

METHODS AND APPARATUSES OF MRO FOR A FAILURE IN LTM PROCEDURE

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to methods and apparatuses of a Mobility Robustness Optimization (MRO) mechanism for a failure in a master cell group (MCG) L1/L2-Triggered Mobility (LTM) procedure or an LTM primary cell (PCell) switch procedure in a dual connectivity scenario, or in an LTM cell switch procedure in a single connectivity scenario.

BACKGROUND

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

SUMMARY

[0003] An article "a" before an element is unrestricted and understood to refer to "at least one" of those elements or "one or more" of those elements. The terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. As used herein, including in the claims, "or" as used in a list of items (e.g. a list of items prefaced by a phrase such as "at least one of" or "one or more of" or "one or both of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed

as a reference to a closed set of conditions. For example, an example step that is described as "based on condition A" may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be construed in the same manner as the phrase "based at least in part on. Further, as used herein, including in the claims, a "set" may include one or more elements.

[0004] In an LTM cell switch procedure from a source cell to a target cell in a single connectivity scenario, a centralized unit (CU) of a base station (BS) may be a node which generates an RRC Reconfiguration message for the LTM cell switch procedure or determines to initiate LTM configuration, or the CU may be a node which manages the source cell, or the CU may be a node which manages the target cell. In a master cell group (MCG) LTM procedure or an LTM PCell switch procedure from a source PCell to a target PCell in a dual connectivity scenario, the CU may be a node which generates an RRC Reconfiguration message for the MCG LTM/LTM PCell switch procedure or determines to initiate MCG LTM configuration, or the CU may be a node which manages the source PCell (e.g. source MN), or the CU may be a node which manages the target PCell (e.g. target MN).

[0005] Some implementations of the present disclosure provide a centralized unit (CU) of a base station (BS). The CU includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the CU to: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of a user equipment (UE), obtain failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and transmit the failure information to at least one distributed unit (DU) of the BS, wherein the at least one DU includes at least one of the following: a source DU; a target DU; or at least one candidate target DU. The at least one candidate target DU is configured by a network for the LTM cell switch procedure. In some embodiments, the target DU can be same as or different from the source DU, partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU.

[0006] In some implementations of the CU described herein, the processor is configured to cause the CU to: determine a failure type of the failure; and transmit information indicating the failure type to the at least one DU.

[0007] In some implementations of the CU described herein, the failure type includes at least one of the following: a first failure type which is defined as Too Late LTM cell switch, wherein the UE has received configuration information for the LTM cell switch procedure, but the failure occurs after the UE has stayed for a time period in the source cell or occurs before an LTM cell switch command for the LTM cell switch procedure is triggered to the UE, and the UE attempts to re-connect or re-establish a radio link connection in a cell other than the source cell; a second failure type which is defined as Too Early LTM cell switch, wherein the failure occurs shortly after a successful completion of LTM cell switch from the source cell to the target cell or occurs during an LTM execution, and the UE attempts to re-connect or re-establish a radio link connection in the source cell; or a third failure type which is defined as LTM cell switch to wrong cell, wherein the failure occurs shortly after the successful completion of the LTM cell switch from the source cell to the target cell or occurs during the LTM execution, and the UE attempts to re-connect or re-establish the radio link connection in the cell other than the source cell and the target cell.

[0008] In some implementations of the CU described herein, the processor is configured to cause the CU to: determine that the failure is of the first failure type, if the CU does not receive an LTM cell change notification message from the source DU, but receives a UE radio resource control (RRC) reestablishment request message or a UE RRC reconfiguration complete message from a cell other than the source cell; determine that the failure is of the second failure type, if the CU receives the LTM cell change notification message from the source DU, and receives the UE RRC reestablishment request message or the UE RRC reconfiguration complete message from the source cell; or determine that the failure is of the third failure type, if the CU receives the LTM cell change notification message from the source DU, and receives the UE RRC reestablishment request message or the UE RRC reconfiguration complete message from a cell other than the source cell and the target cell.

[0009] In some implementations of the CU described herein, if a failure recovery mechanism is applied in response to the occurrence of the failure, the failure type includes at least one of the following: a fourth failure type in which a cell selected for failure recovery

is not one of a first set of LTM candidate cells provided by the CU to the at least one DU; a fifth failure type in which the cell selected for failure recovery is one of the first set of LTM candidate cells, but not one of a second set of LTM candidate cells selected by the at least one DU; or a sixth failure type in which the cell selected for failure recovery is one of the second set of LTM candidate cells.

[0010] In some implementations of the CU described herein, if the failure type is the fourth failure type, the processor is configured to cause the CU to determine that the first set of LTM candidate cells provided by the CU is improper.

[0011] In some implementations of the CU described herein, if the failure type is the fifth failure type, the processor is configured to cause the CU to: determine that one or more wrong LTM candidate cells are selected by the at least one DU; and transmit, to the at least one DU, first information indicating that the one or more wrong LTM candidate cells are selected by the at least one DU.

[0012] In some implementations of the CU described herein, the processor is configured to cause the CU to receive one of the following from the at least one DU: information indicating that the CU made a right determination regarding the first information; or information indicating that the CU made a wrong determination regarding the first information.

[0013] In some implementations of the CU described herein, if the failure type is the sixth failure type, the processor is configured to cause the CU to: determine that a wrong LTM target cell is selected by the source DU; and transmit, to the source DU, second information indicating that the wrong LTM target cell is selected by the source DU.

[0014] In some implementations of the CU described herein, the processor is configured to cause the CU to receive one of the following from the source DU: information indicating that the CU made a right determination regarding the second information; or information indicating that the CU made a wrong determination regarding the second information.

[0015] In some implementations of the CU described herein, the processor is configured to cause the CU to: receive, from the at least one DU, third information indicating that one or more wrong LTM candidate cells are selected by the at least one DU, wherein the third information is determined by the at least one DU.

[0016] In some implementations of the CU described herein, the processor is configured to cause the CU to: receive, from the source DU, fourth information indicating that a wrong LTM target cell is selected by the source DU, wherein the fourth information is determined by the source DU.

[0017] In some implementations of the CU described herein, to obtain the failure information, the processor is configured to cause the CU to derive the failure information by itself or to receive the failure information which is stored or transmitted by the UE, and wherein the failure information includes at least one of the following: information regarding the source cell; information regarding a cell where the failure happens; information regarding an LTM candidate cell selected for failure recovery; information regarding a selected beam in the target cell; information regarding one or more neighbour cells; information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate cell; information indicating that the failure happens in the LTM cell switch procedure; information regarding at least one LTM candidate cell configured for the LTM cell switch procedure; cell configuration information for the at least one LTM candidate cell; a set of channel state information (CSI) resources for the LTM cell switch procedure; a reference configuration for the LTM cell switch procedure; time elapsed between reception of an LTM cell switch command and reception of a latest RRC reconfiguration message for the LTM cell switch procedure; time elapsed between the reception of the LTM cell switch command and the occurrence of the failure; or time elapsed between the occurrence of the failure and the failure information is transmitted by the UE.

[0018] In some implementations of the CU described herein, the processor is configured to cause the CU to receive fifth information from the at least one DU, and wherein the fifth information is related to the LTM cell switch procedure, or related to UE context, or related to a set of parameters or configurations used by the UE or a group of UEs involved in the LTM cell switch procedure.

[0019] In some implementations of the CU described herein, if the fifth information is generated by the source DU, the fifth information is received via one of the following: a UE context modification response message; a UL RRC message transfer message; or an LTM cell change notification message; and wherein if the fifth information is generated by the at least one candidate target DU, the fifth information is received via one of the following: a

UE context setup response message; a UE context modification response message; or an access success message.

[0020] In some implementations of the CU described herein, the processor is configured to cause the CU to transmit the fifth information back to the at least one DU.

[0021] In some implementations of the CU described herein, the processor is configured to cause the CU to detect whether a ping-pong event occurs, and wherein for the ping-pong event, after a successful completion of LTM cell switch from a first cell to a second cell, the UE is switched back to the first cell within a predefined time period or the UE successfully performs another LTM cell switch from the second cell back to the first cell.

[0022] In some implementations of the CU described herein, the processor is configured to cause the CU to detect that the ping-pong event occurs, based on at least one of the following: UE history information stored by the CU; UE history information received from the UE; at least one LTM cell change notification message received by the CU; or at least one access success message received by the CU.

[0023] In some implementations of the CU described herein, the processor is configured to cause the CU to transmit, to the at least one DU, information indicating an occurrence of the ping-pong event.

[0024] Some implementations of the present disclosure provide a processor for wireless communication, comprising at least one controller coupled with at least one memory and configured to cause the processor to: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of a user equipment (UE), obtain failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and transmit the failure information to at least one distributed unit (DU) of the BS, wherein the at least one DU includes at least one of the following: a source DU; a target DU; or at least one candidate target DU. The at least one candidate target DU is configured by a network for the LTM cell switch procedure. In some embodiments, the target DU can be same as or different from the source DU, partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU.

[0025] Some implementations of the present disclosure provide a method performed by centralized unit (CU) of a base station (BS). The method includes: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of a user equipment (UE), obtaining failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and transmitting the failure information to at least one distributed unit (DU) of the BS, wherein the at least one DU includes at least one of the following: a source DU; a target DU; or at least one candidate target DU. The at least one candidate target DU is configured by a network for the LTM cell switch procedure. In some embodiments, the target DU can be same as or different from the source DU, partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU.

[0026] Some implementations of the present disclosure provide a distributed unit (DU) of a base station (BS). The DU includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the DU to: receive failure information related to a L1/L2-Triggered Mobility (LTM) cell switch procedure from a centralized unit (CU) of the BS, wherein a failure happens in the LTM cell switch procedure, and the failure includes at least one of an LTM execution failure or a radio link failure (RLF).

[0027] In some implementations of the DU described herein, the processor is configured to cause the DU to receive information indicating a failure type of the failure from the CU.

[0028] In some implementations of the DU described herein, the failure type includes at least one of the following: a first failure type which is defined as Too Late LTM cell switch, wherein the UE has received configuration information for the LTM cell switch procedure, but the failure occurs after the UE has stayed for a time period in the source cell or occurs before an LTM cell switch command for the LTM cell switch procedure is triggered to the UE, and the UE attempts to re-connect or re-establish a radio link connection in a cell other than the source cell; a second failure type which is defined as Too Early LTM cell switch, wherein the failure occurs shortly after a successful completion of LTM cell switch from the source cell to the target cell or occurs during an LTM execution, and the UE attempts to re-connect or re-establish a radio link connection in the source cell; or a third failure type which

is defined as LTM cell switch to wrong cell, wherein the failure occurs shortly after the successful completion of the LTM cell switch from the source cell to the target cell or occurs during the LTM execution, and the UE attempts to re-connect or re-establish the radio link connection in the cell other than the source cell and the target cell.

[0029] In some implementations of the DU described herein, if a failure recovery mechanism is applied in response to the occurrence of the failure, the failure type includes at least one of the following: a fourth failure type in which a cell selected for failure recovery is not one of a first set of LTM candidate cells provided by the CU to at least one DU; a fifth failure type in which the cell selected for failure recovery is one of the first set of LTM candidate cells, but not one of a second set of LTM candidate cells selected by the at least one DU; or a sixth failure type in which the cell selected for failure recovery is one of the second set of LTM candidate cells.

[0030] In some implementations of the DU described herein, if the failure type is the fifth failure type, the processor is configured to cause the DU to receive, from the CU, first information indicating that one or more wrong LTM candidate cells are selected by the DU.

[0031] In some implementations of the DU described herein, the processor is configured to cause the DU to verify whether the one or more wrong LTM candidate cells are selected by the DU.

[0032] In some implementations of the DU described herein, the processor is configured to cause the DU to transmit one of the following to the CU: information indicating that the CU made a right determination regarding the first information; or information indicating that the CU made a wrong determination regarding the first information.

[0033] In some implementations of the DU described herein, if the failure type is the sixth failure type, the processor is configured to cause the DU to receive, from the CU, second information indicating that a wrong LTM target cell is selected by the DU.

[0034] In some implementations of the DU described herein, the processor is configured to cause the DU to verify whether the wrong LTM target cell is selected by the DU.

[0035] In some implementations of the DU described herein, the processor is configured to cause the DU to transmit one of the following to the CU: information indicating that the

CU made a right determination regarding the second information; or information indicating that the CU made a wrong determination regarding the second information.

[0036] In some implementations of the DU described herein, the processor is configured to cause the DU to: determine whether one or more wrong LTM candidate cells are selected by the DU; and if the one or more wrong LTM candidate cells are selected by the DU, transmit, to the CU, third information indicating that the one or more wrong LTM candidate cells are selected by the DU.

[0037] In some implementations of the DU described herein, the processor is configured to cause the DU to: determine whether a wrong LTM target cell is selected by the DU; and if the wrong LTM target cell is selected by the DU, transmit, to the CU, fourth information indicating that the wrong LTM target cell is selected by the DU.

[0038] In some implementations of the DU described herein, the failure information is derived by the CU itself or received by the CU, and wherein the failure information includes at least one of the following: information regarding the source cell; information regarding a cell where the failure happens; information regarding an LTM candidate cell selected for failure recovery; information regarding a selected beam in the target cell; information regarding one or more neighbour cells; information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate cell; information indicating that the failure happens in the LTM cell switch procedure; information regarding at least one LTM candidate cell configured for the LTM cell switch procedure; cell configuration information for the at least one LTM candidate cell; a set of channel state information (CSI) resources for the LTM cell switch procedure; a reference configuration for the LTM cell switch procedure; time elapsed between reception of an LTM cell switch command cell and reception of a latest RRC reconfiguration message for the LTM cell switch procedure; time elapsed between the reception of the LTM cell switch command and the occurrence of the failure; or time elapsed between the occurrence of the failure and the failure information is transmitted by the UE.

[0039] In some implementations of the DU described herein, the processor is configured to cause the DU to generate fifth information and transmit the fifth information to the CU, and wherein the fifth information is related to the LTM cell switch procedure, or related to

UE context, or related to a set of parameters or configurations used by the UE or a group of UEs involved in the LTM cell switch procedure.

[0040] In some implementations of the DU described herein, the fifth information is transmitted via one of the following: a UE context modification response message; a UL RRC message transfer message; an LTM cell change notification message; a UE context setup response message; or an access success message.

[0041] In some implementations of the DU described herein, the processor is configured to cause the DU to receive the fifth information from the CU.

[0042] In some implementations of the DU described herein, the processor is configured to cause the DU to receive, from the CU, information indicating an occurrence of a ping-pong event, and wherein for the ping-pong event, after a successful completion of LTM cell switch from a first cell to a second cell, the UE is switched back to the first cell within a predefined time period or the UE successfully performs another LTM cell switch from the second cell back to the first cell.

