can include an IE indicating DAPS PSCell change in the Context Modification Request message so that the S-DU **174**A continues communicating with the UE **102**. In yet other implementations, the CU **172** in event **816** can send a DL RRC Message Transfer message (instead of the UE Context Modification Request message) including the RRC reconfiguration message to the S-DU **174**A.

[0161] FIG. **9** is a flow diagram depicting an example method **900**, implemented in a centralized unit of a base station (e.g., base station **104**), for preparing a user device (e.g., UE **102**) to perform DAPS handover, from a source distributed unit of the base station to a target distributed unit of the base station.

[0162] At block **902**, the centralized unit determines to perform DAPS handover from the source distributed unit to the target distributed unit for the user device (e.g., in event **504**).

[0163] At block **904**, the centralized unit determines whether the user device is configured with a DAPS (e.g., in event **504**). The centralized unit can determine whether the user device is configured with a DAPS according to a DAPS handover capability in a UE Capability IE of a message (e.g., in a UECapabilityInformation message) received from the user device, a core network, or another base station.

[0164] If the centralized unit determines that the user device is configured with the DAPS, at block **906**, the centralized unit sends, to the target distributed unit, a UE Context Setup Request message to request a DAPS handover configuration from the target distributed unit (e.g., in event **506**). Then, at block **908**, the centralized unit sends, to the source distributed unit, a message indicating to continue communicating with the user device until the user device successfully completes the DAPS handover to the target distributed unit using the DAPS handover configuration (e.g., in event **516**). The message can be a handover command message, a DL RRC Message Transfer message, or a UE Context Modification Request message.

[0165] If the centralized unit determines that the user device is not configured with the DAPS, at block **910**, the centralized unit sends, to the target distributed unit, a UE Context Setup Request message to request a non-DAPS handover configuration from the target distributed unit, and subsequently at block **912**, sends to the source distributed unit, a message indicating to stop communicating with the user device before the user device successfully completes the non-DAPS handover to the target distributed unit using the non-DAPS handover configuration. The message can be a handover command message, a DL RRC Message Transfer message, or a UE Context Modification Request message.

[0166] FIG. **10** is a flow diagram depicting an example method **1000**, implemented in a centralized unit of a base station (e.g., base station **104**), for preparing a user device (e.g., UE **102**) to perform DAPS PSCell change, from a source distributed unit of the base station to a target distributed unit of the base station.

[0167] At block **1002**, the centralized unit determines to perform DAPS PSCell change from the source distributed unit to the target distributed unit for the user device (e.g., in event **804**).

[0168] At block **1004**, the centralized unit determines whether the user device is configured with a DAPS (e.g., in event **804**). The centralized unit can determine whether the user device is configured with a DAPS according to a DAPS PSCell change capability in a UE Capability IE of a message (e.g., in a UECapabilityInformation message) received from the user device, a core network, or another base station.

[0169] If the centralized unit determines that the user device is configured with the DAPS, at block **1006**, the centralized unit sends, to the target distributed unit, a UE Context Setup Request message to request a DAPS PSCell change configuration from the target distributed unit (e.g., in event **806**). Then, at block **1008**, the centralized unit sends, to the source distributed unit, a message indicating to continue communicating with the user device until the user device successfully completes the DAPS PSCell change to the target distributed unit using the DAPS configuration (e.g., in event **516**). The message can be an RRC reconfiguration message, a DL RRC Message Transfer message, or a UE Context Modification Request message.
[0170] If the centralized unit determines that the user device is not configured with the DAPS, at block **1010**, the centralized unit sends, to the target distributed unit, a UE Context Setup Request message to request a non-DAPS PSCell change configuration from the target distributed unit, and subsequently at block **1012**, sends to the source distributed unit, a message indicating to stop communicating with the user device before the user device successfully completes the non-DAPS PSCell change to the target distributed unit using the non-DAPS PSCell change configuration. The message can be an RRC reconfiguration message, a DL RRC Message Transfer message, or a UE Context Modification Request message.
[0171] FIG. **11** is a flow diagram depicting an example method **1100** in a CU of a distributed base station for configuring a DAPS procedure at a UE communicating with the distributed base station via a source DU.
[0172] At block **1102**, the CU determines that the UE is to perform the DAPS procedure to disconnect from the source DU and connect to a target DU (e.g., in any one of events **504**, **804**).
[0173] At block **1104**, the CU transmits, to the source DU, an indication that the source DU is to continue communicating with the UE during the DAPS procedure (e.g., in any one of events **516**, **816**).
[0174] At block **1106**, the CU transmits, in response to determining that the UE has begun communicating with the target DU, a release indication to the target DU, the release indication causing the target DU to release the DAPS procedure (e.g., in any one of events **531**, **831**).
[0175] At block **1108**, the CU, subsequently to transmitting the release indication, causes the source DU to release the UE context (e.g., in any one of events **540**, **840**).
[0176] The following description may be applied to the description above.
[0177] A user device in which the techniques of this disclosure can be implemented (e.g., the UE **102**) can 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 can operate as an internet-of-things (IoT) device or a mobile-internet device (MID). Depending on the type, the user device can include one or more general-purpose processors, a computer-readable memory, a user interface, one or more network interfaces, one or more sensors, etc.
[0178] Certain embodiments are described in this disclosure as including logic or a number of components or modules. Modules may can 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 can 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.
[0179] When implemented in software, the techniques can be provided as part of the operating system, a library used by multiple applications, a particular software application, etc. The software can be executed by one or more general-purpose processors or one or more special-purpose processors.
[0180] Upon reading this disclosure, those of skill in the art will appreciate still additional and alternative structural and functional designs for handling mobility between base stations through the principles disclosed herein. Thus, while particular embodiments and applications have been illustrated and described, 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.
[0181] Example 1. A method in a central unit (CU) of a distributed base station for configuring a dual active protocol stack (DAPS) procedure at a UE communicating with the distributed base station via a source distributed unit (DU), the method comprising: transmitting, by the processing hardware and to the UE, a command to perform the DAPS procedure in order to disconnect from the source DU and connect to a target DU; transmitting, by the processing hardware and to the source DU, an indication that the source DU is to continue communicating with the UE during the DAPS procedure; in response to determining that the UE has begun communicating with the target DU, transmitting a release indication to the target DU, the release indication causing the target DU to release the DAPS procedure; and subsequently to transmitting the release indication, causing the source DU to release the UE context.
[0182] Example 2. The method of example 1, wherein the indication transmitted to the source DU is a Transmission Action Indicator information element (IE).
[0183] Example 3. The method of example 2, including assigning a “restart” value to the Transmission Action Indicator IE.
[0184] Example 4. The method of example 1, wherein the indication transmitted to the source DU is included in a handover command.
[0185] Example 5. The method of example 4, wherein the handover command is included in a UE Context Modification Request.
[0186] Example 6. The method of example 1, wherein causing the source DU to release the UE context includes transmitting a UE Context Release Command to the source DU.
[0187] Example 7. The method of example 6, further comprising: receiving, from the source DU and in response to the UE Context Release Command, a UE Context Release Complete message.
[0188] Example 8. The method of example 1, wherein the causing occurs concurrently with the target DU transmitting, to the UE, an indication that the DAPS procedure is released.
[0189] Example 9. The method of example 1, wherein the DAPS procedure is a handover procedure.
[0190] Example 10. The method of example 1, wherein the DAPS procedure is a DAPS primary secondary cell (PSCell) change procedure.