[0043] In some implementations of the DU described herein, the occurrence of the ping-pong event is detected based on at least one of the following: UE history information stored by the CU; UE history information received from the UE; at least one LTM cell change notification message received by the CU; or at least one access success message received by the CU.

[0044] Some implementations of the present disclosure provide a processor for wireless communication, comprising at least one controller coupled with at least one memory and configured to cause the processor to: receive failure information related to a L1/L2-Triggered Mobility (LTM) cell switch procedure from a centralized unit (CU) of the BS, wherein a failure happens in the LTM cell switch procedure, and the failure includes at least one of an LTM execution failure or a radio link failure (RLF).

[0045] Some implementations of the present disclosure provide a method performed by a network node. The method includes: receiving failure information related to a L1/L2-Triggered Mobility (LTM) cell switch procedure from a centralized unit (CU) of the BS, wherein a failure happens in the LTM cell switch procedure, and the failure includes at least one of an LTM execution failure or a radio link failure (RLF).

[0046] Some implementations of the present disclosure provide a user equipment (UE). The UE includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the UE to: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of the UE, store failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and transmit the failure information.

[0047] In some implementations of the UE described herein, a failure type of the failure includes at least one of the following: a first failure type which is defined as Too Late LTM cell switch, wherein the UE has received configuration information for the LTM cell switch procedure, but the failure occurs after the UE has stayed for a time period in the source cell or occurs before an LTM cell switch command for the LTM cell switch procedure is triggered to the UE, and the UE attempts to re-connect or re-establish a radio link connection in a cell other than the source cell; a second failure type which is defined as Too Early LTM cell switch, wherein the failure occurs shortly after a successful completion of LTM cell switch from the source cell to the target cell or occurs during an LTM execution, and the UE attempts to re-connect or re-establish a radio link connection in the source cell; or a third failure type which is defined as LTM cell switch to wrong cell, wherein the failure occurs shortly after the successful completion of the LTM cell switch from the source cell to the target cell or occurs during the LTM execution, and the UE attempts to re-connect or re-establish the radio link connection in the cell other than the source cell and the target cell.

[0048] In some implementations of the UE described herein, if a failure recovery mechanism is applied in response to the occurrence of the failure, a failure type of the failure includes at least one of the following: a fourth failure type in which a cell selected for failure recovery is not one of a first set of LTM candidate cells provided by a centralized unit (CU) of a base station (BS) involved in the LTM cell switch procedure to at least one DU of the BS; a fifth failure type in which the cell selected for failure recovery is one of the first set of LTM candidate cells, but not one of a second set of LTM candidate cells selected by the at least one DU; or a sixth failure type in which the cell selected for failure recovery is one of the second set of LTM candidate cells. The at least one DU includes at least one of the following: a source DU; a target DU; or at least one candidate target DU. The at least one

candidate target DU is configured by a network for the LTM cell switch procedure. In some embodiments, the target DU can be same as or different from the source DU, partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU.

[0049] In some implementations of the UE described herein, the failure information includes at least one of the following: information regarding the source cell; information regarding a cell where the failure happens; information regarding an LTM candidate cell selected for failure recovery; information regarding a selected beam in the target cell; information regarding one or more neighbour cells; information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate cell; information indicating that the failure happens in the LTM cell switch procedure; information regarding at least one LTM candidate cell configured for the LTM cell switch procedure; cell configuration information for the at least one LTM candidate cell; a set of channel state information (CSI) resources for the LTM cell switch procedure; a reference configuration for the LTM cell switch procedure; time elapsed between reception of an LTM cell switch command and reception of a latest RRC reconfiguration message for the LTM cell switch procedure; time elapsed between the reception of the LTM cell switch command and the occurrence of the failure; or time elapsed between the occurrence of the failure and the failure information is transmitted by the UE.

[0050] Some implementations of the present disclosure provide a processor for wireless communication, comprising at least one controller coupled with at least one memory and configured to cause the processor to: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of the UE, store failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and transmit the failure information.

[0051] Some implementations of the present disclosure provide a method performed by a user equipment (UE). The method includes: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of the UE, storing failure information related to the LTM cell switch procedure,

wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and transmitting the failure information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0052] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.

[0053] Figure 2 illustrates an example of a user equipment (UE) 200 in accordance with aspects of the present disclosure.

[0054] Figure 3 illustrates an example of a processor 300 in accordance with aspects of the present disclosure.

[0055] Figure 4 illustrates an example of a network equipment (NE) 400 in accordance with aspects of the present disclosure.

[0056] Figure 5A illustrates a schematic diagram of an intra-CU intra-DU mobility scenario in accordance with aspects of the present disclosure.

[0057] Figure 5B illustrates a schematic diagram of an intra-CU inter-DU mobility scenario in accordance with aspects of the present disclosure.

[0058] Figure 5C illustrates a schematic diagram of an inter-CU mobility scenario in accordance with aspects of the present disclosure.

[0059] Figure 6 illustrates a schematic diagram of an inter-DU intra-CU LTM procedure for intra-NR in accordance with aspects of the present disclosure.

[0060] Figures 7 and 8 illustrate flowcharts of a method related to an LTM cell switch procedure in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0061] In general, when a UE moves from one cell to another cell, at some point a serving cell change needs to be performed. In the legacy, the serving cell change is done by explicit RRC reconfiguration signalling (e.g. a handover (HO) command) to trigger the synchronization of a target cell based on L3 measurements report. It leads to longer latency, larger overhead, and longer interruption time than beam level mobility. Therefore, in 3GPP,

LTM was approved to change a serving cell via L1/L2 signalling, in order to reduce the latency, overhead and interruption time.

[0062] LTM is a procedure in which a BS receives L1 measurement report(s) from a UE, and on their basis the BS changes UE's serving cell by a cell switch command signaled via a medium access control (MAC) control element (CE), e.g. LTM cell switch MAC CE or LTM Command MAC CE. The cell switch command indicates an LTM target cell e.g. an LTM candidate cell configuration that the BS previously prepared and provided to the UE through RRC signalling. Then the UE switches to the LTM target cell according to the cell switch command. The LTM procedure can be used to reduce the mobility latency.

[0063] In some cases, subsequent LTM may be supported. Subsequent LTM means subsequent LTM cell switch procedures between LTM candidate cells where the UE does not need to be reconfigured by the network in between.

[0064] A supervision timer can be used to detect failure of LTM execution or LTM cell switch procedure, wherein LTM procedure fails if the LTM supervision timer expires, upon which the UE initiates an RRC connection re-establishment procedure. For example, legacy T304 timer is used as the supervision timer to supervision the LTM cell switch procedure.

[0065] "LTM candidate cell" refers to a candidate cell configured to a UE for LTM. There may be multiple LTM candidate cells prepared for the UE, where the LTM candidate cells may belong to the same or different candidate DUs.

[0066] "LTM candidate cell configuration" refers to a configuration associated with an LTM candidate cell. An LTM candidate cell configuration can be a complete LTM candidate cell configuration or a delta (difference) configuration with respect to an LTM reference configuration. Each LTM candidate cell configuration may be identified by an index, called as LTM candidate cell configuration index, LTM candidate configuration index, or other names. In one example, the LTM candidate cell configuration index is LTM-CandidateId, which is used to identity an LTM candidate cell configuration.

[0067] "LTM Reference Configuration" refers to a configuration provided by the network to the UE that is common to all the configured LTM candidate cells. It is used by the UE to generate a complete LTM candidate cell configuration (i.e., by applying an LTM candidate cell configuration on top of an LTM reference configuration).

[0068] "Complete LTM Candidate Cell Configuration" refers to a configuration that contains all the necessary fields needed to perform an LTM cell switch procedure. This configuration can be an LTM candidate cell configuration itself or be generated by applying an LTM candidate cell configuration on top of an LTM reference configuration.

[0069] MCG LTM or LTM PCell switch in a dual connectivity scenario is a PCell switch procedure that the network triggers via a MAC CE based on L1 measurements. LTM cell switch procedure from a source cell to a target cell in a single connectivity scenario is a cell switch procedure that the network triggers via a MAC CE based on L1 measurements. The potential applicable scenarios of MCG LTM or LTM cell switch include "intra-CU intra-DU LTM," "intra-CU inter-DU LTM," and "inter-CU LTM" as shown in Figures 5A-5C as described below.

- (1) Intra-CU intra-DU mobility: a UE moves between different cells within a DU.
- (2) Intra-CU inter-DU mobility: a UE moves between different cells belonging to different DUs but within a CU.
- (3) Inter-CU mobility: a UE moves between different cells belonging to different DUs different CUs.

[0070] Upon an LTM execution failure or LTM cell switch failure (i.e., supervision timer expiry) or an RLF, LTM fast failure recovery mechanism may be supported: a UE performs a cell selection; if the selected cell is an LTM candidate cell, the UE performs RACH-based LTM cell switch on the selected cell (network-controlled); and if the selected cell is not an LTM candidate cell, the UE transmits an RRC re-establishment request.

[0071] In general, one of the functions of MRO is to detect connection failures that occur due to Too Early or Too Late Handovers, or Handover to Wrong Cell. These problems are defined as follows:

- (1) Intra-system Too Late Handover: an RLF occurs after the UE has stayed for a long period of time in the cell; the UE attempts to re-establish the radio link connection in a different cell.

- (2) Intra-system Too Early Handover: an RLF occurs shortly after a successful handover from a source cell to a target cell or a handover failure occurs during the handover procedure; the UE attempts to re-establish the radio link connection in the source cell.
- (3) Intra-system Handover to Wrong Cell: an RLF occurs shortly after a successful handover from a source cell to a target cell or a handover failure occurs during the handover procedure; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the target cell.

[0072] In the definition above, the "successful handover" refers to the UE state, namely the successful completion of the RA procedure. In case of CHO, the Too Late Handover, Too Early Handover and Handover to Wrong Cell in the definition above means Too Late CHO Execution, Too Early CHO Execution and CHO Execution to Wrong Cell.

[0073] A failure indication may be initiated after a UE attempts to re-establish the radio link connection at NG-RAN node B after a failure at NG-RAN node A. NG-RAN node B may initiate the Failure Indication procedure towards multiple NG-RAN nodes if they control cells which use the PCI signalled by the UE during the re-establishment procedure. The NG-RAN node receiving this selects the UE context that matches the received Failure Cell ID and C-RNTI, and, if available, uses the shortMAC-I to confirm this identification, by calculating the shortMAC-I and comparing it to the received IE.

[0074] A failure indication may also be sent to the node last serving the UE when the NG-RAN node fetches the RLF REPORT from UE by triggering:

- (1) The Failure Indication procedure over Xn interface.
- (2) The Uplink RAN configuration transfer procedure and Downlink RAN configuration transfer procedure over NG.

[0075] In case of Too Early Handover or Handover to Wrong Cell, the NG-RAN node receiving the failure indication may inform the NG-RAN node controlling the cell where the mobility configuration caused the failure by means of the Handover Report procedure over Xn or the Uplink RAN Configuration Transfer procedure over NG. This may include the RLF report.

[0076] After RLF or Handover failure, a UE will perform re-establishment in a cell. The UE will store some information related with an RLF failure and/or handover failure information. The UE stores the latest RLF Report, including an RLF report until the RLF report is fetched by the network or for 48 hours after the connection failure is detected. For analysis of connection failures, the UE makes the RLF report available to the network. The availability of the RLF report may be indicated by an RRC setup complete message, an RRC resume complete message or an RRC re-establishment complete message, e.g. if the UE has failure related information available in VarRLF-Report, it can include rlf-InfoAvailable in the RRC setup complete message, the RRC resume complete message or the RRC re-establishment complete message. The network may fetch information of an RLF report via UE Information Request/Response mechanism, i.e. a BS may transmit a UE information request message to UE. Then, the UE will transmit a UE information response message including the RLF report to network. The network can optimize the mobility problem based on the response from the UE.

[0077] One objective for mobility enhancements in 3GPP Rel-18 is to specify an MCG LTM procedure in a dual connectivity scenario (i.e. a PCell switch procedure triggered by a network via a MAC CE based on L1 measurement result(s)), or an LTM cell switch procedure in a single connectivity scenario (i.e. a cell switch procedure triggered by a network via a MAC CE based on L1 measurement result(s)). In an MCG LTM or LTM cell switch procedure, an LTM execution failure or an RLF may happen. To improve mobility robustness, following issues regarding an MRO mechanism for an LTM cell switch or MCG LTM procedure need to be considered, including, e.g., what is failure type definition(s) for an LTM cell switch or LTM PCell switch, what information needs to be reported from a UE for the network to perform MRO optimization for LTM related configurations, and how a network performs failure detection or analysis, e.g. signalling exchange between a CU and one or more relevant DUs.

[0078] Currently, details regarding an MRO mechanism for a failure in an LTM cell switch or MCG LTM procedure have not been discussed yet. Embodiments of the present disclosure aim to resolve the abovementioned issues. Some embodiments of the present application define failure type definition(s) for an LTM cell switch or LTM PCell switch in

case that LTM failure recovery mechanism is applied upon a connection failure (e.g. an LTM execution failure or an RLF) happens.

[0079] Some embodiments of the present disclosure study an MRO mechanism for an LTM cell switch or MCG LTM procedure. More specifically, in some embodiments of the present disclosure, to enable MRO analysis and optimization for an LTM cell switch or MCG LTM procedure, a UE may store or report LTM specific information or LTM related failure information. In some other embodiments of the present disclosure, a CU which generates an RRC reconfiguration message for LTM may derive LTM specific information or LTM related failure information by itself. For instance, the LTM specific information or LTM related failure information may include at least one of the following:

- (1) an indication concerning that a failure happens in an LTM procedure or a connection failure due to LTM, e.g. introduce a new type for last mobility type (e.g. an LTM cell switch); or an explicit indication of the type of an LTM cell switch; or a new one-bit flag (to add an indicator in the failure report indicating whether the last executed mobility before the connection failure was an LTM cell switch);
- (2) a set of configured LTM candidate cell(s);
- (3) a reference configuration for LTM;
- (4) a set of LTM candidate cell configurations, wherein each configuration is used to configure an LTM candidate cell;
- (5) time elapsed between reception of an LTM cell switch command (e.g. a MAC CE) and when the corresponding latest RRC reconfiguration message for LTM is received;
- (6) time elapsed between when an LTM execution towards a target cell/PCell is triggered and when the corresponding latest RRC reconfiguration message for LTM is received;
- (7) time elapsed between reception of an LTM cell switch command (e.g. a MAC CE) and when a connection failure occurs; or
- (8) time elapsed between when an LTM execution towards a target cell/PCell is triggered and when a connection failure occurs.

[0080] In some embodiments of the present disclosure, a CU serves a UE at the last initialisation of an LTM procedure, or which generates or sends an RRC reconfiguration message for the LTM procedure to the UE. In an LTM cell switch procedure from a source cell to a target cell in a single connectivity scenario, the CU may be a node which generates an RRC Reconfiguration message for the LTM cell switch procedure, or the CU may be a node which manages the source cell, or the CU may be a node which manages the target cell. For MRO detection or analysis in case that an LTM execution failure or an RLF happens, the CU may detect and indicate the failure type of Too Late LTM cell switch, or Too Early LTM cell switch, or LTM cell switch to wrong cell to the corresponding DU (e.g. at least one (candidate) target DU or a source DU). Furthermore, the CU may detect whether it is improper LTM candidate cell(s) provided by the CU, or wrong LTM candidate cell(s) selected by the (candidate) target DU, or a wrong LTM target cell selected at a source DU. Then, the CU may indicate the detected problem to the corresponding DU. Optionally, the corresponding DU may further verify whether the problem detected by the CU is correct. Then, the CU may indicate the detected problem to the corresponding DU. Optionally, the corresponding DU may further verify whether the problem detected by the CU is correct.

[0081] In a MCG LTM procedure or an LTM PCell switch procedure from a source PCell to a target PCell in a dual connectivity scenario, the CU may be a node which generates an RRC Reconfiguration message for the MCG LTM/LTM PCell switch procedure, or the CU may be a node which manages the source PCell (e.g. source MN), or the CU may be a node which manages the target PCell (e.g. target MN). For MRO detection or analysis in case that an MCG LTM execution failure or an MCG RLF happens, the CU may detect and indicate the failure type of Too Late LTM PCell switch, or Too Early LTM PCell switch, or LTM PCell switch to wrong cell to the corresponding DU (e.g. a (candidate) target DU or a source DU). Furthermore, the CU may detect whether it is improper LTM candidate cell(s) provided by the CU, or wrong LTM candidate cell(s) selected by the (candidate) target DU, or a wrong LTM target cell selected at a source DU. Then, the CU may indicate the detected problem to the corresponding DU. Optionally, the corresponding DU may further verify whether the problem detected by the CU is correct.

[0082] In some embodiments of the present disclosure, a CU may forward LTM related failure information to the corresponding DU. The corresponding DU may detect the problem. Optionally, the corresponding DU may indicate the detected problem to the CU.

[0083] In some embodiments of the present disclosure, to identify the UE context in a source DU or a (candidate) target DU when LTM related failure information is received, the source DU or the (candidate) target DU may create information (e.g. may be named as "a reference" or the like) related to the UE context. A CU may send the reference received from the source DU back to the source DU when sending the LTM related failure information to the source DU. Or, the CU may send the reference received from the (candidate) target DU back to the (candidate) target DU when sending the LTM related failure information to the (candidate) target DU.

[0084] More details of the embodiments of the present disclosure will be illustrated in the following text in combination with the appended drawings.

[0085] Figure 1 illustrates an example of a wireless communications system 100 in accordance with aspects of the present disclosure. The wireless communications system 100 may include one or more NE 102, one or more UE 104, and a core network (CN) 106. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an LTE network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a NR network, such as a 5G network, a 5G-Advanced (5G-A) network, or a 5G ultrawideband (5G-UWB) network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G, for example, 6G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0086] The one or more NE 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the NE 102 described herein

may be or include or may be referred to as a network node, a base station, a network element, a network function, a network entity, a radio access network (RAN), a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. An NE 102 and a UE 104 may communicate via a communication link, which may be a wireless or wired connection. For example, an NE 102 and a UE 104 may perform wireless communication (e.g. receive signaling, transmit signaling) over a Uu interface.

[0087] An NE 102 may provide a geographic coverage area for which the NE 102 may support services for one or more UEs 104 within the geographic coverage area. For example, an NE 102 and a UE 104 may support wireless communication of signals related to services (e.g. voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, an NE 102 may be moveable, for example, a satellite associated with a non-terrestrial network (NTN). In some implementations, different geographic coverage areas 112 associated with the same or different radio access technologies may overlap, but the different geographic coverage areas may be associated with different NE 102.

[0088] The one or more UE 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a remote unit, a mobile device, a wireless device, a remote device, a subscriber device, a transmitter device, a receiver device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples.

[0089] A UE 104 may be able to support wireless communication directly with other UEs 104 over a communication link. For example, a UE 104 may support wireless communication directly with another UE 104 over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link 114 may be referred to as a sidelink. For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0090] An NE 102 may support communications with the CN 106, or with another NE 102, or both. For example, an NE 102 may interface with other NE 102 or the CN 106 through one or more backhaul links (e.g. S1, N2, N2, or network interface). In some implementations, the NE 102 may communicate with each other directly. In some other implementations, the NE 102 may communicate with each other or indirectly (e.g. via the CN 106. In some implementations, one or more NE 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as a radio heads, smart radio heads, or transmission-reception points (TRPs).

[0091] The CN 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The CN 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g. a mobility management entity (MME), an access and mobility management functions (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g. a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g. data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more NE 102 associated with the CN 106.

[0092] The CN 106 may communicate with a packet data network over one or more backhaul links (e.g. via an S1, N2, N2, or another network interface). The packet data network may include an application server. In some implementations, one or more UEs 104 may communicate with the application server. A UE 104 may establish a session (e.g. a protocol data unit (PDU) session, or the like) with the CN 106 via an NE 102. The CN 106 may route traffic (e.g. control information, data, and the like) between the UE 104 and the application server using the established session (e.g. the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the CN 106 (e.g. one or more network functions of the CN 106).

[0093] In the wireless communications system 100, the NEs 102 and the UEs 104 may use resources of the wireless communications system 100 (e.g. time resources (e.g. symbols,

slots, subframes, frames, or the like) or frequency resources (e.g. subcarriers, carriers)) to perform various operations (e.g. wireless communications). In some implementations, the NEs 102 and the UEs 104 may support different resource structures. For example, the NEs 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the NEs 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the NEs 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The NEs 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0094] One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g. $\mu=0$) may be associated with a first subcarrier spacing (e.g. 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g. $\mu=0$) associated with the first subcarrier spacing (e.g. 15 kHz) may utilize one slot per subframe. A second numerology (e.g. $\mu=1$) may be associated with a second subcarrier spacing (e.g. 30 kHz) and a normal cyclic prefix. A third numerology (e.g. $\mu=2$) may be associated with a third subcarrier spacing (e.g. 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g. $\mu=3$) may be associated with a fourth subcarrier spacing (e.g. 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g. $\mu=4$) may be associated with a fifth subcarrier spacing (e.g. 240 kHz) and a normal cyclic prefix.

[0095] A time interval of a resource (e.g. a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (ms) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1 ms duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a frame may have the same duration.

[0096] Additionally or alternatively, a time interval of a resource (e.g. a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g. quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For

instance, the first, second, third, fourth, and fifth numerologies (i.e., $\mu=0$, $\mu=1$, $\mu=2$, $\mu=3$, $\mu=4$) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g. quantity) of symbols (e.g. OFDM symbols). In some implementations, the number (e.g. quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g. applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g. $\mu=0$) associated with a first subcarrier spacing (e.g. 15 kHz) may be used interchangeably between subframes and slots.

[0097] In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the NEs 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the NEs 102 and the UEs 104, among other equipment or devices for cellular communications traffic (e.g. control information, data). In some implementations, FR2 may be used by the NEs 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0098] FR1 may be associated with one or multiple numerologies (e.g. at least three numerologies). For example, FR1 may be associated with a first numerology (e.g. $\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g. $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g. $\mu=2$), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g. at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g. $\mu=2$),

which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g. $\mu=3$), which includes 120 kHz subcarrier spacing.

[0099] Figure 2 illustrates an example of a UE 200 in accordance with aspects of the present disclosure. The UE 200 may include a processor 202, a memory 204, a controller 206, and a transceiver 208. The processor 202, the memory 204, the controller 206, or the transceiver 208, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g. operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0100] The processor 202, the memory 204, the controller 206, or the transceiver 208, or various combinations or components thereof may be implemented in hardware (e.g. circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0101] The processor 202 may include an intelligent hardware device (e.g. a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 202 may be configured to operate the memory 204. In some other implementations, the memory 204 may be integrated into the processor 202. The processor 202 may be configured to execute computer-readable instructions stored in the memory 204 to cause the UE 200 to perform various functions of the present disclosure.

[0102] The memory 204 may include volatile or non-volatile memory. The memory 204 may store computer-readable, computer-executable code including instructions when executed by the processor 202 cause the UE 200 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such the memory 204 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0103] In some implementations, the processor 202 and the memory 204 coupled with the processor 202 may be configured to cause the UE 200 to perform one or more of the functions described herein (e.g. executing, by the processor 202, instructions stored in the memory 204). For example, in a single connectivity scenario, the processor 202 may support wireless communication at the UE 200 in accordance with examples as disclosed herein. In response to an occurrence of a failure associated with an LTM cell switch procedure from a source cell to a target cell of the UE 200, the UE 200 may be configured to support: a means for storing failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or an RLF, and a means for transmitting the failure information. For another example, in a dual connectivity scenario, the processor 202 may support wireless communication at the UE 200 in accordance with examples as disclosed herein. In response to an occurrence of a failure associated with an LTM PCell switch procedure from a source PCell to a target PCell of the UE 200, the UE 200 may be configured to support: a means for storing failure information related to the LTM PCell switch procedure, wherein the failure includes at least one of an LTM execution failure or an RLF, and a means for transmitting the failure information.

[0104] The controller 206 may manage input and output signals for the UE 200. The controller 206 may also manage peripherals not integrated into the UE 200. In some implementations, the controller 206 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 206 may be implemented as part of the processor 202.

[0105] In some implementations, the UE 200 may include at least one transceiver 208. In some other implementations, the UE 200 may have more than one transceiver 208. The transceiver 208 may represent a wireless transceiver. The transceiver 208 may include one or more receiver chains 210, one or more transmitter chains 212, or a combination thereof. The means for receiving abovementioned in the processor 202 or the means for transmitting in the processor 202 may be implemented via at least one transceiver 208.

[0106] A receiver chain 210 may be configured to receive signals (e.g. control information, data, packets) over a wireless medium. For example, the receiver chain 210 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 210 may include at least one amplifier (e.g. a low-noise amplifier (LNA))

configured to amplify the received signal. The receiver chain 210 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 210 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0107] A transmitter chain 212 may be configured to generate and transmit signals (e.g. control information, data, packets). The transmitter chain 212 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 212 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 212 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0108] Figure 3 illustrates an example of a processor 300 in accordance with aspects of the present disclosure. The processor 300 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 300 may include a controller 302 configured to perform various operations in accordance with examples as described herein. The processor 300 may optionally include at least one memory 304, which may be, for example, an L1/L2/L3 cache. Additionally, or alternatively, the processor 300 may optionally include one or more arithmetic-logic units (ALUs) 306. One or more of these components may be in electronic communication or otherwise coupled (e.g. operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g. buses).

[0109] The processor 300 may be a processor chipset and include a protocol stack (e.g. a software stack) executed by the processor chipset to perform various operations (e.g. receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g. memory local to or included in the processor chipset (e.g. the processor 300) or other memory (e.g. random

access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[0110] The controller 302 may be configured to manage and coordinate various operations (e.g. signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 300 to cause the processor 300 to support various operations in accordance with examples as described herein. For example, the controller 302 may operate as a control unit of the processor 300, generating control signals that manage the operation of various components of the processor 300. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[0111] The controller 302 may be configured to fetch (e.g. obtain, retrieve, receive) instructions from the memory 304 and determine subsequent instruction(s) to be executed to cause the processor 300 to support various operations in accordance with examples as described herein. The controller 302 may be configured to track memory address of instructions associated with the memory 304. The controller 302 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 302 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 300 to cause the processor 300 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 302 may be configured to manage flow of data within the processor 300. The controller 302 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 300.

[0112] The memory 304 may include one or more caches (e.g. memory local to or included in the processor 300 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 304 may reside within or on a processor chipset (e.g. local to the processor 300). In some other implementations, the memory 304 may reside external to the processor chipset (e.g. remote to the processor 300).

[0113] The memory 304 may store computer-readable, computer-executable code including instructions that, when executed by the processor 300, cause the processor 300 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 302 and/or the processor 300 may be configured to execute computer-readable instructions stored in the memory 304 to cause the processor 300 to perform various functions. For example, the processor 300 and/or the controller 302 may be coupled with or to the memory 304, the processor 300, the controller 302, and the memory 304 may be configured to perform various functions described herein. In some examples, the processor 300 may include multiple processors and the memory 304 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[0114] The one or more ALUs 306 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 306 may reside within or on a processor chipset (e.g. the processor 300). In some other implementations, the one or more ALUs 306 may reside external to the processor chipset (e.g. the processor 300). One or more ALUs 306 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 306 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 306 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 306 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 306 to handle conditional operations, comparisons, and bitwise operations.

[0115] The processor 300 may support wireless communication in accordance with examples as disclosed herein.

[0116] In some implementations, the processor 300 may be configured to support means for performing operations as described with respect to Figure 7. For example, in response to an occurrence of a failure associated with an LTM cell switch procedure from a source cell to a target cell of a UE or an occurrence of a failure associated with an LTM PCell switch

procedure from a source PCell to a target PCell of a UE, the processor 300 may be configured to or operable to support a means for obtaining failure information related to the LTM cell switch procedure or the LTM PCell switch procedure, wherein the failure includes at least one of an LTM execution failure or an RLF, and to support a means for transmitting the failure information to at least one DU of the BS, wherein the at least one DU includes at least one of the following: a source DU; a target DU; or at least one candidate target DU. The at least one candidate target DU is configured by a network for the LTM cell switch procedure or the LTM PCell switch procedure. In some embodiments, the target DU can be same as or different from the source DU, partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU.

[0117] In some implementations, the processor 300 may be configured to support means for performing operations as described with respect to Figure 8. For example, in response to an occurrence of a failure associated with an LTM cell switch procedure from a source cell to a target cell of the UE or an occurrence of a failure associated with an LTM PCell switch procedure from a source PCell to a target PCell of a UE, the processor 300 may be configured to or operable to support: a means for storing failure information related to the LTM cell switch procedure or the LTM PCell switch procedure, wherein the failure includes at least one of an LTM execution failure or an RLF; and a means for transmitting the failure information.

[0118] In some additional implementations, the processor 300 may be configured to support means for performing operations of a DU of a BS. For example, the processor 300 may be configured to or operable to support a means for receiving failure information related to an LTM cell switch procedure or an LTM PCell switch procedure from a CU of the BS, wherein a failure happens in the LTM cell switch procedure or the LTM PCell switch procedure, and the failure includes at least one of an LTM execution failure or an RLF.

[0119] It should be appreciated by persons skilled in the art that the components in exemplary processor 300 may be changed, for example, some of the components in exemplary processor 300 may be omitted or modified or new component(s) may be added to exemplary processor 300, without departing from the spirit and scope of the disclosure. For example, in some embodiments, the processor 300 may not include the ALUs 306.