Claims

1. A method in a distributed unit (DU) of a distributed base station for managing a dual active protocol stack (DAPS) procedure at a User Equipment (UE) communicating with the distributed base station via the DU, the method comprising: receiving, from a central unit (CU) of the distributed base station, a first message indicating that the DU is to continue communicating with the UE during a DAPS procedure; and subsequent to the receiving of the first message, receiving,

from the CU, a second message indicating that the DU is to stop communicating with the UE.
2. The method of claim 1, wherein the first message is a DL RRC Message Transfer message.
3. The method of claim 1, wherein the first message is included in a handover command.
4. The method of claim 3, wherein the handover command is included in a UE Context Modification Request.
5. The method of claim 4, wherein the UE Context Modification Request excludes a Transmission Action Indicator field, the exclusion indicating that the DU is to continue communicating with the UE during the DAPS procedure.
6. The method of claim 4, wherein the UE Context Modification Request includes a Transmission Action Indicator indicative of a restart of communications with the UE, thereby indicating that the DU is to continue communicating with the UE during the DAPS procedure.
7. The method of claim 1, further comprising releasing a context of the UE.
8. The method of claim 7, wherein the second message is a UE Context Release Command and the releasing of the UE context is responsive to receiving the UE Context Release Command.
9. The method of claim 8, further comprising transmitting, to the CU and in response to the UE Context Release Command, a UE Context Release Complete message.
10. The method of claim 1, wherein the DAPS procedure is a DAPS handover procedure.
11. The method of claim 1, wherein the DAPS procedure is a DAPS primary secondary cell (PSCell) change procedure.
12. A distributed unit (DU) of a distributed base station for managing a dual active protocol stack (DAPS) procedure at a User Equipment (UE) communicating with the distributed base station via the DU, the DU comprising processing hardware and configured to: receive, from a central unit (CU) of the distributed base station, a first message indicating that the DU is to continue communicating with the UE during a DAPS procedure; and subsequent to the reception of the first message, receive, from the CU, a second message indicating that the DU is to stop communicating with the UE.
13. The DU of claim 12, wherein the first message is a DL RRC Message Transfer message.
14. The DU of claim 12, wherein the first message is included in a UE Context Modification Request of a handover command.
15. The DU of claim 14, wherein the UE Context Modification Request excludes a Transmission Action Indicator field, the exclusion indicating that the DU is to continue communicating with the UE during the DAPS procedure.
16. The DU of claim 14, wherein the UE Context Modification Request includes a Transmission Action Indicator indicative of a restart of communications with the UE, thereby indicating that the DU is to continue communicating with the UE during the DAPS procedure.
17. The DU of claim 12, wherein the processing hardware is further configured to release a context of the UE.
18. The DU of claim 17, wherein the second message is a UE Context Release Command received from the UE, and the release of the UE context is responsive to the UE Context Release Command.
19. The DU of claim 18, wherein the processing hardware is further configured to transmit, to the CU, a UE Context Release Complete message in response to the UE Context Release Command.
20. The DU of claim 12, wherein the DAPS procedure is a DAPS handover procedure.
21. The DU of claim 12, wherein the DAPS procedure is a DAPS primary secondary cell (PSCell) change procedure.