[0120] Figure 4 illustrates an example of a NE 400 in accordance with aspects of the present disclosure. The NE 400 may include a processor 402, a memory 404, a controller 406, and a transceiver 408. The processor 402, the memory 404, the controller 406, or the transceiver 408, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. These components may be coupled (e.g. operatively, communicatively, functionally, electronically, electrically) via one or more interfaces.

[0121] The processor 402, the memory 404, the controller 406, or the transceiver 408, or various combinations or components thereof may be implemented in hardware (e.g. circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), or other programmable logic device, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure.

[0122] The processor 402 may include an intelligent hardware device (e.g. a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, or any combination thereof). In some implementations, the processor 402 may be configured to operate the memory 404. In some other implementations, the memory 404 may be integrated into the processor 402. The processor 402 may be configured to execute computer-readable instructions stored in the memory 404 to cause the NE 400 to perform various functions of the present disclosure.

[0123] The memory 404 may include volatile or non-volatile memory. The memory 404 may store computer-readable, computer-executable code including instructions when executed by the processor 402 cause the NE 400 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such the memory 404 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.

[0124] In some implementations, the processor 402 and the memory 404 coupled with the processor 402 may be configured to cause the NE 400 to perform one or more of the

functions described herein (e.g. executing, by the processor 402, instructions stored in the memory 404). For example, the processor 402 may support wireless communication at the NE 400 in accordance with examples as disclosed herein. For example, the NE 400 may be configured to support means for performing the operations as described with respect to Figure 6 or operations of a candidate target SN as described below.

[0125] In some implementations, the NE 400 may be a CU of a BS. In response to an occurrence of a failure associated with an LTM cell switch procedure from a source cell to a target cell of a UE or an occurrence of a failure associated with an LTM PCell switch procedure from a source PCell to a target PCell of a UE, the NE 400 may be configured to support: a means for obtaining failure information related to the LTM cell switch procedure or the LTM PCell switch procedure, wherein the failure includes at least one of an LTM execution failure or an RLF; and a means for transmitting the failure information to at least one DU of the BS, wherein the at least one DU includes at least one of the following: a source DU; a target DU; or at least one candidate target DU. The at least one candidate target DU is configured by a network for the LTM cell switch procedure or the LTM PCell switch procedure. In some embodiments, the target DU can be same as or different from the source DU, partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU.

[0126] In some implementations, the NE 400 may be a DU of a BS and configured to support a means for receiving failure information related to an LTM cell switch procedure or an LTM PCell switch procedure from a CU of the BS, wherein a failure happens in the LTM cell switch procedure or the LTM PCell switch procedure, and the failure includes at least one of an LTM execution failure or an RLF.

[0127] The controller 406 may manage input and output signals for the NE 400. The controller 406 may also manage peripherals not integrated into the NE 400. In some implementations, the controller 406 may utilize an operating system such as iOS®, ANDROID®, WINDOWS®, or other operating systems. In some implementations, the controller 406 may be implemented as part of the processor 402.

[0128] In some implementations, the NE 400 may include at least one transceiver 408. In some other implementations, the NE 400 may have more than one transceiver 408. The transceiver 408 may represent a wireless transceiver. The transceiver 408 may include one or more receiver chains 410, one or more transmitter chains 412, or a combination thereof. The means for receiving or the means for transmitting abovementioned in the processor 402 may be implemented via at least one transceiver 408.

[0129] A receiver chain 410 may be configured to receive signals (e.g. control information, data, packets) over a wireless medium. For example, the receiver chain 410 may include one or more antennas for receive the signal over the air or wireless medium. The receiver chain 410 may include at least one amplifier (e.g. a low-noise amplifier (LNA)) configured to amplify the received signal. The receiver chain 410 may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receiver chain 410 may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[0130] A transmitter chain 412 may be configured to generate and transmit signals (e.g. control information, data, packets). The transmitter chain 412 may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmitter chain 412 may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmitter chain 412 may also include one or more antennas for transmitting the amplified signal into the air or wireless medium.

[0131] It should be appreciated by persons skilled in the art that the components in exemplary NE 400 may be changed, for example, some of the components in exemplary NE 400 may be omitted or modified or new component(s) may be added to exemplary NE 400, without departing from the spirit and scope of the disclosure. For example, in some embodiments, the NE 400 may not include the controller 406.

[0132] Figure 5A illustrates a schematic diagram of an intra-CU intra-DU mobility scenario in accordance with aspects of the present disclosure. The wireless communication system in Figure 5A includes a DU, a UE (e.g. UE 101A), and some access nodes (e.g. access node 102A and access node 103A). The access node 102A and access node 103A are controlled by the DU, and provides services for UEs within cell #1 and cell #2 respectively. Even though there are only one UE and two access nodes in Figure 5A, persons skilled in the art will recognize that any number of UEs and access nodes may be included in the wireless communication system.

[0133] In Figure 5A, UE 101A is moving from cell #1 to cell #2, and may perform an LTM cell switch procedure from cell #1 to access to cell #2, which is an LTM cell switch procedure performed between different cells within a DU. This scenario may be referred to as intra-CU intra-DU mobility. In short, this scenario may be called as intra-DU mobility.

[0134] Figure 5B illustrates a schematic diagram of an intra-CU inter-DU mobility scenario in accordance with aspects of the present disclosure. The wireless communication system in Figure 5B includes a CU, a UE (e.g. UE 101B), and some DUs (e.g. DU #1 and DU #2). DU #1 and DU #2 are controlled by the CU, and provides services for UEs within cell #A and cell #B respectively. Even though there are only one UE and two DUs in Figure 5B, persons skilled in the art will recognize that any number of UEs and DUs may be included in the wireless communication system.

[0135] In Figure 5B, UE 101B is moving from cell #A to cell #B, and may perform an LTM cell switch procedure from cell #A to access to cell #B, which is an LTM cell switch procedure performed between different cells belonging to different DUs but within the same CU. This scenario may be referred to as intra-CU inter-DU mobility. In short, this scenario may be called as inter-DU mobility.

[0136] Figure 5C illustrates a schematic diagram of an inter-CU mobility scenario in accordance with aspects of the present disclosure. The wireless communication system in Figure 5C includes some CUs (e.g. CU #1 and CU #2), a UE (e.g. UE 101C), and some DUs (e.g. DU #A and DU #B). DU #A is controlled by CU #1 and provides services for UEs within cell #X. DU #B is controlled by CU #2 and provides services for UEs within cell #Y. Even though there are only one UE, two DUs, and two CUs in Figure 5C, persons skilled in

the art will recognize that any number of UEs, DUs, and CUs may be included in the wireless communication system.

[0137] In Figure 5C, UE 101C is moving from cell #X to cell #Y, and may perform an LTM cell switch procedure from cell #X to access to cell #Y, which is an LTM cell switch procedure performed between different cells belonging to different DUs within different CUs. This scenario may be referred to as inter-CU mobility.

[0138] Figure 6 illustrates a schematic diagram of an inter-DU intra-CU LTM procedure for intra-NR in accordance with aspects of the present disclosure. An inter-DU intra-CU LTM procedure is used for the case when a UE moves from one DU to another DU within the same CU during NR operation for LTM.

[0139] In the embodiments of Figure 6, a wireless communication system includes a UE, a source DU (which may also be referred to a serving DU, the source DU serves the UE before an LTM procedure is triggered), one or more candidate DUs (which may also be referred to as "target DU(s)," "(candidate) target DU(s)," "candidate target DU(s)" or "candidate DU(s)" in Figure 6), and a CU. The source DU and the one or more candidate DUs are within the CU. The UE is moving from the source DU to one of the one or more candidate DUs. The source DU may manage (or control) the serving cell of the UE, and one or more source cells. The serving cell and the one or more source cells are considered as in the source DU. Each candidate DU of the candidate DU(s) may manage one or more LTM candidate cells, and the one or more candidate cells are considered as in each candidate DU. One of the one or more candidate DUs manages the LTM candidate cell to which the UE may be switched. In some embodiments, the LTM candidate cell to which the UE may be switched to may be referred to as the "LTM candidate target cell." When one LTM candidate cell is selected as a target cell for LTM by the network or is indicated in the LTM cell switch MAC CE, the LTM candidate cell can be called as an LTM target cell. Then, the candidate DU which manages or controls the LTM candidate cell can be called as a target DU, i.e. the LTM target cell is managed by the target DU, and the LTM candidate cell is managed by the candidate target DU.

[0140] In operation 601, the UE sends a measurement report message to the source DU containing measurements of neighboring cells. The source DU sends an UL RRC message transfer message conveying the received measurement report message to the CU.

[0141] In operation 602, the CU determines to initiate LTM configuration.

[0142] In operation 603, the CU sends a UE context setup request message to the candidate DU, containing one target candidate cell ID. The CU indicates the source DU ID, and requests PRACH resources from the Candidate DU.

[0143] In operation 604, if the candidate DU accepts the request of LTM configuration, it responds with a UE context setup response message including the generated lower layer RRC configuration (e.g., transmission configuration indication (TCI) state configuration and RACH configuration) and the RS configuration for the accepted LTM candidate cell.

[0144] In operation 605, the CU sends a UE context modification request message to the source DU including the collected RS configuration, TCI state configuration and RACH configuration for the accepted LTM candidate cell(s) in other DUs.

[0145] In operation 606, the source DU responds with a UE context modification response message which may include the RS configuration of the source cell, prepared LTM candidate cells and the generated CSI resource configuration.

[0146] In operation 607, the CU sends a UE context modification request message to the candidate DU(s) containing the cell ID(s) of the prepared LTM candidate cell(s) and associated RS configuration for each LTM candidate cell in other candidate DU(s). In some cases, the source cell may be configured as one LTM candidate cell.

[0147] In operation 608, the candidate DU responds with a UE context modification response message including the generated CSI resource configuration.

[0148] In operation 609, the CU sends a DL RRC message transfer message to the source DU, which includes the generated RRC reconfiguration message with the LTM configuration.

[0149] In operation 610, the source DU forwards the received RRC reconfiguration message to the UE.

[0150] In operation 611, the UE responds to the source DU with an RRC reconfiguration complete message.

[0151] In operation 612, the source DU forwards the RRC reconfiguration complete message to the CU via an UL RRC message transfer message.

[0152] In operation 613, the UE sends the lower layer measurement result e.g. L1 measurement results to the source DU.

[0153] In operation 614, the source DU decides to execute LTM to an LTM candidate target cell.

[0154] In operation 615, the source DU sends an LTM command to the UE.

[0155] In operation 616, the source DU sends the LTM cell change notification message to the CU to indicate the initiation of the LTM command to the UE including the target cell ID and the selected beam information.

[0156] In operation 617, the CU sends the target cell ID and the selected beam information to the target DU.

[0157] In operation 618, the target DU detects the access of the UE.

[0158] In operation 619, the target DU sends the access success message to the CU with the target cell ID.

[0159] In operation 620 (optional), the CU may send a UE context release command message to the source DU to release the resources of prepared cells.

[0160] In operation 621 (optional), the source DU responds with a UE context release complete message.

[0161] Some embodiments of the present disclosure refer to an intra-DU intra-CU LTM procedure for intra-NR, wherein the serving or source cell and one or more LTM candidate cells are considered as in the same DU. A wireless communication system of the intra-DU LTM procedure includes a UE, a DU (which may also be referred to a source or serving DU, or candidate DU), and a CU. The source DU is within the CU. That is to say, different from the source DU and the candidate DU(s) in Figure 6, the intra-DU LTM procedure only refers to one DU, i.e. source DU and candidate DU(s) are the same node. In an intra-DU LTM

procedure, the messages transferred between the DU and the CU are similar as the messages transferred between the source DU or the one or more candidate DUs and the CU in an inter-DU LTM procedure as described in the embodiments of Figure 6.

[0162] In some embodiments of the present disclosure, in an LTM cell switch procedure (e.g. a cell change triggered by an LTM cell switch MAC CE), or in an MCG LTM procedure (e.g. a PCell change triggered by an LTM cell switch MAC CE), an LTM cell switch failure or an LTM execution failure (i.e., supervision timer T304 expiry) or a connection failure (e.g. an RLF) may happen. Upon a connection failure happens, an LTM failure recovery mechanism may be applied. Upon an LTM cell switch failure or an LTM execution failure or an RLF occurs, a UE may perform a cell selection. If the selected cell is an LTM candidate cell or one of the candidate cell(s) configured for LTM (e.g. included in the RRC reconfiguration message for LTM), the UE may perform a RACH-based LTM cell switch on the selected cell, or the UE may access to the selected cell, or the UE may perform LTM cell switch execution to the selected cell. If the selected cell is not an LTM candidate cell, the UE may trigger an RRC re-establishment request.

[0163] In some embodiments of the present disclosure, one of the functions of MRO is to detect event(s) or connection failure(s) that occur in an LTM cell switch procedure or in an MCG LTM procedure (i.e. an LTM PCell switch procedure). The event types may also be named as "problem types" or "failure types" or "case types" or the like. Some embodiments of the present disclosure define following event types in an LTM cell switch procedure or in an MCG LTM procedure procedure, i.e., Embodiments 1-1, 1-2, 1-3, and 1-4 as below.

[0164] Embodiment 1-1 (Too Late LTM cell switch)

[0165] The failure type of "Too Late LTM cell switch" may be defined as follows: a UE receives configuration information for an LTM procedure or an RRC reconfiguration message for an LTM procedure is configured to the UE, while an RLF occurs after the UE has stayed for a long time period in the serving cell; or, an RLF occurs before an LTM cell switch MAC CE is initiated or triggered to the UE; and the UE attempts to re-connect or re-establish the radio link connection in a different cell (i.e. a cell other than the source cell). "Too Late LTM cell switch" can also be named as "Too Late LTM" or "Too Late LTM PCell switch" or "Too Late MCG LTM" or "Too Late LTM for MCG" or other.

[0166] Embodiment 1-2 (Too Early LTM cell switch)

[0167] The failure type of "Too Early LTM cell switch" may be defined as follows: a radio link failure occurs shortly after a successful LTM cell switch from a source cell to a target cell, or a failure occurs during the LTM execution or the LTM cell switch fails; and the UE attempts to re-connect or re-establish the radio link connection in the source cell. "Too Early LTM cell switch" can also be named as "Too Early LTM" or "Too Early LTM PCell switch" or "Too Early MCG LTM" or "Too Early LTM for MCG" or other.

[0168] Embodiment 1-3 (LTM cell switch to wrong cell)

[0169] The failure type of "LTM cell switch to wrong cell" may be defined as follows: an RLF occurs shortly after a successful LTM cell switch from a source cell to a target cell or a failure occurs during the LTM execution or the LTM cell switch fails; and the UE attempts to re-connect or re-establish the radio link connection in a cell other than the source cell and the target cell. "LTM cell switch to wrong cell" can also be named as "LTM to wrong cell" or "LTM PCell switch to wrong cell" or "MCG LTM to wrong PCell" or "LTM for MCG to wrong cell" or other.

[0170] Embodiment 1-4 (ping-pong)

[0171] If subsequent LTM cell switch procedures are executed in a single connectivity scenario, or if subsequent LTM PCell switch procedures are executed in a dual connectivity scenario, one of the functions of MRO is to detect ping-pong that occur in the subsequent LTM cell or PCell switch procedures. Ping-pong may be named as "ping-pong event" or "ping-pong case" or the like.

[0172] The event of "ping-pong(s) in subsequent cell switch procedures" may be defined as follows:

- A UE performs an LTM cell switch from a cell (e.g. cell #1) to another cell (e.g. cell #2) successfully, but within a predefined limited time, the UE is switched back to cell #1, or the UE performs LTM cell switch from cell #2 back to cell #1 successfully. In some cases, cell #1 may be a source cell of the UE, and cell #2 may be a target cell of the UE.
- A ping-pong event may occur more than once after an RRC reconfiguration message (e.g. which includes the LTM candidate cell configuration(s) of one or more LTM candidate

cells) for LTM is received by the UE. A ping-pong event may be named as a ping-pong case or the like.

[0173] The event of "ping-pong(s) in subsequent MCG LTM/LTM PCell switch procedures" may be defined as follows:

- A UE performs an LTM PCell switch from a PCell (e.g. cell #a) to another PCell (e.g. cell #b) successfully, but within a predefined limited time, the UE is switched back to cell #a, or the UE performs LTM PCell switch from cell #b back to cell #a successfully. In some cases, cell #a may be a source PCell of the UE. Cell #b may be a target PCell of the UE.
- A ping-pong event may occur more than once after an RRC reconfiguration message (e.g. which includes the LTM candidate PCell configuration(s) of one or more LTM candidate PCells) for LTM is received by the UE. A ping-pong event may be named as a ping-pong case or the like.

[0174] In some other embodiments of the present disclosure, failure type definitions for an LTM cell switch may be defined as below (e.g. in case that an LTM failure recovery mechanism is applied upon an occurrence of a connection failure):

- (1) if the cell for LTM failure recovery is not one of at least one LTM candidate cell provided by a CU to at least one (candidate) target DU, it is wrong LTM candidate cell(s) selection at the CU (e.g. the CU is a node which generates an RRC reconfiguration message for an LTM procedure or which determines to initiate LTM configuration);
- (2) if the cell for LTM failure recovery is one of at least one LTM candidate cell provided by a CU to at least one (candidate) target DU, but not one of at least one LTM candidate cell selected by the at least one (candidate) target DU, it is wrong LTM candidate cell(s) selection at the at least one (candidate) target DU;
- (3) if the cell for LTM failure recovery is one of at least one LTM candidate cell selected by at least one (candidate) target DU (i.e. one of the LTM candidate cell(s) included in the RRC reconfiguration message for an LTM procedure), it is wrong LTM target cell decision at a source DU. For instance, an index of a target cell (e.g. "Target Configuration ID") included in an LTM cell switch command (e.g. a MAC CE) is wrong.

[0175] Figure 7 illustrates a flowchart of a method related to an LTM cell switch procedure in accordance with aspects of the present disclosure. The operations of the method may be implemented by a network node as described herein. In some implementations, the network node may be a CU of a BS, and may execute a set of instructions to control the function elements of the CU to perform the described functions. In some implementations, aspects of operations 702 and 704 may be performed by NE 400 as described with reference to Figure 4, CU as described with reference to Figure 5B, or CU #1 or CU #2 as described with reference to Figure 5C. Each of operations 702 and 704 may be performed in accordance with examples as described herein.

[0176] At operation 702, in response to an occurrence of a failure associated with an LTM cell switch procedure from a source cell to a target cell of a UE, or in response to an occurrence of a failure associated with an LTM PCell cell switch procedure from a source PCell to a target PCell of a UE, the method may include obtaining, by a CU of a BS, failure information related to the LTM cell switch procedure or the LTM PCell switch procedure. The failure includes an LTM execution failure and/or an RLF. The LTM execution failure is an LTM cell switch failure, in which the UE fails to perform an LTM cell switch from a source cell to a target cell, or the UE fails to perform an LTM PCell switch from a source PCell to a target PCell. The RLF may an RLF before LTM cell switch is triggered, or a shortly RLF after the successful LTM execution. The CU is a node which generates an RRC reconfiguration message for LTM procedure or which determines to initiate LTM configuration.

[0177] At operation 704, the method may include transmitting the failure information by the CU to at least one DU of the BS. The at least one DU includes at least one of the following:

- (1) A source DU which manages or controls the source cell.
- (2) A target DU which manages or controls the target cell. The target DU can be the same as or different from the source DU. For example, in an intra-DU mobility scenario, the target DU is the same as the source DU. In an inter-DU mobility scenario, the target DU is different from the source DU.
- (3) At least one candidate target DU configured for the LTM cell switch procedure or the LTM PCell switch procedure. The at least one candidate target DU is a node which manages

or controls one or more LTM candidate cells. The target DU belongs to the at least one candidate target DU. In other words, an LTM target cell is included in at least one LTM candidate cell. An LTM target cell is managed by the target DU. An LTM candidate cell is managed by a candidate target DU. In some examples, partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU. For example, in an intra-DU mobility scenario, all of the at least one candidate target DU are the same as the source DU. In an inter-DU mobility scenario, partial or all of the at least one candidate target DU can be different from the source DU.

[0178] In some implementations of the method described herein, the CU may determine a failure type of the failure, and transmit information indicating the failure type to the at least one DU.

[0179] In an implementation, the failure type includes at least one of the following:

- (1) A failure type (denoted as "failure type #1") which is defined as "Too Late LTM cell switch" or "Too Late LTM" or other name, wherein the UE has received configuration information for the LTM cell switch procedure or an RRC reconfiguration message for an LTM procedure is configured to the UE, but the failure occurs after the UE has stayed for a time period in the source cell; or the failure occurs before an LTM cell switch command for the LTM cell switch procedure is triggered to the UE; and the UE attempts to re-connect or re-establish a radio link connection in a cell other than the source cell. In case of dual connectivity scenario, "failure type #1" can be defined as "Too Late LTM PCell switch" or "Too Late MCG LTM" or "Too Late LTM for MCG" or other name, wherein the UE has received configuration information for the LTM PCell switch procedure or an RRC reconfiguration message for an LTM procedure is configured to the UE, but the failure occurs after the UE has stayed for a time period in the source PCell; or the failure occurs before an LTM cell switch command for the LTM PCell switch procedure is triggered to the UE; and the UE attempts to re-connect or re-establish a radio link connection in a cell other than the source PCell.
- (2) A failure type (denoted as "failure type #2") which is defined as "Too Early LTM cell switch" or "Too Early LTM" or other name, wherein the failure occurs shortly after a

successful completion of LTM cell switch from the source cell to the target cell or occurs during an LTM execution, and the UE attempts to re-connect or re-establish a radio link connection in the source cell. In case of dual connectivity scenario, "failure type #2" can be defined as "Too Early LTM PCell switch" or "Too Early LTM PCell switch" or "Too Early MCG LTM" or "Too Early LTM for MCG" or other name, wherein the failure occurs shortly after a successful completion of LTM PCell switch from the source PCell to the target PCell or occurs during an MCG LTM execution, and the UE attempts to re-connect or re-establish a radio link connection in the source PCell.

- (3) A failure type (denoted as "failure type #3") which is defined as "LTM cell switch to wrong cell" or "LTM to wrong cell" or other name, wherein the failure occurs shortly after the successful completion of the LTM cell switch from the source cell to the target cell or occurs during the LTM execution, and the UE attempts to re-connect or re-establish the radio link connection in the cell other than the source cell and the target cell. In case of dual connectivity scenario, "failure type #3" can be defined as "LTM PCell switch to wrong cell" or "LTM PCell switch to wrong cell" or "MCG LTM to wrong PCell" or "LTM for MCG to wrong cell" or other name, wherein the failure occurs shortly after the successful completion of the LTM PCell switch from the source PCell to the target PCell or occurs during the MCG LTM execution, and the UE attempts to re-connect or re-establish the radio link connection in the cell other than the source PCell and the target PCell. Specific examples are described in Embodiment 3-1 as follows.

[0180] In some implementations, the CU may determine that the failure is of failure type #1, if the CU does not receive an LTM cell change notification message from the source DU, but receives a UE RRC reestablishment request message or a UE RRC reconfiguration complete message from a cell other than the source cell.

[0181] In some other implementations, the CU may determine that the failure is of failure type #2, if the CU receives the LTM cell change notification message from the source DU, and receives the UE RRC reestablishment request message or the UE RRC reconfiguration complete message from the source cell.

[0182] In some additional implementations, the CU may determine that the failure is of failure type #3, if the CU receives the LTM cell change notification message from the source

DU, and receives the UE RRC reestablishment request message or the UE RRC reconfiguration complete message from a cell other than the source cell and the target cell.

[0183] In some implementations of the method described herein, the failure type of the failure associated with the LTM cell switch procedure or LTM PCell switch procedure may include at least one of the following (e.g. if a failure recovery mechanism is applied in response to the occurrence of the failure):

- (1) A failure type (denoted as "failure type #4") in which a cell selected for failure recovery is not one of a first set of LTM candidate cells provided by the CU to the at least one DU.
- (2) A failure type (denoted as "failure type #5") in which the cell selected for failure recovery is one of the first set of LTM candidate cells, but not one of a second set of LTM candidate cells selected by the at least one DU.
- (3) A failure type (denoted as "failure type #6") in which the cell selected for failure recovery is one of the second set of LTM candidate cells.

[0184] In some implementations, if the failure type is failure type #4, the CU may detect or determine that the first set of LTM candidate cells provided by the CU is improper. In some implementations, the failure type may be detected by the CU.

[0185] In some implementations, if the failure type is failure type #5, the processor is configured to cause the CU to: detect or determine that one or more wrong LTM candidate cells are selected by the at least one DU; and transmit, to the at least one DU, information (denoted as "information #1") indicating that the one or more wrong LTM candidate cells are selected by the at least one DU. In some implementations, the failure type may be detected by the CU.

[0186] In an implementation, the CU may receive one of the following from the at least one DU:

- (1) Information indicating that the CU made a right determination regarding information #1.
- (2) Information indicating that the CU made a wrong determination regarding information #1.

[0187] In some implementations, if the failure type is failure type #6, the CU may detect or determine that a wrong LTM target cell is selected by the source DU and transmit, to the source DU, information (denoted as "information #2") indicating that the wrong LTM target cell is selected by the source DU. In some implementations, the failure type may be detected by the CU.

[0188] In an implementation, the CU may receive one of the following from the source DU:

- (1) Information indicating that the CU made a right determination regarding information #2.
- (2) Information indicating that the CU made a wrong determination regarding information #2.

[0189] In some implementations of the method described herein, the CU may receive, from the at least one DU, information (denoted as "information #3") indicating that one or more wrong LTM candidate cells are selected by the at least one DU. Information #3 is determined by the at least one DU.

[0190] In some implementations of the method described herein, the CU may receive, from the source DU, information (denoted as "information #4") indicating that a wrong LTM target cell is selected by the source DU. Information #4 is determined by the source DU. Specific examples are described in Embodiment 3-2 as follows.

[0191] In an implementation, to obtain the failure information in operation 702, the CU may derive the failure information by itself or to receive the failure information. For instance, the UE stores or transmits the failure information to a third-party network node (i.e. a receiving node), and then, the third-party network node transfers the failure information to the CU. The failure information derived or received by the CU may include at least one of the following:

- (1) information regarding the source cell, e.g. including cell ID or L1/L3 measurement results of source cell, cell ID may include reference ID or index mapped with source cell, PCI and carrier frequency information (e.g. ARFCN), and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode);

- (2) information regarding a cell where the failure happens, e.g. including cell ID or L1/L3 measurement results of the cell, cell ID may include reference ID or index mapped with this cell, for example, if the cell is the LTM target cell, the cell ID may be reference ID or index mapped with the target cell e.g. which is indicated in LTM cell switch MAC CE (e.g. "Target Configuration ID" included in the MAC CE), or, cell ID may include PCI and carrier frequency information (e.g. ARFCN), and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode);
- (3) information regarding an LTM candidate cell selected for failure recovery, e.g. including cell ID or L1/L3 measurement results of the cell, cell ID may include reference ID or index mapped with the cell, PCI and carrier frequency information (e.g. ARFCN), and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode);
- (4) information regarding a selected beam in the target cell, e.g. TCI state;
- (5) information regarding one or more neighbour cells, e.g. including cell ID or L1/L3 measurement results of the one or more neighbour cells, cell ID may include reference ID or index mapped with the one or more neighbour cells, PCI and carrier frequency information (e.g. ARFCN), and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode);
- (6) information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate cell;
- (7) information indicating that the failure happens in the LTM cell switch procedure or the LTM PCell switch procedure, for example, an indication concerning that failure happens in an LTM cell switch procedure or connection failure due to LTM, e.g. to introduce a new type for last mobility type e.g. LTM cell switch; or an explicit indication of the type of LTM cell switch; or a new one-bit flag indicating whether the last executed mobility before the connection failure was an LTM cell switch;
- (8) information regarding at least one LTM candidate cell configured for the LTM cell switch procedure or the LTM PCell switch procedure;
- (9) cell configuration information for the at least one LTM candidate cell, wherein each cell configuration information of one LTM candidate cell is used to configure an LTM

candidate cell, e.g. which is represented by IE LTM-Candidate-r18 configured in the RRC Reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells, for example, the cell configuration information at least includes LTM-CandidateId, delta configuration which is on top of the reference configuration, configuration for early UL-Sync, ltm-NoResetID, TCI-States of LTM candidate cell and etc;

- (10) a set of channel state information (CSI) resources for the LTM cell switch procedure or the LTM PCell switch procedure, e.g. which is represented by IE LTM-CSI-ResourceConfig configured in the RRC Reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells;
- (11) a reference configuration for the LTM cell switch procedure or the LTM PCell switch procedure, e.g. which is represented by IE ltm-ReferenceConfiguration-r18 configured in the RRC Reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells;
- (12) time elapsed between reception of an LTM cell switch command and reception of a latest RRC reconfiguration message for the LTM cell switch procedure or the LTM PCell switch procedure;
- (13) time elapsed between the reception of the LTM cell switch command and the occurrence of the failure; or
- (14) time elapsed between the occurrence of the failure and the failure information is transmitted by the UE. Specific examples are described in Embodiment 2 as follows.

[0192] In some implementations of the method described herein, the CU may receive information (denoted as "information #5") from the at least one DU. Information #5 is related to the LTM cell switch procedure or the LTM PCell switch procedure, or related to UE context, or related to a set of parameters or configurations used by the UE or a group of UEs involved in the LTM cell switch procedure or the LTM PCell switch procedure. Information #5 may be named as "a reference," "LTM configuration information" or "mobility information" or "LTM information" or the like.

[0193] In some implementations, if information #5 is generated by the source DU, information #5 is received via one of the following:

- (1) a UE context modification response message;
- (2) a UL RRC message transfer message; or
- (3) an LTM cell change notification message; and

[0194] In some other implementations, if information #5 is generated by the at least one candidate target DU, information #5 is received via one of the following:

- (1) a UE context setup response message;
- (2) a UE context modification response message; or
- (3) an access success message.

[0195] In some implementations of the method described herein, the CU may transmit information #5 back to the at least one DU (e.g. the source DU or the at least one candidate target DU). Specific examples are described in Embodiment 3-3 as follows.

[0196] In some implementations of the method described herein, the CU may detect whether a ping-pong event occurs. For the ping-pong event, after a successful completion of an LTM cell switch from a cell to another cell (e.g., from cell #m to cell #n), the UE is switched back to cell #m within a predefined time period or the UE successfully performs another LTM cell switch from cell #n back to cell #m. In some cases, cell #m may be a source cell of the UE, and cell #n may be a target cell of the UE.

[0197] In some implementations of the method described herein, the CU may detect that the ping-pong event occurs, based on at least one of the following:

- (1) UE history information stored by the CU;
- (2) UE history information received from the UE;
- (3) at least one LTM cell change notification message received by the CU; or
- (4) at least one access success message received by the CU.

[0198] In some implementations of the method described herein, the CU may transmit, to the at least one DU, information indicating an occurrence of the ping-pong event.

[0199] It should be noted that the method described in Figure 7 describes possible implementations, and that the operations and the steps may be rearranged or otherwise eliminated or modified and that other implementations are possible, without departing from the spirit and scope of the disclosure.

[0200] Figure 8 illustrates a flowchart of a method related to an LTM cell switch procedure in accordance with aspects of the present disclosure. The operations of the method may be implemented by a UE as described herein. In some implementations, the UE may execute a set of instructions to control the function elements of the UE to perform the described functions. In some implementations, aspects of operations 802 and 804 may be performed by UE 200, UE 101A, UE 101B, or UE 101C, as described with reference to Figures 2 and 5A-5C. Each of operations 802 and 804 may be performed in accordance with examples as described herein.

[0201] At operation 802, in response to an occurrence of a failure associated with an LTM cell switch procedure from a source cell to a target cell of a UE, or in response to an occurrence of a failure associated with an LTM PCell switch procedure from a source PCell to a target PCell of a UE, the method may include storing failure information related to the LTM cell switch procedure or the LTM PCell switch procedure by the UE, wherein the failure includes at least one of an LTM execution failure or an RLF.

[0202] At operation 804, the method may include transmitting the failure information by the UE. The failure information may include similar elements as those of the failure information (obtained in operation 702) as described in the embodiments of Figure 7. For example, the failure information may be transmitted by the UE to a third-party network node (i.e. a receiving node). Then, the third-party network node transfers the failure information to a CU of a BS which generates an RRC reconfiguration message for LTM procedure or which determines to initiate LTM configuration.

[0203] In some implementations, a failure type of the failure includes failure type #1, failure type #2, and/or failure type #3 as described in the embodiments of Figure 7.

[0204] In some implementations, a failure type of the failure includes failure type #4, failure type #5, and/or failure type #6 as described in the embodiments of Figure 7.

[0205] It should be noted that the method described in Figure 8 describes possible implementations, and that the operations and the steps may be rearranged or otherwise eliminated or modified and that other implementations are possible, without departing from the spirit and scope of the disclosure.

[0206] In accordance with some other aspects of the present disclosure, operations of a method related to an LTM cell switch procedure may be implemented by a DU of a BS as described herein. In some implementations, the DU may execute a set of instructions to control the function elements of the DU to perform the described functions.

[0207] In particular, in some implementations, the method may include receiving failure information related to an LTM cell switch procedure or an LTM PCell switch procedure by a DU of a BS from a CU of the BS, wherein a failure happens in the LTM cell switch procedure or the LTM PCell switch procedure. The failure includes at least one of an LTM execution failure or an RLF. The CU may be a node which generates an RRC reconfiguration message for LTM procedure or which determines to initiate LTM configuration. The DU may be source DU or target DU or at least one candidate target DU that is relevant to the CU. In some embodiments, the target DU can be same as or different from the source DU, and partial or all of the at least one candidate target DU can be same as or different from the source DU. In some embodiments, the source DU can be configured as a candidate target DU. In an implementation, the failure information is derived by the CU itself or received by the CU. The failure information may include similar elements as those of the failure information (obtained in operation 702) as described in the embodiments of Figure 7.

[0208] In some implementations of the method described herein, the DU may receive information indicating a failure type of the failure from the CU.

[0209] In some implementations, the failure type of the failure includes failure type #1, failure type #2, and/or failure type #3 as described in the embodiments of Figure 7.

[0210] In some other implementations, the failure type of the failure includes failure type #4, failure type #5, and/or failure type #6 as described in the embodiments of Figure 7.

[0211] In an implementation, if the failure type is failure type #5, the DU may receive, from the CU, information (i.e., information #1) indicating that one or more wrong LTM candidate cells are selected by the DU. In some embodiments, the DU may verify whether the one or more wrong LTM candidate cells are selected by the DU. For instance, the DU may transmit at least one of the following to the CU:

- (1) Information indicating that the CU made a right determination regarding information #1.
- (2) Information indicating that the CU made a wrong determination regarding information #1.

[0212] In another implementation, if the failure type is failure type #6, the DU may receive, from the CU, information (i.e., information #2) indicating that a wrong LTM target cell is selected by the DU. For example, the DU may be a source DU which manages or controls the source cell. In some embodiments, the DU may verify whether the wrong LTM target cell is selected by the DU. For instance, the DU may transmit at least one of the following to the CU:

- (1) Information indicating that the CU made a right determination regarding information #2.
- (2) Information indicating that the CU made a wrong determination regarding information #2.

[0213] In some implementations, the DU may determine whether one or more wrong LTM candidate cells are selected by the DU. If the one or more wrong LTM candidate cells are selected by the DU, the DU may transmit, to the CU, information (i.e., information #3) indicating that the one or more wrong LTM candidate cells are selected by the DU.

[0214] In some implementations, the DU may determine whether a wrong LTM target cell is selected by the DU. If the wrong LTM target cell is selected by the DU, the DU may transmit, to the CU, information (i.e., information #4) indicating that the wrong LTM target cell is selected by the DU.

[0215] In some implementations of the method described herein, the DU may generate information (i.e., information #5) and transmit information #5 to the CU. Information #5 is related to the LTM cell switch procedure or the LTM PCell switch procedure, or related to UE context, or related to a set of parameters or configurations used by the UE or a group of

UEs involved in the LTM cell switch procedure or the LTM PCell switch procedure. Information #5 may be transmitted via one of the following:

- (1) a UE context modification response message;
- (2) a UL RRC message transfer message;
- (3) an LTM cell change notification message;
- (4) a UE context setup response message; or
- (5) an access success message.

[0216] In some implementations of the method described herein, the DU may receive information #5 from the CU.

[0217] In some implementations of the method described herein, the DU may receive, from the CU, information indicating an occurrence of a ping-pong event as described above. In some implementations, the occurrence of the ping-pong event may be detected based on at least one of the following:

- (1) UE history information stored by the CU;
- (2) UE history information received from the UE;
- (3) at least one LTM cell change notification message received by the CU; or
- (4) at least one access success message received by the CU.

[0218] The following text describes specific embodiments of the flowcharts as shown and illustrated above, i.e., Embodiment 2 and Embodiment 3.

[0219] Embodiment 2 (details of LTM related failure information)

[0220] As described in Embodiments 1-1 to 1-4, in an LTM cell switch procedure (e.g. a cell change triggered by an LTM cell switch MAC CE) or in an MCG LTM procedure (e.g. a PCell change triggered by an LTM cell switch MAC CE), an LTM cell switch failure or an LTM execution failure or any connection failure (e.g. an RLF) may happen. For any connection failure, to enable the network to understand why the LTM procedure is not successfully performed, or to help the network know whether or how to modify the LTM related configuration (e.g. to optimize a set of LTM candidate cell(s), or RA resource related

information for an early TA acquisition or RACH-less LTM, or contention-free random access (CFRA) resource related information included in an LTM cell switch MAC CE), LTM specific information needs to be stored or reported by a UE, to enable distinguishing a failure in an LTM cell switch procedure or MCG LTM procedure from a failure in L3 mobility procedure. For example, a UE may store or report LTM related failure information in a failure report. The failure report may be an existing report (e.g. an RLF report) or in a newly introduced report (e.g. an LTM failure report).

[0221] The failure report or LTM related failure information stored or reported by the UE may include LTM specific information or LTM related failure information, e.g. including at least one of following:

- (1) Information of a source PCell or a source cell (e.g. a cell ID and/or L1/L3 measurement results). For example, a cell ID may include a reference ID or index which is mapped with a source cell, PCI+ carrier frequency information (e.g. ARFCN), and/or CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode).
- (2) Information of a failed PCell or a failed cell (e.g. a cell ID and/or L1/L3 measurement results). For example, a cell ID may include a reference ID or index which is mapped with this cell. For instance, if the failed cell is a target cell for LTM, the cell ID may be a reference ID or index mapped with the target cell e.g. which is indicated in an LTM cell switch MAC CE (e.g. "Target Configuration ID" included in the LTM cell switch MAC CE). Or, a cell ID may include PCI+ carrier frequency information (e.g. ARFCN), and/or CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode).
- (3) Information of LTM candidate cell(s) that the UE selected for LTM failure recovery (e.g. a cell ID and/or L1/L3 measurement results). For example, cell ID may include a reference ID or index which is mapped with the LTM candidate cell for failure recovery, PCI+ carrier frequency information (e.g. ARFCN), and/or CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode).
- (4) Information of selected beam in target PCell or target cell (e.g. CTI state of the target cell), if indicated in an LTM cell switch MAC CE.
- (5) Information of one or more neighbour cells (e.g. a cell ID of each neighbour cell, L1/L3 measurement results of each neighbour cell, and/or one flag to indicate whether a

measured neighbour cell included in the L1 or L3 measurement results is an LTM candidate cell).

- (6) An indication concerning that a failure happens in an LTM cell switch procedure or a connection failure due to LTM, e.g. introducing a new type for last mobility type (e.g. LTM cell switch); or an explicit indication of the type of LTM cell switch; or introduce a new one-bit flag (e.g. add an indicator in the failure report indicating whether the last executed mobility before the connection failure was an LTM cell switch).
- (7) A set of LTM candidate cell(s) (e.g. a list of cell ID(s) of LTM candidate cell(s)), for example, which are not included in the L1 or L3 measurement results.
- (8) A reference configuration for LTM, e.g. which is represented by information element (IE) ltm-ReferenceConfiguration-r18 configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells.
- (9) A set of LTM candidate cell configurations or cell configuration information for the at least one LTM candidate cell, each configuration is used to configure an LTM candidate cell, e.g. which is represented by IE LTM-Candidate-r18 configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells, for example, the configuration at least includes LTM-CandidateId, delta configuration which is on top of the reference configuration, configuration for early UL-Sync, ltm-NoResetID, TCI-States of LTM candidate cell and etc.
- (10) A group of one or more CSI resources for LTM candidate cell configuration(s), e.g. which is represented by IE LTM-CSI-ResourceConfig configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells.
- (11) Time elapsed between reception of an LTM cell switch MAC CE (or LTM execution towards target PCell or target cell is triggered) and the corresponding latest RRC reconfiguration message for LTM is received.

- (12) Time elapsed between reception of an LTM cell switch MAC CE (or LTM execution towards target PCell or target cell is triggered) and the connection failure.
- (13) Time elapsed between the connection failure and the stored information/report is reported.

[0222] In another solution, some information can be derived by a CU which determines to initiate LTM configuration, or which generates or sends an RRC reconfiguration message including the LTM candidate cell configurations of one or multiple LTM candidate cells, even though the UE does not report them to network. For example, the CU can derive at least one of the following by itself:

- (1) Information about whether a measured neighbour cell included in the UE reported L1 or L3 measurement results is an LTM candidate cell.
- (2) Information about whether failure happens in an LTM procedure or a connection failure due to LTM.
- (3) A set of LTM candidate cell(s).
- (4) A TA value for RACH-less LTM or derived in early RACH procedure for early TA acquisition.
- (5) The reference configuration for LTM, e.g. which is represented by IE ltm-ReferenceConfiguration-r18 configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells.
- (6) A set of LTM candidate cell configurations or cell configuration information for the at least one LTM candidate cell, each configuration is used to configure an LTM candidate cell, e.g. which is represented by IE LTM-Candidate-r18 configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells, for example, the configuration at least includes LTM-CandidateId, delta configuration which is on top of the reference configuration, configuration for early UL-Sync, ltm-NoResetID, TCI-States of LTM candidate cell and etc.

- (7) A group of one or more CSI resources for LTM candidate cell configuration(s), e.g. which is represented by IE LTM-CSI-ResourceConfig configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells.
- (8) Time elapsed between reception of an LTM cell switch MAC CE (or LTM execution towards target cell is triggered) and the corresponding latest RRC reconfiguration message for LTM is received, for example, CU can derive this time duration which is equal to the time between receiving the UL RRC MESSAGE TRANSFER message (including RRC Reconfiguration Complete), and receiving the latest LTM CELL CHANGE NOTIFICATION message.

[0223] In an LTM procedure (e.g. a cell switch or a PCell change triggered by an LTM cell switch MAC CE), when an RLF occurs before an LTM cell switch MAC CE is received, or when an LTM cell switch failure or an LTM execution failure happens (i.e., supervision timer T304 expiry), the receiving node (e.g. CU1 which receives a failure report or LTM related failure information from the UE) sends the failure report or LTM related failure information to the node where LTM cell switch is triggered (e.g. CU2 which generates or sends the RRC reconfiguration message for the LTM procedure to the UE or which determines to initiate LTM configuration), e.g. via Failure Indication message. CU2 may further send the failure report or LTM related failure information to source DU and/or at least one (candidate) target DU, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).

[0224] In an LTM procedure (e.g. a cell switch or a PCell change triggered by an LTM cell switch MAC CE), when an RLF occurs shortly after a successful LTM cell switch from a source cell to a target cell, the receiving node (e.g. CU1 which receives a failure report or LTM related failure information from the UE) sends the failure report or LTM related failure information to the last serving node (e.g. the last serving CU). For instance, in case of intra-CU LTM, the last serving CU is the node which determines to initiate LTM configuration. In case of inter-CU LTM, the last serving CU is the node which manages LTM target cell, the last serving CU and the node which determines to initiate LTM configuration are two different nodes.

[0225] Then, the last serving node sends the failure report or the LTM related failure information to the node which determines to initiate LTM configuration (e.g. CU2 which generates or sends the RRC reconfiguration message for the LTM procedure to the UE or determines to initiate LTM configuration, or which manages source cell), e.g. via Failure Indication message. CU2 may further send the failure report or the LTM related failure information to a target DU, and/or a source DU, and/or at least one (candidate) target DU except the target DU. The target DU may analyse the failure report or the LTM related failure information, and then send the analysis information to the source DU directly or via CU2.

[0226] In above, CU (e.g. CU2) may send the failure report or the LTM related failure information to source DU and/or at least one (candidate) target DU, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other). For example, the failure report or the LTM related failure information may include at least one of below (the below information may be reported by the UE or derived by CU2 itself):

- (1) information of a source PCell or a source cell (e.g. a cell ID and/or L1/L3 measurement results);
- (2) information of a failed PCell or a failed cell (e.g. a cell ID and/or L1/L3 measurement results);
- (3) information of LTM candidate cell that the UE selected for LTM failure recovery (e.g. a cell ID and/or L1/L3 measurement results);
- (4) information of selected beam in target PCell or target cell (e.g. CTI state of the target cell), if indicated in an LTM cell switch MAC CE;
- (5) information of one or more neighbour cells (e.g. a cell ID of each neighbour cell, L1/L3 measurement results of each neighbour cell, and/or one flag to indicate whether a measured neighbour cell included in the L1 or L3 measurement results is an LTM candidate cell);
- (6) an indication concerning that a failure happens in an LTM procedure or a connection failure due to LTM, e.g. introducing a new type for last mobility type (e.g. LTM cell switch); or an explicit indication of the type of LTM cell switch; or a new one-bit flag

- (e.g. transfer an indicator indicating whether the last executed mobility before the connection failure was an LTM cell switch);
- (7) a set of LTM candidate cell(s) (e.g. a list of cell ID(s) of LTM candidate cell(s)), for example, which are not included in the L1 or L3 measurement results;
 - (8) a reference configuration for LTM, e.g. which is represented by IE ltm-ReferenceConfiguration-r18 configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells;
 - (9) a set of LTM candidate cell configurations or cell configuration information for the at least one LTM candidate cell, each configuration is used to configure an LTM candidate cell, e.g. which is represented by IE LTM-Candidate-r18 configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells, for example, the configuration at least includes LTM-CandidateId, delta configuration which is on top of the reference configuration, configuration for early UL-Sync, ltm-NoResetID, TCI-States of LTM candidate cell and etc.;
 - (10) a group of one or more CSI resources for LTM candidate cell configuration(s), e.g. which is represented by IE LTM-CSI-ResourceConfig configured in the RRC reconfiguration message to the UE including the LTM candidate cell configurations of one or multiple LTM candidate cells;
 - (11) time elapsed between reception of an LTM cell switch MAC CE (or LTM execution towards target PCell or target cell is triggered) and the corresponding latest RRC reconfiguration message for LTM is received;
 - (12) time elapsed between reception of an LTM cell switch MAC CE (or LTM execution towards target PCell or target cell is triggered) and the connection failure; or
 - (13) time elapsed between the connection failure and the stored information/report is reported.

[0227] Embodiment 3 (MRO detection or analysis at network side)

[0228] Embodiment 3 provide solutions about how a network performs an MRO detection or analysis for an LTM procedure.

[0229] Embodiment 3-1 (mechanism for failure detection or analysis)

[0230] The detailed detection mechanism for Too Late LTM cell switch, or Too Early LTM cell switch, or LTM cell switch to wrong cell may be carried out in a node that served a UE in an LTM procedure before the reported connection failure (e.g. a CU which generates an RRC reconfiguration message for an LTM procedure or which determines to initiate LTM configuration):

(1) Too Late LTM cell switch ("Too Late LTM cell switch" can also be named as "Too Late LTM" or "Too Late LTM PCell switch" or "Too Late MCG LTM" or "Too Late LTM for MCG" or other):

- a) there is no recent LTM cell switch for a UE prior to a connection failure, or none LTM cell switch MAC CE is transmitted to the UE prior to the connection failure, or an RLF occurs before an LTM cell switch MAC CE is initiated or triggered to the UE; or
- b) configuration information for an LTM procedure or an RRC reconfiguration message for an LTM procedure is configured, but an RLF occurs after the UE has stayed for a long time period in the serving cell or an LTM execution (e.g. an LTM cell switch from a source cell to a target cell) is not initiated for the UE prior to the connection failure; or
- c) configuration information for an LTM procedure or an RRC reconfiguration message for an LTM procedure is configured, but an LTM cell switch MAC CE is not received by the UE prior to the connection failure,
- d) in above description a) or b) or c) for Too Late LTM cell switch, the UE reported timer is absent or larger than the configured threshold (e.g. Tstore_UE_cntxt).

(2) Too Early LTM cell switch: there is a recent LTM cell switch for a UE prior to a connection failure, the first re-establishment attempt cell or the successful re-connect cell is the cell that served the UE at the last initialisation of LTM cell switch. In some examples, for Too Early LTM cell switch, the UE reported timer is smaller than the

configured threshold (e.g. Tstore_UE_cntxt). "Too Early LTM cell switch" can also be named as "Too Early LTM" or "Too Early LTM PCell switch" or "Too Early MCG LTM" or "Too Early LTM for MCG" or other.

- (3) LTM cell switch to wrong Cell: there is a recent LTM cell switch for a UE prior to a connection failure, the firstly re-establishment attempt cell or the cell UE attempts to re-connect or the cell UE selects for LTM failure recovery is neither "the cell that served the UE at the last initialisation of LTM cell switch" nor "the cell that served the UE where the RLF happened or the cell that the LTM execution was initialized toward". In some examples, for LTM cell switch to wrong Cell, the UE reported timer is smaller than the configured threshold (e.g. Tstore_UE_cntxt). "LTM cell switch to wrong cell" can also be named as "LTM to wrong cell" or "LTM PCell switch to wrong cell" or "MCG LTM to wrong PCell" or "LTM for MCG to wrong cell" or other.

[0231] In some cases, Too Late LTM cell switch means that, if a CU (e.g. which served a UE at the last initialisation of LTM procedure or which determines to initiate LTM configuration) does not receive an LTM CELL CHANGE NOTIFICATION message from a source DU (e.g. which served the UE at the last initialisation of LTM procedure), but receives a UE RRC Re-establishment Request message or a UE RRC Reconfiguration Complete message from another cell, the CU detects or determines that the connection failure is Too Late LTM cell switch.

[0232] In some cases, Too Early LTM cell switch means that, if a CU (e.g. which served a UE at the last initialisation of LTM procedure or which generates or sends the RRC reconfiguration message for the LTM procedure to the UE or which determines to initiate LTM configuration) receives an LTM CELL CHANGE NOTIFICATION message from a source DU (e.g. which sends or triggers an LTM cell switch MAC CE to the UE, e.g. including the index of target cell and the selected beam information), and receives a UE RRC Re-establishment Request message or a UE RRC Reconfiguration Complete message from the source cell (e.g. which served the UE at the last initialisation of an LTM procedure), the CU detects or determines that the connection failure is Too Early LTM cell switch.

[0233] In some cases, LTM cell switch to wrong Cell means that, if a CU (e.g. which served a UE at the last initialisation of LTM procedure or which generates or sends the RRC

reconfiguration message for the LTM procedure to the UE or which determines to initiate LTM configuration) receives an LTM CELL CHANGE NOTIFICATION message from a source DU (e.g. which sends or triggers an LTM cell switch MAC CE to the UE, e.g. including the index of target cell and the selected beam information), and receives a UE RRC Re-establishment Request message or a UE RRC Reconfiguration Complete message from a cell other than the source cell and the target cell, the CU detects or determines that the connection failure is LTM cell switch to wrong Cell.

[0234] As mentioned above, Too Late LTM cell switch, or Too Early LTM cell switch, or LTM cell switch to wrong Cell may be detected by a CU (e.g. which served a UE at the last initialisation of LTM procedure or which generates or sends an RRC reconfiguration message for the LTM procedure to the UE or which determines to initiate LTM configuration). The CU may indicate a failure type of Too Late LTM cell switch, or Too Early LTM cell switch, or LTM cell switch to wrong Cell to the corresponding DU (e.g. a source DU, or a target DU, or at least one (candidate) target DU except the target DU), via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).

[0235] For ping-pong event as described in Embodiment 1-4, e.g. the UE performs an LTM cell switch from a cell (e.g. cell #1) to another cell (e.g. cell #2) successfully, but within a predefined limited time, the UE is switched back to cell #1, or the UE performs LTM cell switch from cell #2 back to cell #1 successfully, statistical information regarding ping-pong occurrences in subsequent LTM cell switch procedures or subsequent LTM PCell switch procedures may be collected by a CU. The CU is a node which triggers LTM procedure or which generates an RRC reconfiguration message for MCG LTM or LTM PCell switch or which determines to initiate LTM configuration, e.g. source node's CU or MN's CU. Ping-pong in subsequent MCG LTM or LTM cell switch procedures may be analysed by the CU, in following three options, i.e. Option #X, Option #Y, and Option #Z.

[0236] Option #X: based on UE History Information stored by the CU or based on UE History Information received from the UE. For example, based on the time duration of the UE staying in cell #1, or cell #2, or when back to cell #1, if within a predefined limited time the UE leaves cell #2 and then back to cell #1, or if the UE stays in cell #2 for a short

predefined time, the CU detects it as a ping-pong event, i.e., the CU detects that a ping-pong event occurs.

[0237] Option #Y: based on the received LTM CELL CHANGE NOTIFICATION message(s), e.g. based on the time duration between receiving two LTM CELL CHANGE NOTIFICATION messages for a same cell (e.g. a cell where the UE was back to, e.g. cell #1). For example, the received LTM CELL CHANGE NOTIFICATION message indicates the initiation of an LTM cell switch MAC CE to a UE, based on the time duration between receiving the LTM CELL CHANGE NOTIFICATION message for cell #1 and receiving the LTM CELL CHANGE NOTIFICATION message for cell #2, and/or based on the time duration between receiving the LTM CELL CHANGE NOTIFICATION message for cell #2 and receiving the LTM CELL CHANGE NOTIFICATION message for back to cell #1, if within a predefined limited time the UE is switched back to cell #1, or if the UE stays in cell #2 for a short predefined time and leaves cell #2 and then back to cell #1 (e.g. the time duration of the UE staying in cell #2 equals to the time between receiving the ACCESS SUCCESS message for cell #2, and receiving the LTM CELL CHANGE NOTIFICATION message for switching back to cell #1), the CU detects it as a ping-pong event.

[0238] Option #Z: based on received ACCESS SUCCESS message, e.g. based on the time duration between receiving two ACCESS SUCCESS messages for a same cell (e.g. a cell where the UE was back to, e.g. cell #1). The received ACCESS SUCCESS message indicates the success of the LTM execution including the target cell ID, based on the time duration between receiving the ACCESS SUCCESS message for cell #1 and receiving the ACCESS SUCCESS message for cell #2, and/or based on the time duration between receiving the ACCESS SUCCESS message for cell #2 and receiving the ACCESS SUCCESS message for back to cell #1, if within a predefined limited time the UE is switched back to cell #1 successfully, or if the UE stays in cell #2 for a short predefined time and leaves cell #2 and then back to cell #1 successfully, the CU detects it as a ping-pong event.

[0239] In some embodiments, the CU may indicate an occurrence of potential ping-pong event to the corresponding DU. For example, the corresponding DU may be a source DU, or a target DU, or at least one (candidate) target DU except the target DU that is relevant to the CU. For instance, the corresponding DU is DU(s) where ping-pong occurs, e.g. the DU which manages cell #1, or the DU which manages cell #2.

[0240] Embodiment 3-2 (F1 interface signalling)

[0241] In Embodiment 3-2, in case that an LTM execution failure or an RLF happens, a CU (e.g. which served a UE at the last initialisation of LTM procedure or which generates or sends an RRC reconfiguration message for the LTM procedure to the UE or which determines to initiate LTM configuration) performs an MRO detection or failure analysis.

[0242] For example, in one solution, the CU may detect whether it is improper LTM candidate cell(s) provided by the CU, one or more wrong LTM candidate cells selected by (candidate) target DU(s), or a wrong LTM target cell selected at a source DU. Then, the CU may indicate the detected problem to the corresponding DU (e.g. (candidate) target DU(s) or a source DU). Optionally, the corresponding DU may further verify whether the problem detected by the CU is correct. In Embodiment 3-2, one (candidate) target DU can be same as or different from the source DU. In Embodiment 3-2, the source DU can be configured as a (candidate) target DU.

[0243] In another solution, the CU may forward LTM related failure information to the corresponding DU (e.g. (candidate) target DU(s) or a source DU), and the corresponding DU detects the problem. Optionally, the corresponding DU may indicate the detected problem to the CU. In Embodiment 3-2, one (candidate) target DU can be same as or different from the source DU. In Embodiment 3-2, the source DU can be configured as a (candidate) target DU.

[0244] The detailed mechanism of Embodiment 3-2 is given in following cases, i.e. Case #A, Case #B, Case #C:

[0245] Case #A: if the cell for LTM failure recovery (e.g. the information of this cell that a UE selected for LTM failure recovery may be included in the failure report or the UE reported LTM related failure information) is not contained in at least one LTM candidate cell provided by a CU to at least one (candidate) target DU, the CU detects that the at least one LTM candidate cell provided by CU are improper. Then, the CU may modify the at least one LTM candidate cell or the set of candidate cell(s) for LTM provided by the CU. Optionally, the CU may indicate to the at least one (candidate) target DU or source DU that the at least one LTM candidate cell provided by CU are improper, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).

[0246] Case #B: if the cell for LTM failure recovery is contained in at least one LTM candidate cell provided by a CU to a (candidate) target DU, but not contained in at least one LTM candidate cell selected or prepared by the (candidate) target DU (i.e. the (candidate) target DU is anyone of the at least one (candidate) target DU), there may be following two options in different embodiments, i.e. Option #1 and Option #2.

[0247] Option #1: a CU detects that it is wrong LTM candidate cell(s) selection or preparation at the (candidate) target DU. In Option #1, the CU may indicate to the (candidate) target DU that wrong LTM candidate cell(s) are selected or prepared by the (candidate) target DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other). For example, one indication concerning that wrong LTM candidate cell(s) are selected or prepared may be included in the new introduced F1 message or the existing F1 message.

[0248] In Option #1, optionally, the CU may forward a failure report or LTM related failure information (e.g. including information as mentioned in Embodiment 2, such as the information of LTM candidate cell that a UE selected for LTM failure recovery, the at least one LTM candidate cell provided by the CU to the (candidate) target DU and etc.) to the (candidate) target DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).

[0249] Then, optionally, the (candidate) target DU may verify whether it is wrong LTM candidate cell(s) selected or prepared by the (candidate) target DU:

- (1) If yes, the (candidate) target DU may modify its selected or prepared one or more LTM candidate cells. Optionally, the (candidate) target DU may respond to the CU that wrong LTM candidate cell(s) are selected or prepared by the (candidate) target DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. GNB-DU CONFIGURATION UPDATE message or other). For example, one indication concerning that wrong LTM candidate cell(s) are selected or prepared by the (candidate) target DU may be included in the new introduced F1 message or the existing F1 message.
- (2) If no, optionally, the (candidate) target DU may respond to the CU that the CU made a wrong detection, i.e. it is not wrong LTM candidate cell(s) selection or preparation in the (candidate) target DU, e.g. via a new introduced F1 message or an existing F1 message

(e.g. GNB-DU CONFIGURATION UPDATE message or other). For example, one indication concerning that it is not wrong LTM candidate cell(s) selection or preparation in the (candidate) target DU may be included in the new introduced F1 message or the existing F1 message.

[0250] Option #2: a CU may forward a failure report or LTM related failure information (e.g. including information as mentioned in Embodiment 2, such as the information of LTM candidate cell that a UE selected for LTM failure recovery, the at least one LTM candidate cell provided by the CU to the (candidate) target DU and etc.) to the (candidate) target DU, e.g. a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other). The (candidate) target DU may detect that one or more wrong LTM candidate cells are selected or prepared at the (candidate) target DU (e.g. based on the information of cell for LTM failure recovery, the at least one LTM candidate cell provided by CU to the (candidate) target DU, and the at least one LTM candidate cell selected or prepared by the (candidate) target DU). Then, the (candidate) target DU may modify its selected or prepared one or more LTM candidate cells. Optionally, the (candidate) target DU may indicate to the CU that wrong LTM candidate cell(s) are selected or prepared by the (candidate) target DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. GNB-DU CONFIGURATION UPDATE message or other). For example, one indication concerning that wrong LTM candidate cell(s) are selected or prepared may be included in the new introduced F1 message or the existing F1 message.

[0251] Case #C: if the cell for LTM failure recovery is contained in at least one LTM candidate cell selected or prepared by the (candidate) target DU (i.e. the (candidate) target DU is anyone of the at least one (candidate) target DU), there may be following two options, i.e. Option #A and Option #B.

[0252] Option #A: a CU detects that it is wrong LTM target cell selection or decision at a source DU (e.g. a reference ID of target cell i.e. "Target Configuration ID" included in an LTM Command MAC CE is wrong). In Option #A, the CU may indicate to the source DU that the source DU configures or indicates a wrong LTM target cell to a UE, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other). For example, one indication concerning that a wrong LTM target cell is

selected or decided at the source DU may be included in the new introduced F1 message or the existing F1 message.

[0253] In Option #A, optionally, CU may forward failure report or LTM related failure information (e.g. including information as mentioned in Embodiment 2, such as the information of LTM candidate cell that the UE selected for LTM failure recovery, the at least one LTM candidate cell provided by CU to the (candidate) target DU, the at least one LTM candidate cell selected or prepared by the (candidate) target DU, and etc.) to the source DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).

[0254] Then, optionally, the source DU may further verify whether it is wrong LTM target cell selection/decision at source DU:

- (1) If yes, the source DU may modify the target cell for LTM. Optionally, the source DU may respond to the CU that a wrong LTM target cell is selected or decided by the source DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. GNB-DU CONFIGURATION UPDATE message or other). For example, one indication concerning that a wrong LTM target cell is selected or decided by the source DU may be included in the new introduced F1 message or the existing F1 message.
- (2) If no, optionally, the source DU may respond to the CU that the CU made a wrong detection, i.e. it is not wrong LTM target cell selection or decision at the source DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. GNB-DU CONFIGURATION UPDATE message or other). For example, one indication concerning that it is not wrong LTM target cell is selected or decision at the source DU may be included in the new introduced F1 message or the existing F1 message.

[0255] Option #B: CU may forward failure report or LTM related failure information (e.g. including information as mentioned in Embodiment 2, such as the information of LTM candidate cell that the UE selected for LTM failure recovery, the at least one LTM candidate cell provided by CU to the (candidate) target DU, the at least one LTM candidate cell selected or prepared by the (candidate) target DU, and etc.) to source DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other), and the source DU detects it is wrong LTM target cell selection/decision at source DU (e.g.

reference ID of target cell i.e. "Target Configuration ID" included in the LTM cell switch MAC CE is wrong) (e.g. based on the information of cell for LTM failure recovery, and the at least one LTM candidate cell selected or prepared by the (candidate) target DU). Then, the source DU may modify the target cell for LTM. Optionally, the source DU may indicate the CU that wrong LTM target cell is selected or decided by the source DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. GNB-DU CONFIGURATION UPDATE message or other). For example, one indication concerning wrong LTM target cell is selected or decided may be included in the new introduced F1 message or the existing F1 message.

[0256] Embodiment 3-3 (UE context identification)

[0257] When a source DU or a (candidate) target DU receives a failure report or LTM related failure information from a CU (e.g. which served the UE at the last initialisation of LTM procedure or which generates or sends the RRC reconfiguration message for the LTM procedure to the UE or which determines to initiate LTM configuration), the UE context (e.g. information related to a UE, for example, UE related configuration of interest, or mobility strategies) may be released. Embodiment 3-3 gives the solutions about how to enable the source DU or the (candidate) target DU to retrieve the UE context. In Embodiment 3-3, one (candidate) target DU can be same as or different from the source DU. In Embodiment 3-3, the source DU can be configured as a (candidate) target DU.

[0258] In order to identify the UE context in the source DU or the (candidate) target DU when a failure report or LTM related failure information is received from the CU (e.g. which served the UE at the last initialisation of LTM procedure or which generates or sends the RRC reconfiguration message for the LTM procedure to the UE or which determines to initiate LTM configuration), there may be following solutions:

- (1) The source DU may create a reference related to the UE context, or a configuration or a set of parameters used by one UE or a group of UEs involved in an LTM procedure. For example, via source DU implementation, the reference can be called as "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other name. Then, the source DU may send this reference (which may be represented by "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other

name) to the CU, e.g. via UE Context Modification Response message or UL RRC Message Transfer message or LTM Cell Change Notification message or other.

- (2) The (candidate) target DU may create a reference related to the UE context, or a configuration or a set of parameters used by one UE or a group of UEs involved in an LTM procedure. For example, via (candidate) target DU implementation, the reference can be called as "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other name. Then, the (candidate) target DU may send this reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) to a CU, e.g. via UE Context Setup Response message or UE Context Modification Response message or Access Success message or other.
- (3) The CU may store the reference (which may be represented by "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other name) if the reference is received from the source DU, and the CU may store the reference (which may be represented by "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other name) if the reference is received from at least one (candidate) target DU, respectively.
- (4) The CU may send the reference (which may be represented by "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other name) received from the source DU back to the source DU, when the CU sends the failure report or the LTM related failure information to the source DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).
- (5) The CU may send the reference (which may be represented by "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other name) received from the (candidate) target DU back to the (candidate) target DU, when the CU sends the failure report or the LTM related failure information to the (candidate) target DU, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).

[0259] Based on the reference (which may be represented by "LTM Configuration Information" or "Mobility Information" or "LTM Information" or other name), the source

DU or the (candidate) target DU can identify the UE context or understand the received failure report or LTM related failure information.

[0260] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

What is claimed:

1. A centralized unit (CU) of a base station (BS), comprising:
 - at least one memory; and
 - at least one processor coupled to the at least one memory and configured to cause the CU to:
 - in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of a user equipment (UE), obtain failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and
 - transmit the failure information to at least one distributed unit (DU) of the BS, wherein the at least one DU includes at least one of the following:
 - a source DU;
 - a target DU; or
 - at least one candidate target DU.
2. The CU of Claim 1, wherein the processor is configured to cause the CU to:
 - determine a failure type of the failure; and
 - transmit information indicating the failure type to the at least one DU.
3. The CU of Claim 2, wherein the failure type includes at least one of the following:
 - a first failure type which is defined as Too Late LTM cell switch, wherein the UE has received configuration information for the LTM cell switch procedure, but the failure occurs after the UE has stayed for a time period in the source cell or occurs before an LTM cell switch command for the LTM cell switch procedure is triggered to the UE, and the UE attempts to re-connect or re-establish a radio link connection in a cell other than the source cell;
 - a second failure type which is defined as Too Early LTM cell switch, wherein the failure occurs shortly after a successful completion of LTM cell switch from the source cell to the target cell or occurs during an LTM execution, and the UE attempts to re-connect or re-establish a radio link connection in the source cell; or
 - a third failure type which is defined as LTM cell switch to wrong cell, wherein the failure occurs shortly after the successful completion of the LTM cell switch from the source cell to

the target cell or occurs during the LTM execution, and the UE attempts to re-connect or re-establish the radio link connection in the cell other than the source cell and the target cell.

4. The CU of Claim 2, wherein if a failure recovery mechanism is applied in response to the occurrence of the failure, the failure type includes at least one of the following:

a fourth failure type in which a cell selected for failure recovery is not one of a first set of LTM candidate cells provided by the CU to the at least one DU;

a fifth failure type in which the cell selected for failure recovery is one of the first set of LTM candidate cells, but not one of a second set of LTM candidate cells selected by the at least one DU; or

a sixth failure type in which the cell selected for failure recovery is one of the second set of LTM candidate cells.

5. The CU of Claim 4, wherein if the failure type is the fourth failure type, the processor is configured to cause the CU to determine that the first set of LTM candidate cells provided by the CU is improper.

6. The CU of Claim 4, wherein if the failure type is the fifth failure type, the processor is configured to cause the CU to:

determine that one or more wrong LTM candidate cells are selected by the at least one DU; and

transmit, to the at least one DU, first information indicating that the one or more wrong LTM candidate cells are selected by the at least one DU.

7. The CU of Claim 6, wherein the processor is configured to cause the CU to receive one of the following from the at least one DU:

information indicating that the CU made a right determination regarding the first information; or

information indicating that the CU made a wrong determination regarding the first information.

8. The CU of Claim 4, wherein if the failure type is the sixth failure type, the processor is configured to cause the CU to:

determine that a wrong LTM target cell is selected by the source DU; and

transmit, to the source DU, second information indicating that the wrong LTM target cell is selected by the source DU.

9. The CU of Claim 8, wherein the processor is configured to cause the CU to receive one of the following from the source DU:

information indicating that the CU made a right determination regarding the second information; or

information indicating that the CU made a wrong determination regarding the second information.

10. The CU of Claim 1, wherein to obtain the failure information, the processor is configured to cause the CU to derive the failure information by itself or to receive the failure information which is stored or transmitted by the UE, and wherein the failure information includes at least one of the following:

information regarding the source cell;

information regarding a cell where the failure happens;

information regarding an LTM candidate cell selected for failure recovery;

information regarding a selected beam in the target cell;

information regarding one or more neighbour cells;

information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate cell;

information indicating that the failure happens in the LTM cell switch procedure;

information regarding at least one LTM candidate cell configured for the LTM cell switch procedure;

cell configuration information for the at least one LTM candidate cell;

a set of channel state information (CSI) resources for the LTM cell switch procedure;

a reference configuration for the LTM cell switch procedure;

time elapsed between reception of an LTM cell switch command and reception of a latest RRC reconfiguration message for the LTM cell switch procedure;

time elapsed between the reception of the LTM cell switch command and the occurrence of the failure; or

time elapsed between the occurrence of the failure and the failure information is transmitted by the UE.

11. The CU of Claim 1, wherein the processor is configured to cause the CU to receive fifth information from the at least one DU, and wherein the fifth information is related to the LTM cell switch procedure, or related to UE context, or related to a set of parameters or configurations used by the UE or a group of UEs involved in the LTM cell switch procedure.
12. The CU of Claim 11, wherein the processor is configured to cause the CU to transmit the fifth information back to the at least one DU.
13. The CU of Claim 1, wherein the processor is configured to cause the CU to detect whether a ping-pong event occurs, and wherein for the ping-pong event, after a successful completion of LTM cell switch from a first cell to a second cell, the UE is switched back to the first cell within a predefined time period or the UE successfully performs another LTM cell switch from the second cell back to the first cell.
14. The CU of Claim 13, wherein the processor is configured to cause the CU to transmit, to the at least one DU, information indicating an occurrence of the ping-pong event.
15. A distributed unit (DU) of a base station (BS), comprising:
 - at least one memory; and
 - at least one processor coupled to the at least one memory and configured to cause the DU to:
 - receive failure information related to a L1/L2-Triggered Mobility (LTM) cell switch procedure from a centralized unit (CU) of the BS,
 - wherein a failure happens in the LTM cell switch procedure, and the failure includes at least one of an LTM execution failure or a radio link failure (RLF).
16. The DU of Claim 15, wherein the processor is configured to cause the DU to:
 - determine whether one or more wrong LTM candidate cells are selected by the DU; and
 - if the one or more wrong LTM candidate cells are selected by the DU, transmit, to the CU, third information indicating that the one or more wrong LTM candidate cells are selected by the DU.
17. The DU of Claim 15, wherein the processor is configured to cause the DU to:

determine whether a wrong LTM target cell is selected by the DU; and
if the wrong LTM target cell is selected by the DU, transmit, to the CU, fourth information indicating that the wrong LTM target cell is selected by the DU.

18. A user equipment (UE), comprising:

at least one memory; and

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

in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of the UE, store failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and
transmit the failure information.

19. The UE of Claim 18, wherein the failure information includes at least one of the following:

information regarding the source cell;

information regarding a cell where the failure happens;

information regarding an LTM candidate cell selected for failure recovery;

information regarding a selected beam in the target cell;

information regarding one or more neighbour cells;

information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate cell;

information indicating that the failure happens in the LTM cell switch procedure;

information regarding at least one LTM candidate cell configured for the LTM cell switch procedure;

cell configuration information for the at least one LTM candidate cell;

a set of channel state information (CSI) resources for the LTM cell switch procedure;

a reference configuration for the LTM cell switch procedure;

time elapsed between reception of an LTM cell switch command and reception of a latest RRC reconfiguration message for the LTM cell switch procedure;

time elapsed between the reception of the LTM cell switch command and the occurrence of the failure; or

time elapsed between the occurrence of the failure and the failure information is transmitted by the UE.

20. A processor for wireless communication, comprising:

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

in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) cell switch procedure from a source cell to a target cell of a user equipment (UE), obtain failure information related to the LTM cell switch procedure, wherein the failure includes at least one of an LTM execution failure or a radio link failure (RLF); and

transmit the failure information to at least one distributed unit (DU) of the BS, wherein the at least one DU includes at least one of the following:

a source DU;

a target DU; or

at least one candidate target DU.